Remedial actions for an exceedance of the GWL Compliance Trigger Value will be considered in association with exceedances of any spring flow (SpWF) Control or Compliance Trigger Values (Section 3.7) or Ecology Control or Compliance Trigger Values (Section 3.9). They may include implementing additional monitoring and the provision of an alternative water supply to Moorside Farm or Soulsgrave Farm.

3.3 Groundwater Quality General Construction Activities

3.3.1 Groundwater Quality Assessment Procedure

Details of the groundwater quality monitoring locations and testing suites are presented in Section 2.4 of the Construction and Operation Ground and Surface Water Monitoring Scheme (Ref 1) and the locations are shown in Drawing 1433DevOR410.

Groundwater samples will be taken on a monthly basis and the results of laboratory testing will be available one week after sampling. The laboratory results will be compared with baseline data and the GWQ Control and Compliance Trigger Values to identify any exceedances.

Appendix 1.2 presents the procedure for assessing exceedances of groundwater quality (GWQ) Control and Compliance Trigger Values at the groundwater quality monitoring points, during the general construction activities undertaken as part of the Phase 11 Works. It presents a summary of the sequence of activities and respective timescales for each stage, for which details are provided below.

3.3.2 Consultation with Project Manager and Planning Remedial Actions

The recorded exceedance of any GWQ Control and Compliance Trigger Values and the findings of the construction works inspection will be evaluated by the Environmental Officer in consultation with the Project Manager to determine the cause of the exceedance and the appropriate course of remedial action to be taken.

A natural (non-site related) exceedance of the GWQ Control Trigger Values in the up hydraulic gradient boreholes may require an adjustment of the Control Trigger value, in line with the revised baseline conditions, as described in the Ground and Surface Water Management Scheme (Ref. 1), and records of any changes and reasons for those changes will be kept for any subsequent required review.

The remedial actions will be designed specific to the determinand that has been exceeded, the location where the exceedance was recorded, and the likely cause of this exceedance in either the GWQ Control or Compliance Trigger Values.

3.3.3 Implementing Remedial Actions

Where remedial actions are specified by the Environmental Officer, related to an exceedance in either the GWQ Control or Compliance Trigger Values, they will be advised to the Director of Operations, the Environment Manager and the Regulators (as detailed in Section 2.2), and implemented by the Project Manager.

Remedial actions for a exceedance of GWQ Control Trigger Values may include, but not be limited to; temporarily increasing monitoring frequency to weekly, remediation of spillage site and a change in site construction practices, as detailed in the Construction Environmental Management Plan (CEMP) to prevent future re-occurrence of construction related pollution.

Where the exceedance of the GWQ Compliance Trigger Value occurs down hydraulic gradient of the site, remedial actions may include modelling and installation of additional groundwater monitoring wells to evaluate the magnitude of impact at the site boundary and at the nearest down hydraulic gradient receptor. If the results of that modelling and additional monitoring show that an adverse impact is occurring in exceedance of the Compliance Trigger Value at the groundwater receptor, then groundwater remediation of the pollution source will be considered.

3.4 Groundwater Quality Associated with Bund F

3.4.1 Groundwater Quality Assessment Procedure

Details of the groundwater quality monitoring locations and testing suites are presented in Section 2.4 of the Construction and Operation Ground and Surface Water Monitoring Scheme (Ref 1) and the locations are shown in Drawing 1433DevOR410.

Groundwater samples will be taken on a monthly basis and the results of laboratory testing will be available one week after sampling. The laboratory results will be compared with baseline data and the GWQ Control and Compliance Trigger Values to identify any exceedances.

Appendix 1.2 presents the procedure for assessing exceedances of groundwater quality (GWQ) Control and Compliance Trigger Values at the groundwater quality monitoring points, during the earthworks to construct Bund F utilising the MTS shaft construction arisings. It presents a summary of the sequence of activities and respective timescales for each stage, for which details are provided below.

3.4.2 Consultation with Project Manager and Planning Remedial Actions

Consultation with the Project Manager and Planning of remedial actions will be undertaken as detailed in Section 3.3.3.

3.4.3 Implementing Remedial Actions

Remedial actions for an exceedance of GWQ Control Trigger Values may include, but not be limited to; temporarily increasing monitoring frequency to weekly, change in blast design and management practices, and temporarily recirculating water from the basal drainage system (Manholes BF-BD-100 and BF-BD-200) back onto the earthworks during Bund F construction.

Where exceedances of the GWQ Compliance Trigger Value occurs down hydraulic gradient of the site associated with the leachable content of the extractive materials placed in Bund F, remedial actions may include installing temporary seals to the basal drainage system at manholes BF-BD-100 and BF-BD-200 and commencing recirculation of the basal drainage water onto the exposed rockfill on Bund F, increasing the size of the attenuation facilities downstream on the perimeter swale, modelling and installation of additional groundwater monitoring wells

to evaluate the magnitude of impact at the site boundary and at the nearest down hydraulic gradient receptor. If the results of that modelling and additional monitoring show that an adverse impact is occurring in exceedance of the Compliance Trigger Value at the groundwater receptor, then measures to mitigate pollution will be considered.

3.5 Spring Water Flow Rates

3.5.1 Spring Water Flow Rate Assessment Procedures

Details of the spring water flow rate monitoring is presented in Section 2.5 of the Construction and Operation Ground and Surface Water Monitoring Scheme (Ref 1) and the locations are shown in Drawing 1433DevOR410.

The spring flowrate monitoring will be undertaken at Soulsgrave Farm Spring and Moorside Farm Spring at a weekly frequency and the results compared with baseline data, and the SpWF Control and Compliance Trigger Values.

Appendix 1.3 presents the procedure for assessing exceedances of spring flow (SpWF) Control and Compliance Trigger Values, during the Phase 11 Works. It presents a summary of the sequence of activities and respective timescales for each stage, for which details are provided below.

3.5.2 Consultation with Project Manager and Planning Remedial Actions

The recorded exceedance of either SpWF Control or Compliance Trigger Values will be evaluated by the Environmental Officer in consultation with the Project Manager to determine the cause of the exceedance and the appropriate course of remedial action that will be taken.

A exceedance of the SpWF Control or Compliance Trigger Values for Moorside Farm Spring and Soulsgrave Farm Spring will be assessed in conjunction with the rainfall data and groundwater level data for the preceding period, to ascertain whether the exceedance is due to natural conditions or as a result of the minesite development works.

An exceedance will be classed as either: -

- A natural (non-site related) exceedance of the SpWF Control / Compliance Trigger Value, caused by natural variations in rainfall (i.e. low rainfall).
- An exceedance of the SpWF Control / Compliance Trigger Value caused by the Phase 11 Works.

Where the exceedance is found to be natural, it will be recorded as such and no further remedial actions will be required.

The remedial actions will be designed specific to the degree of exceedance (i.e. physical change in flow rate), the location where the exceedance was recorded, and the likely cause of this exceedance.

3.5.3 Implementing Remedial Actions

Where remedial actions are specified by the Environmental Engineer, related to an exceedance in Trigger Values, they will be advised to the Director of Operations, the Environment Manager and the Regulators (as detailed in Section 2.2), and implemented by the Project Manager.

Remedial actions for a prolonged exceedance of the SpWF Compliance Trigger Values will be considered in association with exceedances of Environmental GWL Control or Compliance Trigger Values or Ecological Control or Compliance Trigger Values (Section 3.8). Such remedial actions may include provision of an alternative water supply to Moorside Farm or Soulsgrave Farm.

3.6 Spring Water Quality

3.6.1 Spring Water Quality Assessment Procedure

Details of the spring water quality monitoring locations and testing suites are presented in Section 2.5 of the Construction and Operation Ground and Surface Water Monitoring Scheme (Ref 1) and the locations are shown in Drawing 1433DevOR410.

The spring water quality monitoring of Moorside Farm Spring and Soulsgrave Farm Spring will be undertaken monthly during the works. The laboratory results will be compared with the baseline and SpWQ Control and Compliance Trigger Values.

Appendix 1.4 presents the procedure for assessing exceedances of spring water quality (SpWQ) Control and Compliance Trigger Values during the minesite development works. It presents a summary of the sequence of activities and respective timescales for each stage, for which details are provided below.

3.6.2 Consultation with Project Manager and Planning Remedial Actions

The recorded exceedance of any SpWQ Control and Compliance Trigger Values will be evaluated by the Environmental Officer in consultation with the Project Manager to determine the cause of the exceedance and the appropriate course of remedial action that will be taken.

An exceedance of the SpWQ Control and Compliance Trigger Value for Moorside Farm Spring and Soulsgrave Farm Spring will be assessed in conjunction with the rainfall data and groundwater quality data for the preceding period, to ascertain whether the exceedance is due to natural conditions or is as a result of the minesite development.

A natural (non-site related) exceedance of the Control Trigger Values in the spring water quality may require an adjustment of the SpWQ Control Trigger Value, in line with the revised baseline conditions.

The remedial actions will be designed specific to the exceedance was recorded and the likely cause.

3.6.3 Implementing Remedial Actions

Where remedial actions are specified by the Environmental Officer, they will be advised to the Director of Operations, the Environment Manager and the Regulators (as detailed in Section 2.2) and implemented by the Project Manager.

Remedial actions for an exceedance may include, but not be limited to, remediation of spillage site / pollution source and a change in site practices, detailed in the Construction Environmental Management Plan (CEMP), to prevent re-occurrence, future spillages / pollution.

Remedial actions for a prolonged exceedance of the SpWQ Compliance Trigger Value may include provision of an alternative water supply to Moorside Farm and remediation to the groundwater source supplying the spring.

3.7 Surface Water Quality and Geomorphology

3.7.1 Surface Water Quality and Geomorphology Assessment Procedures

Surface Water Quality

Details of the surface water quality monitoring locations, testing suites and SWQ Control and Compliance Trigger Values are presented in Section 2.6 of the Construction and Operation Ground and Surface Water Monitoring Scheme (Ref 1) and the locations are shown in Drawing 1433DevOR410.

The surface water drainage system will be inspected on a regular basis to ensure that it is in good working order. This will include, as appropriate, inspection of the swales, filter drains, the attenuation tank for the Materials Handling Area and its outfall to the perimeter swale, and associated catch pits, ponds, oil separators and silt fences. Any visible impact on the surface water courses will be identified and considered in conjunction with the field turbidity readings and their respective background concentrations, such as cloudy discharge due to suspended solids.

The monitoring will be assessed by consideration of the construction activities, as determined from a visual site inspection of the operations, and the meteorological conditions, to identify the cause of a specific exceedance.

Appendix 1.5 presents the procedure for assessing exceedances of surface water quality (SWQ) Control and Compliance Trigger Values during the Phase 11 Works. It presents a summary of the sequence of activities and respective timescales for each stage, for which details are provided below.

Geomorphology

Details of the geomorphological surveys to be undertaken are presented in Section 2.6 of the Construction and Operation Ground and Surface Water Monitoring Scheme (Ref 1) and the locations are shown in Drawing 1433DevOR410.

The construction phase monitoring will be assessed by comparison with the pre-commencement baseline geomorphological conditions to establish evidence of erosion, geotechnical failure, sediment accumulation, vegetation changes, and pollution/discolouration, for which remedial actions to mitigate these changes should be considered.

3.7.2 Consultation with Project Manager and Planning Remedial Actions

The recorded exceedance of the any SWQ Control and Compliance Trigger Values, changes in geomorphological conditions and the findings of the inspection will be evaluated by the Environmental Officer in consultation with the Project Manager to determine the cause of the exceedance and the appropriate course of remedial action that will be taken.

The remedial actions will be designed specific to the cause and form of the exceedance in terms of pollution, erosion, siltation or adverse impact where the exceedance has been recorded.

3.7.3 Implementing Remedial Actions

Where remedial actions are specified by the Environmental Officer, related to either a exceedance in SWQ Control or Compliance Trigger Values or to an adverse change in the stream's geomorphological conditions, they will be advised to the Director of Operations, the Environment Manager and the Regulators (as detailed in Section 2.2), and implemented by the Project Manager.

A natural (non-site related) exceedance of the SWQ Control Trigger Value may require an adjustment of the SWQ Control Trigger value, in line with the revised baseline conditions, as described in the Ground and Surface Water Management Scheme (Ref. 1).

Remedial actions for a exceedance of SWQ Control Trigger Values or due to an adverse change in the geomorphology of the stream may include, but not be limited to; maintenance or extension to swales, addition of check dams and silt fencing, clearance of filter drains and associated catch pits, implementation of silt fences, maintenance of ponds oil separators, management of unspent explosives and hydraulic fluids during MTS shaft construction, management of earthworks and surface water drainage during Bund F construction, management and attenuation of basal drainage discharge from Bund F into the surface water drainage system and temporarily closing off the discharge from the Materials Handling Area attenuation tank and treating this water in the NDWWTP.

Remedial actions for a exceedance of the Compliance Trigger Value or due to an adverse change in the geomorphology of the stream may include, but not be limited to, the above remedial actions, but may also include implementation of additional emergency surface water management measures including the use of additional hay/heather bales, environmentally friendly coagulant, silt busters and silt fences to reduce silt migration, the use of absorbent spill pads and booms to contain and absorb hydrocarbon contamination, installing temporary seals to the basal drainage system at manholes BF-BD-100 and BF-BD-200 and commencing recirculation of the basal drainage water onto the exposed rockfill on Bund F, increasing the

size of the attenuation facilities downstream of the perimeter swale, and temporarily closing off the discharge from the Materials Handling Area attenuation tank and treating this water in the NDWWTP.

3.8 Ecology

3.8.1 Ecological Assessment Procedure

The following sections present the procedure that will be adopted for assessing exceedances of the Ecological Control Trigger Values (Ref. 1) during the Phase 11 Works. It presents a summary of the sequence of activities and respective timescales to assess the Ecological Trigger Values and to implement the remedial actions required.

3.8.2 Monitoring Appraisal

The objective of the ecological monitoring is to determine whether the Phase 11 Works are impacting on the flora in the shallow valley feature, south of Lousy Hill Lane, Ugglebarnby Moor. Any changes in the habitat or its diversity in this area will be compared to changes in the groundwater levels and spring flow rates monitored at Moorside Farm Spring to determine whether these changes in habitat conditions are related to hydrogeological changes.

A series of ten fixed monitoring locations for quadrat sampling will be monitored undertaken in August or September before and after this construction period for change in National Vegetation Classification (NVC), change in percentage cover of the key indicator species and colonisation by new species.

3.8.3 Consultation with Project Manager and Planning Remedial Actions

The recorded exceedance of any Ecological Control Trigger Values will be evaluated by the Environmental Officer in consultation with the Project Manager to determine the cause of the exceedance and the appropriate course of remedial action that will be taken.

An exceedance of the Ecology Control Trigger Values will be assessed in conjunction with the rainfall data, groundwater level and quality data and the spring flow rate and quality data for the preceding period, to ascertain whether the exceedance is due to natural conditions or as a result of the works at Woodsmith Mine.

The remedial actions will be designed to mitigate the specific Ecological Control Trigger Value that has been exceeded.

3.8.4 Implementing Remedial Actions

Where remedial actions are specified by the Environmental Engineer, related to an exceedance in Ecological Control Trigger Values, they will be advised to the Director of Operations, the Environment Manager and the Regulators (as detailed in Section 2.2), and implemented by the Project Manager.

Remedial actions may include replanting of specific vegetation.

4 REPORTING

All exceedances in Groundwater Level, Spring Flow and Surface Water Quality Control and Compliance Trigger Values or visually identified impacts observed and remedial actions implemented will be reported on a weekly basis during the Phase 11 Works and for one month thereafter by the Environmental Engineer. Exceedances in Ground Water and Spring Quality Control and Compliance Trigger Values and remedial actions implemented will be reported on a monthly basis during the Phase 11 Works and for one month thereafter by the Environmental Engineer.

That report will detail the exceedance that occurred, the weekly construction activities and meteorological conditions preceding the exceedance, the results of the site inspection/monitoring, the established cause of the exceedance in Trigger Values and the remedial action specified together with the timescale for it to be implemented.

Where Control or Compliance Trigger Value exceedances are identified associated with the Phase 11 Works, they will be advised to those identified in Section 2.2 within 48 hours of receipt of the laboratory results. Where visual evidence of adverse impacts associated with the Phase 11 Works are identified, the inspection report and remedial action specified will be issued to those identified in Section 2.2 within 24 hours, in respect to spring flows providing domestic water supplies and 48 hours of that exceedance for all other receptors.

On completion of the Remedial Action, a record of the measures implemented, and their effectiveness will be recorded and issued to the relevant parties. The Project Manager will provide a copy of the report to those identified in Section 2.2 to the timescales presented in Section 5.

5 TIMESCALES

A cumulative report detailing the assessment of monitoring and inspection results for groundwater level, spring flow and water quality, and surface water quality and geomorphology, recording any exceedances in Control and Compliance Trigger Values or visually identified impacts observed and remedial actions to be implemented will be compiled on an annual basis. The reports will be issued to the relevant regulators listed in Section 2.2 where a exceedance in Trigger Value or an impact is visually observed.

Control Trigger Value exceedances will be investigated within one week and the remedial action required implemented within two weeks of receipt of the monitoring results reporting the exceedance. Where a cloudy discharge or elevated turbidity readings exceed the Control Trigger Value, remedial action will be implemented within 48 hours.

Compliance Trigger Value exceedances for spring fed domestic water supplies will first be re-investigated within 24 hours of the exceedance. Subject to the findings of that monitoring, remedial action, in the form of providing a temporary tankered water supply, will be initiated within 24 hours of the exceedance and the requirement to introduce a long-term design solution initiated within one month.

Compliance Trigger Value exceedances for surface water will be investigated within 48 hours and the remedial action initiated within one week. Compliance Trigger Value exceedances for groundwater will be investigated within one week, and remedial action initiated within 1 month. Changes to site practices will be implemented within one week.

C MILLER
ASSOCIATE DIRECTOR

R IZATT-LOWRY
DIRECTOR

6 REFERENCES

1 FWS Consultants Ltd. 2019. Construction and Operation Ground and Surface Water Monitoring Scheme, Phase 11 Works at Woodsmith Mine, North Yorkshire (1433DevOR444).

2 FWS Consultants Ltd. 2019. Hydrogeological Risk Assessment (NYMNPA 45 & 46 – Phase 11) Phase 11 Works At Woodsmith Mine, North Yorkshire (1433DevOR433).

APPENDIX 1

APPENDIX 1.1 - PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE FOR GROUNDWATER LEVELS

APPENDIX 1.2 - PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE FOR GROUNDWATER QUALITY

APPENDIX 1.3 - PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE FOR SPRING FLOW RATE

APPENDIX 1.4 - PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE FOR SPRING WATER QUALITY

APPENDIX 1.5 - PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE FOR SURFACE WATER QUALITY AND GEOMORPHOLOGY

APPENDIX 1.1 – PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE OF GROUNDWATER LEVELS

ENVIRONMENTAL			
Procedure	**Responsibility**	**Control Trigger Value Exceedance**	**Compliance Trigger Value Exceedance**
		Groundwater Levels at BHs	**Groundwater Level at GW 133A (HG111A)**
Monitoring	Environmental Officer	A review of the construction activities, excavation, grouting and temporary dewatering on the minesite and the meteorological conditions, up to and during the period of exceedance. An assessment will be made to determine if the exceedance of ground water level Control Trigger Value is a caused by natural climatic variation due to seasonal low rainfall, the Phase 7 to 11 Works, or a non-site related cause.	
Consultation with Project Manager and Planning Remedial Actions	Environmental Engineer/ Project Manager	Evaluate findings of monitoring in conjunction with meteorological data, spring flow rates, groundwater levels in the superficial deposits and ecological monitoring, to determine the cause and effects of the change in baseline conditions. Where the cause is due to natural climatic conditions, record that this change in baseline conditions and accommodate for this change in the Control Trigger Value. Where the cause of the exceedance in Control Trigger Values is due to impacts of the Phase 7 to 11 works, design an appropriate course of remedial action, if required.	
Implementing Remedial Actions	Project Manager/ Environmental Manager/ Environmental Engineer	If the change in the groundwater level below the Control Trigger value has arisen from an adverse impact by the Phase 7 to 11 works, details of the Remedial Actions necessary to prevent continued adverse impact will be specified. Such measures may include installation of recharge trenches.	If the change in the groundwater level below the Compliance Trigger value has arisen from an adverse impact by the Phase 7 to11 works, details of the Remedial Actions necessary to prevent continued impact will be specified. Such measures may include installation of recharge trenches, the provision of an alternative water supply to Moorside Farm and / or Soulsgrave Farm.
Reporting	Environmental Engineer	Report to include details of exceedance, monitoring, and remedial actions.	Report to include details of exceedance, monitoring, and remedial actions.
Timescale		3 months to identify the cause and design and implement any remedial actions required.	6 months to identify the cause and design and implement any remedial actions required.

APPENDIX 1.2 – PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE OF GROUNDWATER QUALITY

GENERAL CONSTRUCTION INCLUDING SHAFT EXCAVATION AND LINING					
Procedure	**Responsibility**	**Control Trigger Value Exceedance**		**Compliance Trigger Value Exceedance**	
		Groundwater Quality at Up Hydraulic Gradient BHs	**Groundwater Quality at Down Hydraulic Gradient BHs**	**Groundwater Quality at Up Hydraulic Gradient BHs**	**Groundwater Quality at Down Hydraulic Gradient BHs**
Monitoring	Environmental Engineer	A review of the construction or potentially polluting activities up hydraulic gradient of the minesite will be undertaken to identify potential sources of contamination impacting on baseline groundwater quality.	A review of the construction, blasting and earthworks activities within the minesite catchment area will be undertaken considering the data up to and during the period of exceedance and of the meteorological conditions during the period of the exceedance. A visual inspection of the ongoing construction works will be carried out. Inspection of oil separators, drill and blast activities, placement of arisings in Bund F, inspection of manholes BF-BD-100 and BF-BD-200, inspection of shaft excavation works and associated plant will be undertaken. The visual inspection will include observations on evidence of salt, grout, hydraulic oils, greases, hydrocarbon spillages and residual unspent explosives within the blast arisings.	A review of activities up hydraulic gradient of the minesite will be undertaken to identify potential sources of contamination impacting on baseline groundwater quality.	A review of the construction, blasting and earthworks activities within the minesite catchment area will be undertaken considering the data up to and during the period of exceedance and of the meteorological conditions during the period of the exceedance. A visual inspection of the ongoing construction works will be carried out. Inspection of oil separators, drill and blast activities, placement of arisings in Bund F, inspection of manholes BF-BD-100 and BF-BD-200, inspection of shaft excavation works, and associated plant will be undertaken. The visual inspection will include observations on evidence of salt, grout, hydraulic oils, greases, hydrocarbon spillages and residual unspent explosives within the blast arisings. Assessment will be undertaken to identify whether exceedancees are associated with leaching of compounds from the extractive materials placed in Bund F.
Consultation with Project Manager and Planning Remedial Actions	Environmental Engineer/ Project Manager	Evaluate findings of monitoring to determine the cause of the change in baseline groundwater quality and design the appropriate course of remedial action, if required.	Evaluate findings of monitoring to determine the cause of the change in groundwater quality and design the appropriate course of remedial action, if required.	Evaluate findings of monitoring to determine the cause of the change in baseline groundwater quality and design the appropriate course of remedial action if required.	Evaluate findings of monitoring to determine the cause of the change in groundwater quality and design the appropriate course of remedial action if required.
Implementing Remedial Actions	Project Manager/ Environmental Manager/ Environmental Engineer	Continued monitoring of BHs to monitor plume movement through site. Consideration of up hydraulic gradient contamination in assessing down hydraulic gradient groundwater. Increase in monitoring frequency until levels return to baseline.	Remediation of site spillages. Maintenance clearance of filter drains to the shaft platform areas, maintenance of oil separator, maintenance of construction vehicles. Changes to the blast design and management to minimise unspent explosives within arisings placed in Bund F. Implement recirculation of groundwater drainage from manholes BF-BD-100 and BF-BD-200 back onto exposed fill on Bund F. Changes to working practices (CEMP).	Continued monitoring of BHs to monitor plume movement through site and installation of additional groundwater monitoring wells, where appropriate. Consideration of up hydraulic gradient contamination source in assessing down hydraulic gradient groundwater quality. Increase in monitoring	Maintenance clearance of filter drains to the shaft platform areas, maintenance of oil separator, maintenance of construction vehicles. Remediation of site spillages. Changes to working practices (CEMP). Changes to the blast design to minimise unspent explosives within arisings placed in Bund F. Installing temporary seals to the basal drainage system at manholes BF-BD-100 and BF-BD-200 and commencing recirculation of the basal drainage water onto the exposed rockfill on Bund F.

			Increase in monitoring frequency until levels return to baseline.	frequency until levels return to baseline.	Increasing the size of the attenuation facilities downstream on the perimeter swale. Modelling and installation of additional groundwater monitoring wells to demonstrate that there is no adverse impact occurring at the site boundary. If the results of that modelling or monitoring of additional boundary monitoring wells show that an impact on the groundwater is occurring, then remediation of the groundwater pollution will be considered. Increase in monitoring frequency until levels return to baseline.
Reporting	Environmental Engineer	Report to include details of exceedance, monitoring, and remedial actions.		Report to include details of exceedance, monitoring, and remedial actions.	
Timescale		1 week to identify the cause and design and implement any remedial actions required.		1 week to identify the cause, 1 week to implement changes determined necessary to site practices and 1 month to design and initiate implementation of any pollution clean-up remedial actions required.	

APPENDIX 1.3 - PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE FOR SPRING FLOW RATE

Procedure	Responsibility	Control Trigger Value Exceedance	Compliance Trigger Value Exceedance
		Spring flow rates	**Spring flow rates**
Inspection	Environmental Engineer	A review will be carried out of the construction activities that have been undertaken within the area of the shaft platform and the meteorological conditions, up to and during the period of exceedance. An assessment will be made to determine if the physical change that has been recorded in the spring flow rate at either Moorside Farm Spring or Soulsgrave Farm Spring is a natural variation due to seasonal low rainfall, or an impact caused by the Phase 11 Works.	
Consultation with Project Manager and Planning Remedial Actions	Environmental Engineer/ Project Manager	Evaluate findings of monitoring to determine the cause of the change in baseline conditions, in association with the groundwater level and ecological monitoring, and design the appropriate course of remedial action, if required.	
Implementing Remedial Actions	Project Manager/ Environmental Manager/ Environmental Engineer	If the change in the baseline data below the Control Trigger value has arisen from an adverse impact by the Phase 2 to 11 works the Remedial Actions to prevent continued impact will be specified. Such measures may include provision of an alternative water supply to replace spring water abstractions.	If the change in the baseline data below the Compliance Trigger value has arisen from an adverse impact by the Phase 2 - 11 works, the Remedial Actions to prevent continued impact will be specified. Such measures may repeat monitoring within 24 hours to confirm if the exceedance conditions are sustained. Subject to which, provision will be made for a temporary tankered water supply to Moorside Farm and Soulsgrave Farms supplemented, where necessary, with the long term solution designed and implemented that may comprise provision of an alternative water supply to replace spring water abstraction.
Reporting	Environmental Engineer	Report to include details of exceedance, monitoring, and remedial actions.	Report to include details of exceedance, monitoring, and remedial actions.
Timescale		1 week to identify the cause and 1 month to undertake the design and implement remedial actions required.	Within 24 hours of repeat follow up monitoring confirming that a Compliance Trigger Value exceedance is being caused by the Phase 2 - 11 works to identify the cause and to provide a tankered interim water supply, if necessary, and within 1 month to design and initiate implementation of any re-infiltration remedial actions required.

APPENDIX 1.4 - PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE FOR SPRING WATER QUALITY

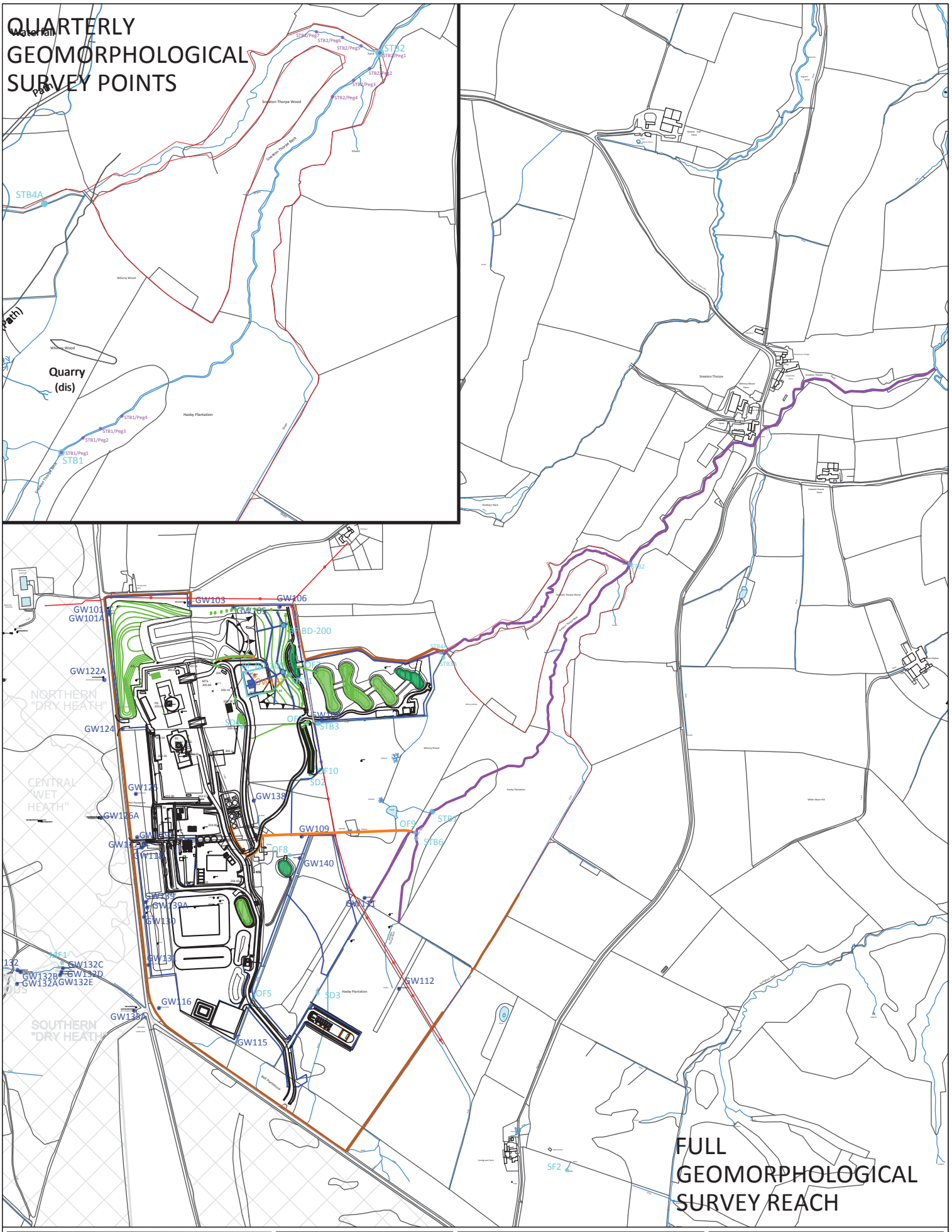
Procedure	Responsibility	Control Trigger Value Exceedance	Compliance Trigger Value Exceedance
		Spring water quality	**Spring water quality**
Inspection	Environmental Engineer	A review will be undertaken of the construction activities on the minesite up to and during the period of exceedance, and of the meteorological conditions during the period of the exceedance. A visual inspection of the ongoing construction works will be carried out including inspection of oil separators for hydrocarbon exceedances, and of fuel, lubricant, hydraulics and salt storage facilities. The visual inspection will include observations on evidence of cloudy discharges and a record of the turbidity value recorded in the surface water and spring discharges.	
Consultation with Project Manager and Planning Remedial Actions	Environmental Engineer/ Project Manager	Evaluate findings of monitoring to determine the cause of the change in conditions and design the appropriate course of remedial action, if required.	
Implementing Remedial Actions	Project Manager/ Environmental Manager/ Environmental Engineer	Changes to working practices including management of fuel, lubricant, hydraulics and salt storage facilities. Maintenance clearance of filter drains to the shaft platform areas, maintenance of oil separator, and maintenance of construction vehicles. Changes to working practices (CEMP) such as implementation of additional surface water management measures, such as additional filter drains, or oil separators.	Changes to working practices including management of fuel, lubricant, hydraulics and salt storage facilities. Maintenance clearance of filter drains to the shaft platform areas, maintenance of oil separator, and maintenance of construction vehicles. Changes to working practices (CEMP) such as implementation of additional surface water management measures, such as additional filter drains, or oil separators. Temporary provision of alternative water supply to Moorside Farm and to Soulsgrave Farm, as necessary. Where groundwater pollution associated with the Phase 11 Works is determined to be the cause of a long-term change to spring quality, remediation of the groundwater pollution will be considered. Such measures may include; repeat monitoring within 24 hours and laboratory analysis on an accelerated turn around, to confirm if the exceedance in water quality conditions is sustained. Subject to the receipt of which, provision will be made within 24 hours for an alternative water supply to Moorside Farm and Soulsgrave Farms supplemented, where necessary, with pollution clean-up proposals.
Reporting	Environmental Engineer	Report to include details of exceedance, inspection, and remedial actions.	
Timescale		1 week to identify the cause and design and implement any remedial actions required. Remedial action of cloudy discharge or turbidity readings exceeding background quality within 48 hrs.	If the repeat follow up monitoring confirms that a Compliance Trigger Value exceedance is being caused by the Phase 2 - 11 works, a tankered interim water supply is to be provided within 24 hours, if necessary. Within a period of 1 month, implementation of any pollution clean-up remedial actions required shall be initiated.

APPENDIX 1.5 - PROCEDURE FOR ADDRESSING TRIGGER VALUE EXCEEDANCE FOR SURFACE WATER QUALITY AND GEOMORPHOLOGY

Procedure	Responsibility	Control Trigger Value Exceedance	Compliance Trigger Value Exceedance
		Surface Water Quality and Stream Geomorphology	**Surface Water Quality and Stream Geomorphology**
Inspection	Environmental Engineer	A review will be undertaken of the construction activities up to and during the period of exceedance and of the meteorological conditions during the period of the exceedance. The visual inspection of the ongoing construction works will include inspection of oil separators for hydrocarbon exceedances, inspection of surface drainage, the Materials Handling attenuation tank and of pond outfalls for evidence of cloudy discharges and to provide a record of the turbidity value recorded, geomorphological inspection for evidence of erosion, geotechnical failure, sediment accumulation, vegetation change, pollution and discolouration and construction litter.	
Consultation with Project Manager and Planning Remedial Actions	Environmental Engineer/ Project Manager	Evaluate findings of monitoring to determine the cause of the physical or chemical change in surface water conditions and design the appropriate course of remedial action, if required.	
Implementing Remedial Actions	Project Manager/ Environmental Manager/ Environmental Engineer	Changes to working practices including implementation of silt fences and hay/heather bales. Maintenance clearance of filter drains to the shaft platform areas, maintenance of oil separator, and maintenance of construction vehicles. Changes to working practices (CEMP). Implementation of additional surface water management measures, such as additional filter drains, or oil separators. Where inspection and monitoring of the outflow to the perimeter swale from the Materials Handling Area attenuation tank OF11 indicates significant pollution associated with unspent explosives or hydraulic oils, close off the penstock valve and pump the water to the NDWWTP for treatment prior to discharge.	Implementation of additional emergency surface water management measures including hay/heather bales, silt busters and silt fences, absorbent spill pads and boons, environmentally friendly coagulant, or additional oil separators, temporarily closing the penstock in the attenuation pond and recirculation of basal drainage from Bund F onto the exposed rock fill. Maintenance clearance of filter drains to site road, ponds including dredging or reprofiling, oil separators and of construction vehicles. Changes to working practices (CEMP). Where inspection and monitoring of the outflow to the perimeter swale from the Materials Handling Area attenuation tank OF11 indicates significant pollution associated with unspent explosives or hydraulic oils, close off the penstock valve and pump the water to the NDWWTP for treatment prior to discharge. Implementation of additional surface water management measures, such as additional filter drains, clay stanks, use of hydrobrakes to slow water flow and discharge rates down and to allow more settlement of suspended solids prior to discharge to Sneaton Thorpe Beck, and potentially increasing the size of the receiving attenuation basin from Bund F to increase dilution of basal drainage and surface runoff prior to discharge to Sneaton Thorpe Beck.
Reporting	Environmental Engineer	Report to include details of exceedance, inspection, and remedial actions.	
Timescale		1 week to identify the cause, design and implement remedial actions required. Remedial action of cloudy discharge or elevated turbidity readings exceeding background quality are to be implemented within 48 hrs.	48 hours to identify the cause and 1 week to design and implement the remedial actions required.

APPENDIX 2

DRAWINGS



NOTES / KEY

SITE OWNERSHIP BOUNDARY
NYM SAC
SURFACE WATER
BOREHOLES GCBH01
SURFACE WATER MONITORING LOCATIONS SD1
GROUNDWATER MONITORING LOCATIONS GW132
LOCATION TO BE DECOMMISIONED GW137
GEOMORPHOLOGY SURVEY

DRAWING TITLE

PHASE 11 SURFACE AND GROUNDWATER QUALITY MONITORING POINTS

INSET - QUARTERLY GEOMORPHOLOGICAL SURVEY REACH

PROJECT TITLE
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS	PROJECT NUMBER
FINAL	1433Dev
DRAWN BY	DATE
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Sirius Minerals

Woodsmith Mine
Phase 11 Works

NYMNPA 76 Soil management plan

40-ARI-WS-7100-CI-PL-01000

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		Signature			
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			Prepared by	Checked by	Approved by
		Name	A Hornung	C Williams	A Hornung
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
				Issue Document verification with document	✓

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References

Drawings

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Drawing 2 FWS drawing 1433DevOD288 Topsoil thickness
Drawing 3 Estell Warren drawing 2309_MH03 Restoration Proposals Rev 07
Drawing 4 YP-P2-CX-031_13 Operational Masterplan
Drawing 5 YP-P2-CX-032_11 Earthworks

Appendices

Appendix A

Record of soil inspection

1 Introduction

1.1 Overview

This document has been prepared on behalf of Sirius Minerals PLC and details the Soil Management Plan for the Phase 11 construction activity at Woodsmith Mine (Phase 11 Works). This is required to discharge condition 76 of the North York Moors National Park Authority (NYMNPA) planning permission NYM/2017/0505/MEIA.

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

The Phase 11 Works comprise:

- Development of landscape mitigation screening;
- Tree clearance within Haxby Plantation;
- Sinking of the MTS shaft via drill and blast method;
- Operation of the Galloway;
- Creation of materials handling area;
- Installation of external silencer to the dust collector of the Service Shaft building;
- Installation of batteries.

This document should be read together with the following documents:

- Construction Environmental Management Plan [1].
- Archaeological Written Scheme of Investigation [2].
- Protected Species Management Plans [3] [4] [5] [6].

1.2 Soil management plan – compliance with conditions

NYMNPA 76	Compliance
Prior to commencement of each phase of construction an updated soil management plan shall be submitted to the MPA for approval. This shall set out any circumstances during which soil handling is to be avoided and shall include the following measures:-	This document
• Soil shall be moved when it is in a dry and friable condition as defined in Chapter 16 of the York Potash Environmental Statement (September 2014 as updated by the supplementary Environmental Statement dated February 2015) and the Supplementary Environmental Statement dated July 2017 (updated by further information dated October and November 2017) as relevant and shall not be moved between 1 October and 31 March unless agreed in writing by the MPA.	Section 3.3
• All topsoil and subsoil stripped from the surface area of the development shall be retained on site.	Section 1.4

• No plant or vehicle shall cross any area of un-stripped topsoil except if essential and unavoidable for the purposes of permitted operation.	Section 3.1
• No part of the site shall be used for a road or for the stationing of plant or buildings until all available topsoil and subsoil have been stripped from that part.	Section 3.1 and 3.3.1
• Soil handling will be in accordance with the "Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (DEFRA 2009)" and appropriate steps shall be taken to prevent the spread of soil-borne or animal diseases.	Section 3.2, 3.3, 3.4, 3.5 and 6.
• Any soil or spoil storage mounds that are to be in place for a period of more than three months are to be grass hydroseeded within four weeks of substantial completion with seed mix agreed by MPA. At all times during the construction period the approved updated soil management plan shall be adhered to.	Section 3.4

1.3 Objectives

The design objective is to avoid any reduction in long term capability, which would downgrade the quality of the disturbed land, through the adoption of good practice techniques in handling, storing and reinstating soils on that land.

The principal objectives of this soil management plan are:

- the conservation of soil resources,
- the avoidance of damage to soil structures,
- the maintenance of soil drainage,
- the reinstatement of the soil profile,
- the preservation of soil biodiversity.

1.4 Principles

Guidance on handling is provided by the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites 2009 published by the Department of Environment, Food and Rural Affairs [7], and the Good practice guide for handling soils (MAFF 2000) [8].

The sustainable reuse of soils displaced by the approved scheme is a key mitigation measure. All topsoil or subsoil stripped from the site is to be retained on site for re-use. Conserved soils will be used for the restoration of land to landscape planting, woodland, and ecological habitat creation, as set out in the Environmental Statement, 2014, [9], Supplementary Environmental Information, 2015, [10] and Supplementary Environmental Statement, 2017, [11].

2 Soil resource

2.1 Investigation

A detailed soil survey was undertaken by Land Research Associates in May 2014 Ref. [12]. This found that the Woodsmith Mine site contained thin clayey loamy topsoil across the site underlain by predominantly heavy clay subsoils.

2.2 Topsoil

Three principal topsoil types are reported on site comprising medium and heavy clay loams and woodland soils, as illustrated on FWS Drawing 1433DevOD287, for which the average soil thicknesses are shown in FWS Drawing 1433DevOD288.

2.2.1 Medium Clay Loam Soils

Over the majority of the central and northern parts of the site, the topsoil is recorded as medium clay loams with a minimum thickness of 0.14 m, a maximum thickness of 0.50 m, and an average thickness of 0.26 m. The topsoil structure comprises a friable very dark greyish brown medium clay loam with a well-developed medium to coarse sub-angular blocky structure, which has an abrupt smooth boundary with the underlying subsoils.

2.2.2 Heavy Clay Loam Soils

In the west and northeast there are three areas of heavy clay loam topsoil, with a minimum thickness of 0.17 m, a maximum thickness of 0.35 m, and an average thickness of 0.25 m. This topsoil comprises a dark greyish brown heavy clay loam with many distinct fine re d root channel mottles. It is very slightly stony and has a moderately developed coarse sub-angular blocky structure and is friable to firm with an abrupt smooth boundary with the underlying subsoil.

2.2.3 Woodland Soils

Woodland soils are present over the southeastern third of the site within Haxby Plantation. They are often peaty/organic but can also be medium to heavy clay loam and sandy loam soils. They have a minimum thickness of 0.11 m, a maximum thickness of 0.48 m, and an average thickness of 0.23 m. This friable stone-free soil has a moderately well-developed sub-angular blocky structure, which has an abrupt smooth boundary with the underlying layers.

2.3 Subsoil

The soil survey [12] identified upper and lower subsoils onsite, as detailed below.

2.3.1 Upper subsoil

The upper subsoil is predominantly a medium clay loam, although it is reported to vary in texture from clay and medium to heavy clay loams, through to sandy clay loams and loamy medium sand soils. The subsoil base varies in depth from 0.25 m to greater than 1.0 m below ground level (bgl) with an average depth to base of 0.54 m bgl.

2.3.2 Lower subsoil

The lower subsoil is predominantly a heavy clay loam although it is reported to vary in texture from a medium / heavy clay loam to a sandy clay loam. It has a greater clay content than the upper subsoils. Its base is generally at a depth of greater than 1 m bgl.

2.4 Quantities

The quantities of topsoil and subsoil available on the site have been estimated based on the soil survey [12] and the approved masterplan YP-P2-CX-031 Rev 13. In estimating the available resource it has been assumed that topsoil will be stripped from all areas of permanent and temporary works and subsoil will be stripped from all areas of permanent works.

Quantities of topsoil and subsoil required for restoration have been estimated based on the approved landscape scheme (Estell Warren drawing 2309.MH03 Rev 7) and the soil thicknesses shown on approved drawing YP-P2-CX-032 Rev 11.

The quantities are summarised in Table 1:

Table 1: Topsoil and subsoil resource

Resource	Available (m^3)	Required (m^3)
Topsoil	95,015	69,478
Subsoil	204,090	183,226

3 Soil handling

3.1 Trafficking by plant and vehicles

Large construction vehicles will not be driven or hauled on any areas within the site from which topsoil/ subsoil has not been stripped (except for the purposes of stripping) unless protective temporary surfaces are used. Wheeled machinery will not go over soil stockpiles or restored soils, unless necessary for seeding, sward maintenance or weed control. Soil handling machinery will be restricted to marked haul routes and will not traverse undisturbed or replaced soils, except where such trafficking is essential for the permitted operations.

All soil materials will be handled under suitable weather and soil conditions using appropriate machinery.

3.2 Vegetation clearance

Vegetation will be removed prior to soil handling. Surface vegetation within the working area will be removed from grassed, scrub and agricultural areas by blading off, by scarification and raking, or kill off by application of a suitable non-residual herbicide applied not less than two weeks before stripping commences. Within woodland areas, trees will be cut down and removed by an appropriately experienced arboricultural contractor, with the stumps removed.

All tree/vegetation clearance will be carried out in accordance with the relevant requirements of the Construction Environmental Management Plan [1] , Archaeological Written Scheme of Investigation [2] and Protected Species Management Plans [3] [4] [5] [6].

3.3 Soil stripping

All soil stripping will be carried out in accordance with the relevant requirements of the Construction Environmental Management Plan [1] , Archaeological Written Scheme of Investigation [2], Protected Species Management Plans [3] [4] [5] [6] and the procedures described below.

3.3.1 Areas of soil stripping

Topsoil is to be stripped from beneath all areas of permanent and temporary works including:

- working platforms,
- laydown areas,
- temporary and permanent buildings,
- temporary construction facilities, e.g. batching plants, generator farms, water treatment facilities, switch-rooms,
- temporary and permanent access and haul roads,
- temporary and permanent earthworks, with the exception of topsoil storage mounds.

Subsoil is to be stripped from beneath all areas of permanent works including:

- working platforms,
- laydown areas,
- permanent buildings,
- ancillary construction facilities, e.g. batching plants, generator farms, water treatment facilities, switch-rooms,
- permanent access and haul roads,
- permanent earthworks bunds.

3.3.2 Soil condition

Condition 76 states that soil shall only be moved when it is in a dry and friable condition and shall not be moved between 1 October and 31 March unless agreed in writing by the Minerals Planning Authority (MPA). This section sets out the proposed method for defining when soil is in a dry and friable condition and can, therefore, be handled on site, including between the period 1 October and 31 March.

3.3.2.1 01 April to 30 September

Between 01 April and 30 September soil stripping may proceed without prior approval from the MPA provided it is in a dry and friable condition.

During periods of heavy prolonged rainfall soil stripping will not be undertaken.

Soils will not be stripped within 24 hours of sustained heavy rainfall (>10mm in 24 hours) to ensure that they are in suitable condition for handling.

Immediately prior to the commencement of any soil stripping activity, trial holes will be excavated in the presence of a suitably experienced soil scientist, engineer or geologist (the Supervising Engineer) to allow inspection of the topsoil and subsoil. Trial holes will be excavated at a frequency not less than four per hectare. The soils will be closely examined by the Supervising Engineer who will determine whether the condition of the soil satisfies the requirement for “dry and friable”. Guidance on the assessment is included in Appendix A.

If the condition is satisfied, the Supervising Engineer will provide written notice that soil stripping may proceed in accordance with Section 3.3.3 below. A template for the notice is included in Appendix A.

If the requirement for dry and friable soil is not satisfied, the Supervising Engineer will provide written notice to Sirius and the Contractor that this is the case using the notice included in Appendix A.

3.3.2.2 01 October to 31 March

Between 01 October and 31 March soil stripping may only proceed with prior approval from the MPA.

Soil will not be stripped within 1 week of heavy rainfall (>10mm in 24 hours).

Not less than 48 hours prior to the commencement of any soil stripping activity, trial holes will be excavated in the presence of the Supervising Engineer to allow inspection of the topsoil and subsoil. Trial holes will be excavated at a frequency not less than four per hectare. The soils will be closely examined by the Supervising Engineer who will determine whether to condition of the soil satisfies the requirement for “dry and friable”. Guidance on the assessment is included in Appendix A.

If the condition is satisfied, the Supervising Engineer will provide written confirmation and soil stripping may proceed in accordance with Section 3.3

below. A template for the notice is included in Appendix A. A copy of the notice will be sent by email to the MPA with a request for approval to undertake soil handling, and soil handling will not commence until the MPA's approval has been received.

If the condition for dry and friable soil is not satisfied, the Supervising Engineer will notify Sirius and the Contractor in writing that this is the case and will include a statement that soils are not to be stripped until they have been re-examined and confirmed to be in a suitable condition. A template for the notice is included in Appendix A.

3.3.3 Method

3.3.3.1 Topsoil

Soil removal will be carried out prior to all main construction activities within an area, utilising earthmoving plant in accordance with MAFF Good practice guide for handling soils [8].

To avoid dilution of the topsoil with the underlying subsoil, topsoil will be stripped to the base of the unit, using a tracked excavator fitted with a smooth ditching bucket in accordance with the Written Scheme of Archaeological Investigation [2].

The preferred method for minimising damage to soil is for stripping to be undertaken in accordance with the bed/strip system as detailed in current guidance.

3.3.3.2 Subsoil

Following removal of topsoil, upper subsoil will be stripped to an average depth of 0.5m. Where stripping of lower subsoil is required, it will be stripped to the required depth and stockpiled separately.

Subsoil will be stripped to the required depth using a tracked excavator fitted with a smooth ditching bucket in accordance with the Written Scheme of Archaeological Investigation [2].

The preferred method for minimising damage to soil is for stripping to be undertaken in accordance with the bed/strip system as detailed in Ref [8].

3.4 Soil stockpiling

All soil stockpiling will be carried out in accordance with the relevant requirements of the Construction Environmental Management Plan [1] , Archaeological Written Scheme of Investigation [2], Protected Species Management Plans [3] [4] [5] [6] and the procedures described below.

Topsoil and subsoil stockpiling will be undertaken in accordance with industry guidance (Refs. [7] and [8]). Topsoil stockpiles will not exceed 3 m high and

subsoil stockpiles will not exceed 7 m high. Side slopes will be no steeper than 1 in 2.

To construct soil stockpiles, dumper trucks will back tip each soil load into the stockpile area, starting from furthest point of access. A backacter will be used to form the soil into a mound, and while standing on the mound will progressively shape and form the sides, to promote shedding of rain. The process is repeated by tipping soil against the forming mound. No wheeled vehicles will be permitted to traverse previously tipped material. Dump trucks will only be permitted to stand and travel on the basal layer for single tier mounds, and the soil mound height will be maximised prior to trucks accessing the upper surface in multi-tiered mounds.

Temporary stockpiles that are to be in place for more than 3 months will be seeded with grass within four weeks of substantial completion, to minimise soil erosion and to help reduce infestation by nuisance weeds. Management of weeds will be undertaken during the summer months, either by spraying to kill them or by mowing or strimming.

3.5 Soil placement

All soil placement will be carried out in accordance with the relevant requirements of the Construction Environmental Management Plan [1] , Archaeological Written Scheme of Investigation [2], Protected Species Management Plans [3] [4] [5] [6] and the procedures described below.

3.5.1 Excavation from soil storage stockpiles

A hydraulic excavator, fitted with a toothed-bucket will be used to load the soil materials from the source area or stockpile into a dump truck, which will then discharge it onto the receiving surface. Where the soils are to be directly replaced without storage in mounds, the initial strip of the upper horizons will be stored temporarily to release the lowest layer and enable the sequential movement of materials. The stored initial soil material will be placed on the lower layer removed from the final strip at the end of the programme or on partially completed profiles, if rain interrupted the operation.

3.5.2 Subsoil placement

Prior to commencing subsoil placement, the surface drainage will be installed. Refer to surface water drainage scheme and management plan, NYMNPA 60 and NYMNPA 79 [14].

Subsoil will be in a dry and friable condition prior to placement.

The area to receive subsoil will be protected from in-flow of water, ponding etc. Any wet areas will be drained in advance.

Subsoil placement will be carried out using the modified loose tipping technique described in the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, ref [7], page 34, using a low ground pressure dozer to spread the soil. To minimise compaction and optimise decompaction the dump trucks

will only operate on the 'basal'/non-soil layer, and their wheels must not in any circumstances run on to the subsoil layer(s). Only the bulldozer is to operate on the subsoil layers to spread the subsoil.

The bed/strip system will be adopted to minimise the need for the trucks to travel on the subsoil layer(s). Machines will only work when ground conditions enable their maximum operating efficiency.

The soil layers above the base/formation layer are to be replaced in sequential strips with the lower subsoil (where required) to be replaced first, followed by upper subsoil then the topsoil layer; each layer being replaced to the specified thickness. The next strip will not be started until the current strip is completed.

Within grassland and open scrub planting areas, the subsoil will be placed in a single lift to the full layer thickness, without compaction.

Within woodland planting areas, lower subsoil will be placed first in 600mm layers to the required thickness, followed by upper subsoil.

The subsoil layer will be decompacted if required (see 3.5.3) prior to placing the topsoil layer.

The bed/strip system provides a basis to regulate the exposure of lower soil layers to periods of rain and a means of maintaining soil moisture contents.

Prior to commencing operations, a weather forecast will be obtained which gives reasonable confidence of soil replacement proceeding without interruptions from rainfall events. If significant rainfall is forecast or occurs during operations, the soil profile within the active strip will be replaced to the topsoil layer before rainfall occurs and before replacement is suspended. Measures will be implemented to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks. Replacement will not restart unless the weather is expected to be dry for at least a full day.

3.5.3 Subsoil decompaction

If required, subsoil will be ripped to relieve compaction using the bulldozer drawn tines method described in Ref [8] sheet 19 using a low ground pressure dozer. To maximise decompaction ripping will only be undertaken when the soils are in a dry and friable condition. Ripping will be undertaken in both directions along an axis oriented down-slope to promote drainage, with overlapping passes. Within grassland and open scrub planting areas, subsoil will be ripped to a depth of 300mm to prevent damage to underlying drains. The tines of the ripper will be sufficiently closely spaced to ensure that full lateral decompaction is achieved with overlapping passes. Within woodland planting areas, subsoil will be ripped to a depth of 600mm.

3.5.4 Topsoil placement

Topsoil will be in a dry and friable condition prior to placement.

The area to receive soil will be protected from in-flow of water, ponding etc. Any wet areas will be drained in advance.

Within open scrub planting areas topsoil will be loose tipped by dumper truck, in the pattern shown on the landscape architects drawings (groups of 7nr individual soil loads of 9m^3 each). The topsoil will then be spread to achieve varied topsoil depths using a low ground pressure dozer to maximum depth of 300mm, feathering out edges to adjoining areas of subsoil. On short slopes such as Bund A (refer to drawing YP-P2-CX-032_11 Earthworks), where soil can be spread from the top of the slope, the topsoil will be spread by the loose tipping method using a long reach excavator with wide bucket.

Within woodland planting areas, topsoil placement will be carried out using the modified loose tipping method described in the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, ref [7], page 34, using a low ground pressure dozer to spread the soil. Machinery will not be permitted to cross completed areas including co-ordination of topsoil spreading operations in strips to avoid crossing completed subsoil areas. Only the bulldozer is to operate on the soil layers to spread the soil.

Machines will only work when ground conditions enable their maximum operating efficiency.

The topsoil layer will be placed in a single lift to the full layer thickness, without compaction.

Prior to commencing operations, a weather forecast will be obtained which gives reasonable confidence of soil replacement proceeding without interruptions from rainfall events. If significant rainfall is forecast or occurs during operations, the soil profile within the active strip will be replaced to the topsoil layer before rainfall occurs and before replacement is suspended. Measures will be implemented to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks. Replacement will not restart unless the weather is expected to be dry for at least a full day.

3.5.5 Topsoil decompaction

Following placement and grading to level, topsoil will, if required, be ripped to relieve compaction using the bulldozer drawn tines method described in Ref [8] sheet 19 using a low ground pressure dozer or tractor drawn subsoiler. To maximise decompaction ripping will only be undertaken when the soils are in a dry and friable condition. Ripping will be undertaken in both directions along an axis oriented down-slope to promote drainage, with overlapping passes. The depth of ripping will be set sufficient to penetrate the full thickness of the topsoil layer and 300mm of the underlying subsoil layer. The tines of the ripper will be sufficiently closely spaced to ensure that full lateral decompaction is achieved with overlapping passes.

3.5.6 Soil Cultivation

After re-spreading topsoil, large, compacted lumps will be broken down by appropriate cultivation to produce a fine tilth suitable for planting (<50 mm) and seeding (<10 mm). All undesirable material brought to the surface including stones larger than 50 mm in any dimension, roots, tufts of grass and foreign matter will to be removed.

4 Soil aftercare

Soil aftercare will be undertaken in accordance with the landscape and ecological management plan [15].

5 Prevention of erosion

The following erosion management measures will be adopted:

- The extent of bare soil left open will be minimised;
- Soil handling operations will be avoided during periods of heavy rainfall;
- Bare surfaces will be left rough to encourage infiltration and minimise surface runoff;
- Silt fences will be established as soon as possible across newly soiled areas in accordance with the surface water drainage scheme and management plan [14] and will be maintained until a grass sward has become established;
- All soil stockpiles that are to in place for more than 3 months will be seeded.

6 Control of soil-borne and animal diseases

Enquiries have been made to Animal Health and Veterinary Laboratories Agency and the Food and Environment Research Agency to confirm if:

1 Any statutory restrictions apply to the site or in the immediate locality, and if any special precautions need to be taken.

2 They know of the presence of any soil-borne diseases in or near to the site.

The Animal and Plant Health Agency has confirmed (copy of correspondence included in previous Phase 2 and Phase 3 soil management plans) that it does not have any records of any burials within the Woodsmith Mine development area. The previous landowners have been contacted to ascertain if there are any recorded animal burials on site.

During the works, if animal burials are identified on site, they will be handled in accordance with current guidance, ref. [13].

7 Compliance monitoring

A suitably experienced soil scientist, engineer or geologist (the Supervising Engineer) will be appointed to oversee implementation of the soil management plan. The Supervising Engineer will undertake the following inspections prior to, during and on completion the soil handling works:

- Prior to commencement of a new soil handling activity the Contractor's method statement and programme will be reviewed to confirm compliance with the objectives of the soil management plan.
- Where the Supervising Engineer considers that the method statement and/or programme is inconsistent with the objectives or requirements of the soil management plan, he will provide written comments to the Contractor. Any comments will be addressed by the Contractor and the documents re-submitted for acceptance prior to commencement of the soil handling.
- During the soil handling process, the Supervising Engineer will coordinate with the Contractor to undertake acceptability inspections in accordance with Section 3.3.2 of the Soil Management Plan.
- Inspection of soil stripping, storage and of topsoil and subsoil amelioration, placement and preparation will be undertaken by the Supervising Engineer at a regular interval during the soils handling. The frequency of such inspections will be determined with consideration of the Contractor's soils handling programme. Where practices are observed that do not comply with the soils management plan, remedial actions will be recommended by the Supervising Engineer and a record of their implementation and effectiveness recorded within subsequent inspection reports. The results of these visual inspections will be reported by the Supervising Engineer within two working days of any inspection.

.

References

[1] Royal Haskoning DHV Phase 11 Woodsmith Mine Construction Environmental Management Plan.

[2] Cotswold Archaeology, 2017, Woodsmith Mine, Sneaton, North Yorkshire, Phase 3, Written Scheme of Investigation for an Archaeological Investigation.

[3] Royal Haskoning DHV, 2017 Woodsmith Mine Protected Species Management Plans – Reptiles (NYMNPA 52 – Phase 3).

[4] Royal Haskoning DHV, 2017 Woodsmith Mine Protected Species Management Plans – Birds (NYMNPA 52 – Phase 3).

[5] Royal Haskoning DHV, 2019 Woodsmith Mine Protected Species Management Plans – Badgers (NYMNPA 52).

[6] Royal Haskoning DHV, 2017 Woodsmith Mine Protected Species Management Plans – Bats (NYMNPA 52 – Phase 9).

[7] DEFRA, 2009, Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.

[8] MAFF, 2000, Good practice guide for handling soils v04.

[9] Royal Haskoning DHV, 2014, York Potash Project Mine, MTS and MHF Environmental Statement.

[10] Royal Haskoning DHV, 2015 York Potash Project Mine, MTS and MHF Environmental Statement: Supplementary Environmental Information.

[11] Lichfields, 2017, York Potash Ltd Woodsmith Mine, S73 Application, Supplementary Environmental Statement.

[12] Land Research Associates, 2014. Soil Resources and Agricultural Use and Quality of Land at Dove's Nest Farm, Sneatonthorpe.

[13] Defra. Precautions to Prevent the Spread of Animal & Poultry Disease - Code of Practice for Civil Engineers, Surveyors & Contractors.

[14] Arup, 2019, Phase 11 Woodsmith Mine, NYMNPA 60 and 79 surface water drainage scheme.

[15] DRaW, Landscape and Ecological Management Plan – Phase 11 (NYMNPA 57)

Drawings

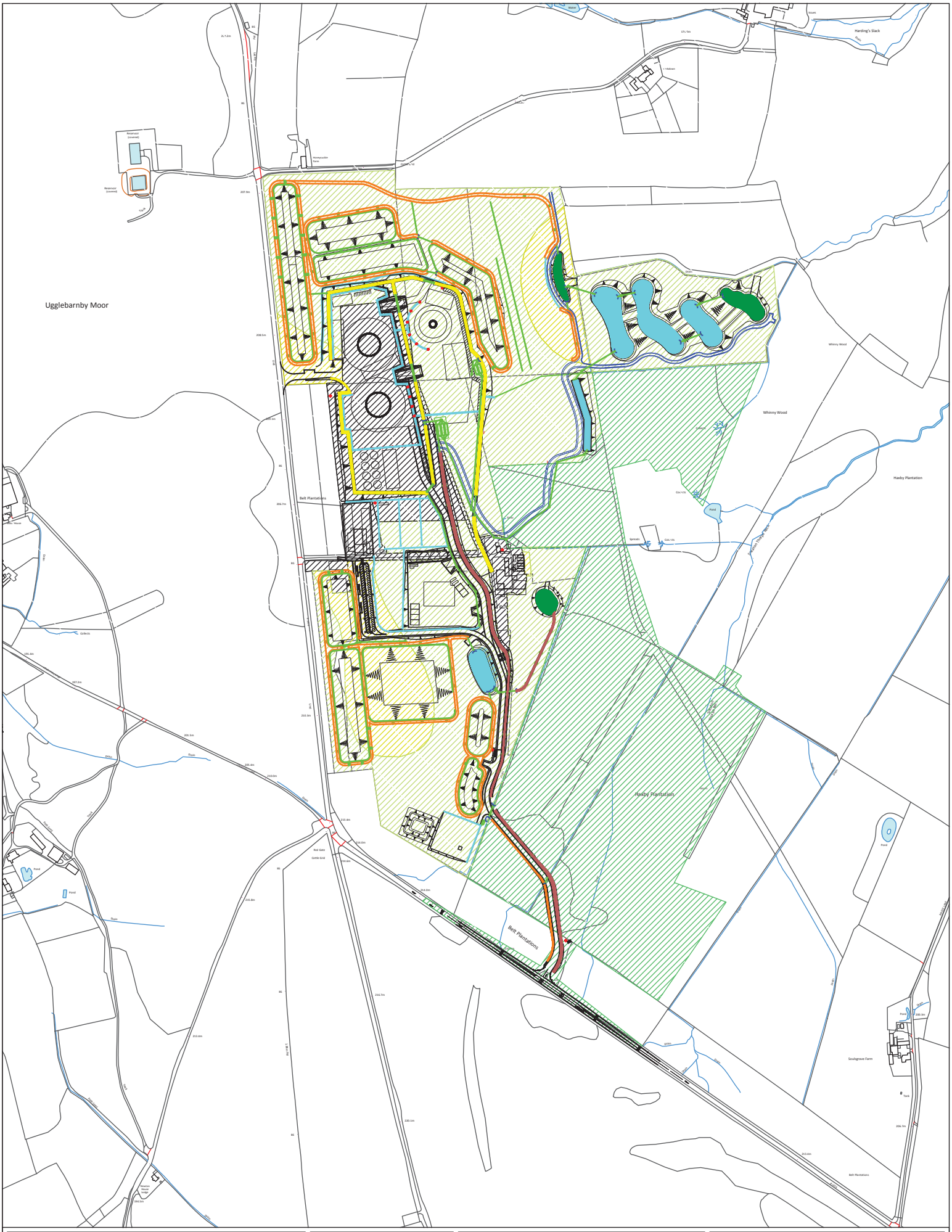
Drawing 1 FWS drawing 1433DevOD287 Topsoil texture types

Drawing 2 FWS drawing 1433DevOD288 Topsoil thickness

Drawing 3 Estell Warren drawing 2309_MH03 Restoration Proposals Rev 07

Drawing 4 YP-P2-CX-031_13 Operational Masterplan

Drawing 5 YP-P2-CX-032_11 Earthworks



NOTES / KEY

SITE OWNERSHIP BOUNDARY

HARDSTANDING/TOPSOIL REMOVED

TOPSOIL TYPES
- MEDIUM CLAY LOAM
- HEAVY CLAY LOAM
- WOODLAND SOILS

Note Topsoil texture types extrapolated from Land Research Soil Resources Report

DRAWING TITLE

TOPSOIL TEXTURE TYPES AND PHASE 4 WORKS

PROJECT TITLE

NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS	PROJECT NUMBER
FINAL	1433
DRAWN BY	DATE
CB	May 2017
SCALE	DRG. No.
1:5,000 @ A3	1433DevOD287

FWS Geological & Geo-Environmental Consultants

Merrington House
Merrington Lane Industrial Estate
Spennymoor
County Durham
DL16 7UT

NOTES / KEY

SITE OWNERSHIP BOUNDARY

HARDSTANDING/TOPSOIL REMOVED

TOPSOIL THICKNESS
- 0 TO 0.15 M
- 0.15 TO 0.20 M
- 0.20 TO 0.25 M
- 0.25 TO 0.35 M
- 0.50 M +
- VARIABLE THICKNESS WOODLAND SOILS

DRAWING TITLE

TOPSOIL THICKNESS AND PHASE 3 SITE PREPARATORY WORKS

PROJECT TITLE

NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS	PROJECT NUMBER
FINAL	1433
DRAWN BY	DATE
CB	May 2017
SCALE	DRG. No.
1:5,000 @ A3	1433DevOD288

FWS Geological & Geo-Environmental Consultants

Merrington House
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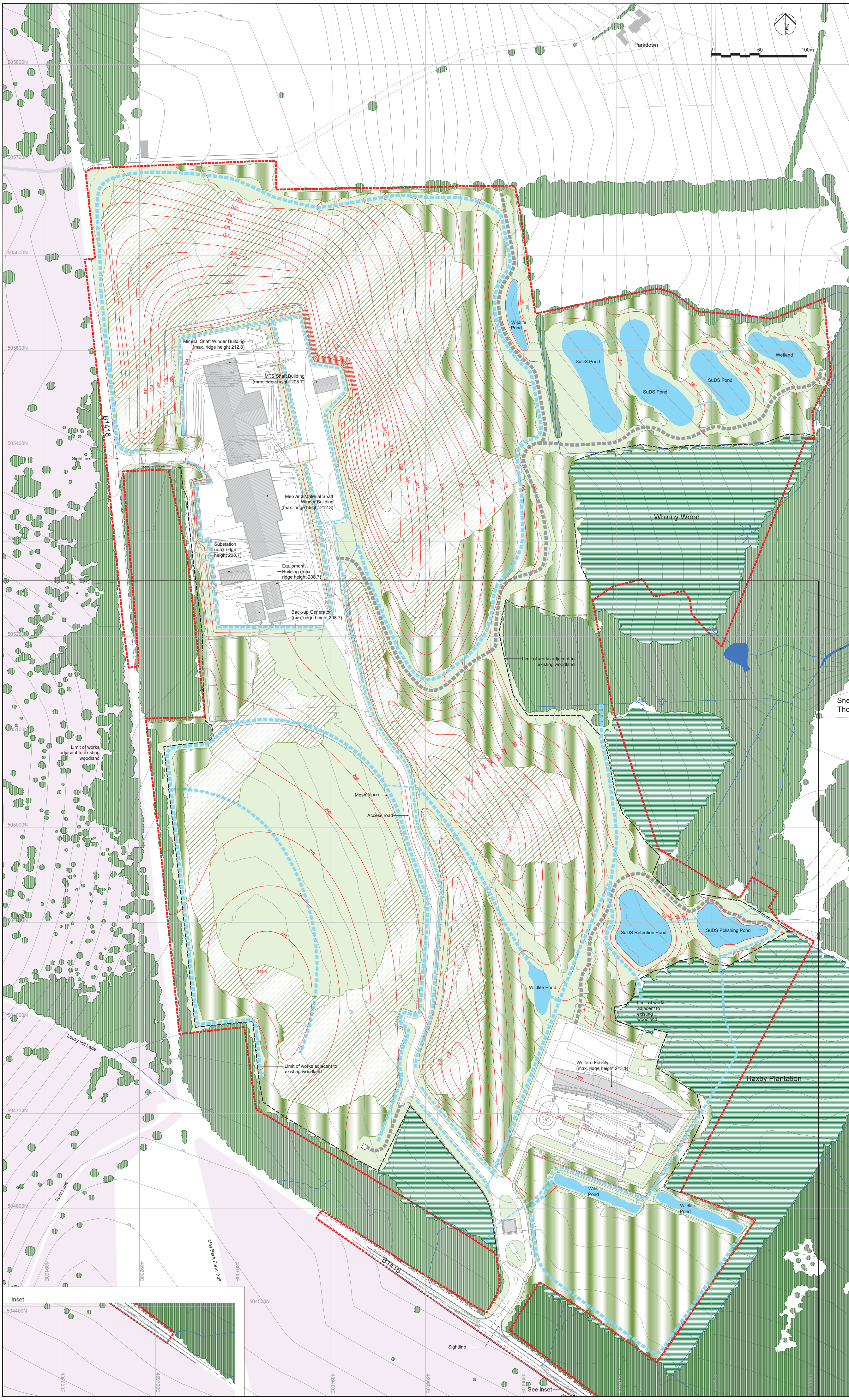


KEY

- Extent of works
- Existing contours
- Proposed contours (at 2m intervals, unless otherwise indicated)
- Existing broadleaved woodland / scrub
- Existing coniferous plantation
- Existing hedgerow
- Existing watercourse
- Proposed woodland planting
- Proposed open scrub and grassland
- Proposed species rich grassland
- SuDS retention ponds & wildlife ponds
- Surface water drainage features pipes/ land drains/ swales
- SuDS maintenance track

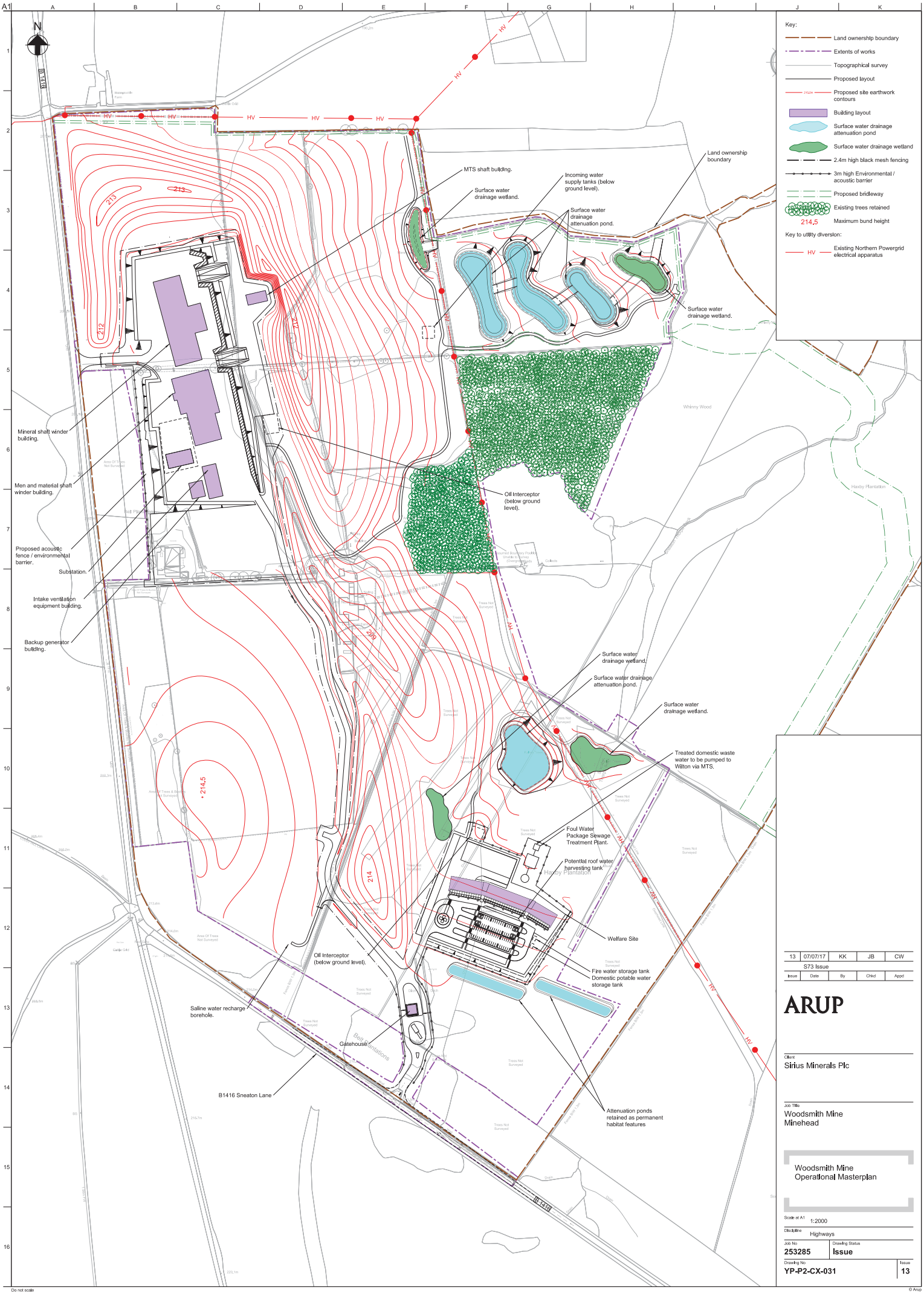
Revision 07. 28/06/2017 Amendments to text.
Revision 06. 13/06/2017 Updated to latest scheme.
Revision 05. 03/02/2015 General amendments.
Revision 04. 22/01/2015 General amendments.
Revision 03. 01/09/2014 Updated to architect layout
Revision 02. 26/06/2014 Site boundary & existing contours updated, & graphic amendments
Revision 01. 27/05/2014 Minor amendments

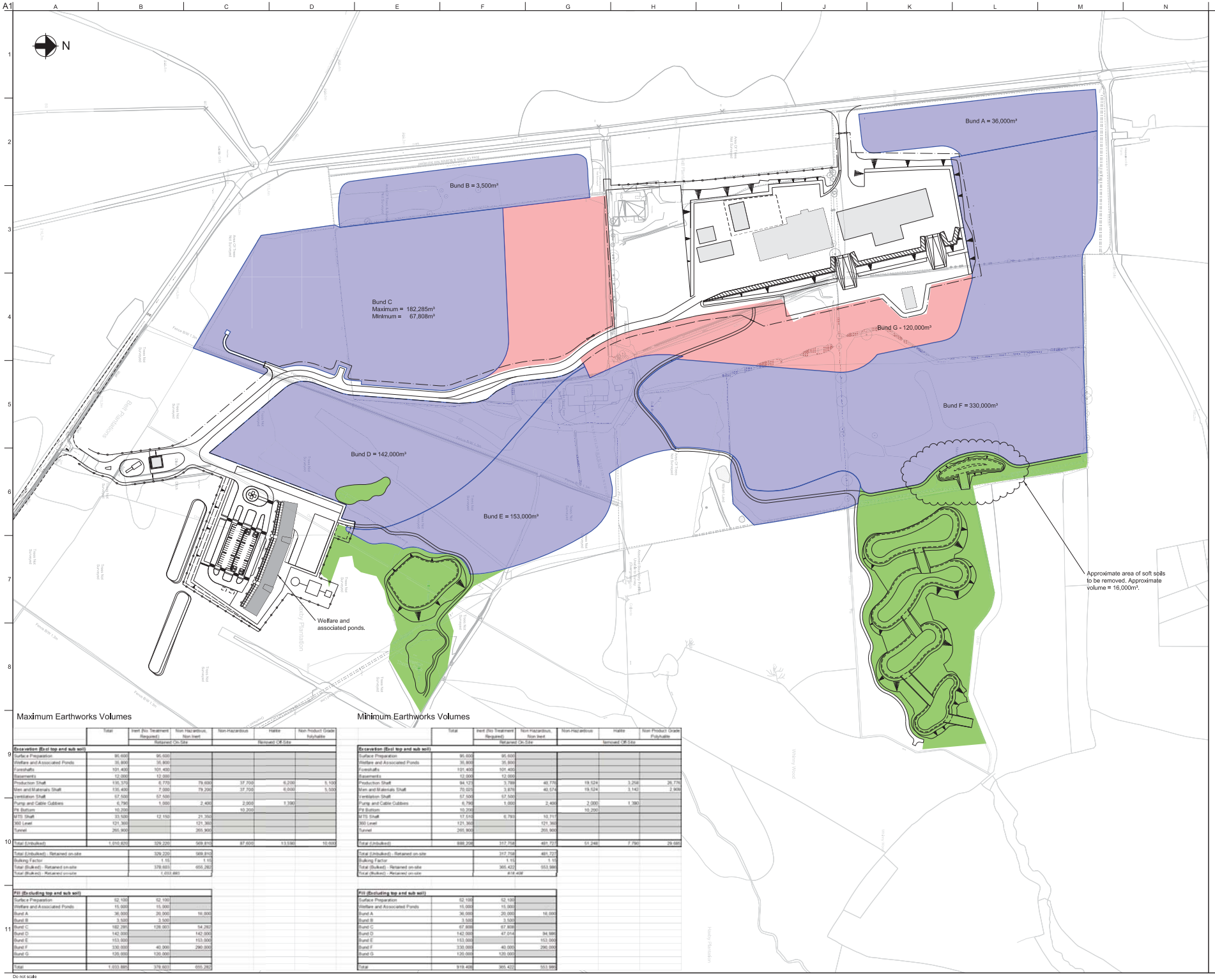
Estell Warren
Landscape Architecture

Estell Warren Ltd
5b Chevin Mill
Leeds Road
Otley

SIRIUS

Project: Woodsmith Mine	
Drawing Title: Restoration Proposals	
Drawing Number: 2309.MH03	Revision: 07
Scale: 1:1250 @ A0	Date: June 2017
Drawn: ME	Checked: SW


Key:
Land ownership boundary
Extents of works
Topographical survey
Proposed layout
Proposed site earthwork contours
Building layout
Surface water drainage attenuation pond
Surface water drainage wetland
2.4m high black mesh fencing
3m high Environmental / acoustic barrier
Proposed bridleway
Existing trees retained
214.5 Maximum bund height
Key to utility diversion:
HV Existing Northern Powergrid electrical apparatus
MTS shaft building.
Surface water drainage wetland.
Incoming water supply tanks (below ground level).
Surface water drainage attenuation pond.
Land ownership boundary
Surface water drainage wetland.
Mineral shaft winder building.
Men and material shaft winder building.
Proposed acoustic fence / environmental barrier.
Substation.
Intake ventilation equipment building.
Backup generator building.
Oil Interceptor (below ground level).
Surface water drainage wetland.
Surface water drainage attenuation pond.
Surface water drainage wetland.
Treated domestic waste water to be pumped to Wilton via MTS.
Foul Water Package Sewage Treatment Plant.
Potential roof water harvesting tank
Welfare Site
Oil Interceptor (below ground level).
Fire water storage tank
Domestic potable water storage tank
Saline water recharge borehole.
Gatehouse
B1416 Sneaton Lane
Attenuation ponds retained as permanent habitat features
Haxby Plantation
Whinny Wood
13 07/07/17 KK JB CW
S73 Issue
ARUP
Client
Sirius Minerals Plc
Job Title
Woodsmith Mine
Minehead
Woodsmith Mine
Operational Masterplan
Scale at A1 1:2000
Discipline Highways
Job No 253285
Drawing Status Issue
Drawing No YP-P2-CX-031
Issue 13
Do not scale
© Arup



Notes:

1. This drawing shows earthworks requirements in relation to the proposed earthwork bunds.
2. Existing subsoil and top soil is to be stripped and replaced following construction of the mounds as follows. Assumed existing and proposed earthworks layer thicknesses are as follows:
   - Existing Top soil layer thickness 0.2m.
   - Existing Sub soil layer thickness 0.5m.
3. Proposed thicknesses as follows:

	Top soil	Sub soil
Woodland (Non Capped)	0.30m	0.90m
Woodland (Capped)	0.30m	1.70m
Scrub	0.15m	0.60m
Grassland	0.30m	0.20m

4. Volumes shown are bund capacities excluding top soil and sub soil.

Key:

- Base case earthworks (construction).
- Additional earthworks to base case (post shaft construction).
- Ponds area

Maximum Earthworks Volumes

	Total	Inert (No Treatment Required)	Non Hazardous, Non Inert	Non-Hazardous	Hallite	Non Product Grade Polyhalite
		Retained On-Site		Removed Off-Site		
Excavation (Excl top and sub soil)						
Surface Preparation	95,600	95,600				
Welfare and Associated Ponds	35,800	35,800				
Forebaths	101,400	101,400				
Basements	12,000	12,000				
Production Shaft	135,370	6,770	79,600	37,700	6,200	5,100
Men and Materials Shaft	135,400	7,000	79,200	37,700	6,000	5,500
Ventilation Shaft	57,500	57,500				
Pump and Cable Cubbies	6,790	1,000	2,400	2,000	1,390	
Pit Bottom	10,200			10,200		
MTS Shaft	33,500	12,150	21,350			
360 Level	121,300		121,300			
Tunnel	265,900		265,900			
Total (Unbulked)	1,010,820	329,220	569,810	87,600	13,590	10,600
Total (Unbulked) - Retained on-site		329,220	569,810			
Bulking Factor		1.15	1.15			
Total (Bulked) - Retained on-site		378,603	655,282			
Total (Bulked) - Retained on-site		1,033,885				
Fill (Excluding top and sub soil)						
Surface Preparation	52,100	52,100				
Welfare and Associated Ponds	15,000	15,000				
Bund A	36,000	20,000	16,000			
Bund B	3,500	3,500				
Bund C	182,285	128,003	54,282			
Bund D	142,000		142,000			
Bund E	153,000		153,000			
Bund F	330,000	40,000	290,000			
Bund G	120,000	120,000				
Total	1,033,885	378,603	655,282			

Minimum Earthworks Volumes

	Total	Inert (No Treatment Required)	Non Hazardous, Non Inert	Non-Hazardous	Hallite	Non Product Grade Polyhalite
		Retained On-Site		Removed Off-Site		
Excavation (Excl top and sub soil)						
Surface Preparation	95,600	95,600				
Welfare and Associated Ponds	35,800	35,800				
Forebaths	101,400	101,400				
Basements	12,000	12,000				
Production Shaft	94,121	3,789	40,776	19,524	3,258	26,774
Men and Materials Shaft	70,023	3,876	40,574	19,524	3,142	2,909
Ventilation Shaft	57,500	57,500				
Pump and Cable Cubbies	6,790	1,000	2,400	2,000	1,390	
Pit Bottom	10,200			10,200		
MTS Shaft	17,510	6,793	10,717			
360 Level	121,300		121,300			
Tunnel	265,900		265,900			
Total (Unbulked)	888,256	317,758	481,727	51,248	7,790	29,683
Total (Unbulked) - Retained on-site		317,758	481,727			
Bulking Factor		1.15	1.15			
Total (Bulked) - Retained on-site		365,422	553,986			
Total (Bulked) - Retained on-site		919,408				
Fill (Excluding top and sub soil)						
Surface Preparation	52,100	52,100				
Welfare and Associated Ponds	15,000	15,000				
Bund A	36,000	20,000	16,000			
Bund B	3,500	3,500				
Bund C	67,808	67,808				
Bund D	142,000	47,014	94,986			
Bund E	153,000		153,000			
Bund F	330,000	40,000	290,000			
Bund G	120,000	120,000				
Total	919,408	365,422	553,986			

Issue	Date	By	Chkd	Appd
11	11/06/17	JB	CW	CW
	Issue			

ARUP

Admiral House, Rose Wharf,
78 East Street, Leeds, LS9 8EE

Client
Sirius Minerals Plc

Job Title
Woodsmith Mine
Minehead

Woodsmith Mine
Site General Arrangement
Illustrative Earthworks Strategy
Earthworks Bunds and Ponds

Scale at A1 1:2000

Discipline Highways

Job No 253285

Drawing Status Planning

Drawing No YP-P2-CX-032

Issue 11

Do not scale

Appendix A

Record of soil inspection

Woodsmith Mine soil management plan record of inspection

DATE:	
INSPECTOR	
CLIENT/CONTRACTOR STAFF -	
WEATHER (Note any occurrence of rain in previous period*)	

ACTIVITY

Topsoil strip Subsoil strip Subsoil placement Topsoil placement

LOCATION	**SOIL DESCRIPTION**

PHOTOGRAPH	**NOTES**

On the basis of the inspection carried out, the soil inspected **IS / IS NOT**[#] in a suitable condition to be handled for the activity stated above.

delete as appropriate

* Between 01 April and 30 September note rainfall in preceding 24 hours
  Between 01 October and 31 March note rainfall in preceding 7 days.

Signature

……..

Notes on field assessment of suitability

The planning permission for the mine requires that soils are only handled when in a dry and friable condition. In this condition, the soil should crumble when handled, should not stick to a blade and should not smear.

The following method may be employed as a field test to assess suitability for soil stripping:

Mould a small ball of soil between the fingers, then form the soil into a thread around 6mm diameter between the first finger and thumb of each hand. Continue to roll the thread on a smooth surface from finger-tip to the second joint, using gentle pressure to keep reducing the diameter of the thread. For the soil to be acceptable, it should not be possible to roll into a thread less than 3mm diameter without the thread breaking.

For soil placement, the soil should be dry to the touch, crumble when handled and it should not be possible to form the soil into a ball.

NYMNPA

29/07/2019

SIRIUS MINERALS PLC

Project Title / Facility Name:

North Yorkshire Polyhalite Project

Document Title:

NYMNPA 60 and 79 Surface Water Drainage Scheme

Document Review Status

- [x] 1. Reviewed – Accepted – Work May Proceed — By: Robert Staniland
- [ ] 2. Reviewed – Accepted As Noted, Work May Proceed, Revise & Resubmit — On: 25 Jul 2019 16:41
- [ ] 3. Reviewed – Work May Not Proceed, Revise & Resubmit
- [ ] 4. For information only

0	24-Jul-2019	Use	IFU			
B	19-Jul-2019	Review	IFR			
A	05-Jul-2019	Review	IFR			
Rev.	Revision Date (dd mmm yyyy)	Reason For Issue		Prepared by	Verified by	Approved by

Document ID:

40-ARI-WS-7100-CI-RP-01007

Sirius Minerals

Phase 11 Woodsmith Mine

NYMNPA 60 and 79 Surface Water Drainage Scheme

40-ARI-WS-7100-CI-RP-01007

Rev 0 | 24 July 2019

Job number 253285-00

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ARUP

Document Verification

ARUP

Job title		Phase 11 Woodsmith Mine		**Job number** 253285-00	
Document title		NYMNPA 60 and 79 Surface Water Drainage Scheme		**File reference** 0-12-08	
Document ref		40-ARI-WS-7100-CI-RP-01007			
Revision	**Date**	**Filename**	40-ARI-WS-7100-CI-RP-01007_A_IFR_20190521_Ph 11 NYM 60 79 SWD Strategy.docx		
Draft A	03 July 2019	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Chris Williams	Nick Ferro	Andrew Hornung
		Signature			
Draft B	19 Jul 2019	**Filename**	40-ARI-WS-7100-CI-RP-01007_B_IFR_20190715_Ph 11 NYM 60 79 SWD Strategy.docx		
		Description	For comment		
			Prepared by	Checked by	Approved by
		Name	Julia Beaumont	Nick Ferro	Alastair Gordon
		Signature			
Rev 0	24 Jul 2019	**Filename**	40-ARI-WS-7100-CI-RP-01007_0_IFU_20190724_Ph 11 NYM 60 79 SWD Strategy.docx		
		Description	Issue		
			Prepared by	Checked by	Approved by
		Name	Julia Beaumont	Nick Ferro	Andrew Hornung
		Signature			
		Filename			
		Description			
			Prepared by	**Checked by**	**Approved by**
		Name			
		Signature			

Press Control+Shift+D to insert or **Issue Document Verification with Document** ✓

Contents

Appendices

Appendix A

Phase 11 Masterplan

Appendix B

Phase 11 Drainage Layout

Appendix C

Micro Drainage Model Outputs

Appendix D

Outfall Velocity Calculations

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 11 construction activity at Woodsmith Mine (Phase 11 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 11 Works comprise:

- Development of landscape mitigation screening;
- Tree clearance within Haxby Plantation;
- Sinking of the MTS shaft via drill and blast method;
- Operation of the Galloway;
- Creation of materials handling area;
- Installation of external silencer to the dust collector of the Service Shaft building;
- Installation of batteries.

1.2 Surface water drainage strategy - compliance with conditions

The surface water drainage system that will be in use during Phase 11 is shown on the general arrangement drawing 40-ARI-WS-7100-CI-22-01057 in Appendix A. The changes between the previous planning phases and Phase 11 are outlined below:

- **Development of landscape mitigation screening**

  Material arisings from the sinking of the MTS shaft are to be placed within the landscape screening bunds within an area of Bund F (refer to planning drawing YP-P2-CX-032_11 Earthworks for bund locations).

  SW Drainage Impact Assessment: The works described above have an impact on the surface water drainage strategy, refer to Section 1.3.1 for details.

- **Tree clearance within Haxby Plantation**

  Further tree clearance within Haxby Plantation including stump removal.

  SW Drainage Impact Assessment: The works described above have no impact on the surface water drainage strategy during this phase, except

for the control of silt laden surface water run-off from the felled area into adjacent water courses. Refer to Section 1.3.2 for further details.

- **Sinking of the MTS shaft via drill and blast method**

  The sinking of the MTS shaft.

  SW Drainage Impact Assessment: The sinking of the MTS shaft will require the removal of material to surface level for the placement within the earthworks screening bunds and the treatment of wastewater within the Non Domestic Wastewater treatment plant prior to outfall into an upper tributaries of Sneaton Thorpe Beck. Refer to Section 1.3.3 for further details.

- **Operation of the Galloway**

  The operational of the Galloway to support shaft sinking

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

- **Creation of materials handling area**

  The creation of an additional hardstanding platform area for the management of arisings from the sinking of the MTS shaft.

  SW Drainage Impact Assessment: The works described above have an impact on the surface water drainage strategy, refer to Section 1.3.4 for further details.

- **Installation of external silencer to the dust collector for the Service Shaft building.**

  The installation of an external silencer to the dust collector for the Service Shaft building is to be provided on the existing construction platform, which has formed the basis of previous planning phases.

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

- **Installation of batteries.**

  The installation of batteries as part of the power distribution system on an area of existing hardstanding constructed during previous planning phases.

  SW Drainage Impact Assessment: The installation of batteries on an existing area of hardstanding does not impact on the surface water drainage strategy with surface water drainage from the area passing through the oil separators and attenuation ponds. Refer to Section 1.3.5 for further details.

1.3 Phase 11 Works

1.3.1 Development of landscape mitigation screening

The development of the landscape mitigation screening mounds 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 11 earthworks (as described on drawings 40-ARI-WS-7100-CI-22-01055 and 40-ARI-WS-7100-CI-18-01061) will involve the exposure of unfinished ground in preparation for deposition of materials extracted from the MTS shaft 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; refer to Section 4. 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 MTS shaft 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 Section 2.4. The basal drainage will be collected and conveyed to the bund perimeter swale which outfalls in to 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. This is described in more detail in Section 2.5.6. Refer to drawing 40-ARI-WS-7100-CI-22-01064 for 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 Section 2.4. 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 Soil Management Plan (40-ARI-WS-7100-CI-PL-01000).

1.3.2 Tree clearance within Haxby Plantation

The clearance of trees within Haxby Plantation has the potential to increase the level of silt laden surface water run-off entering the upper tributaries of Sneaton Thorpe Beck.

Prior to commencing the tree clearance works, silt fences will be installed around the area to be felled to minimise the potential for silt laden surface water run-off. This will include adjacent to all watercourses where the area of felled trees drains towards.

Once the trees have been removed, bare surfaces will be left rough to encourage infiltration and minimise surface runoff. Any areas that are going to be left exposed for more than three months will be grass seeded as early as possible in the appropriate season. Grips will also be installed where required perpendicular to the direction of run-off to intercept overland flows and minimise direct run-off

to the watercourse downstream. No other works are proposed in the area which would result in an increased rate of surface water run-off.

1.3.3 Sinking of the MTS shaft via drill and blast method

During the sinking of the MTS shaft, all extractive material will be brought to the surface and tipped onto a bunded concrete slab, the "muck-bin". Any free draining water will initially drain from the extractive material to a sump where it will be collected. Extractive material will then either be taken directly to the screening mound for placement or to the materials handling area for further conditioning.

Water from the muck-bin will be collected and transferred to the non-domestic wastewater treatment plant for treatment prior to discharge into Sneaton Thorpe Beck (approved as part of the Phase 9 submission) or tankered off site.

Groundwater extracted during the shaft construction is to be treated in the non-domestic wastewater treatment plant prior to outfall or tankered off site as outlined in the Construction Method Statement. Treated water will be discharged into the surface water drainage network in accordance with Environmental Permit EPR/LB/3797VJ. The overall discharge from site will be managed to ensure that the flood risk from the site is not increased. This management will include ensuring that during periods of high rainfall, non-domestic wastewater will be buffered and retained on site within storage tanks to ensure that the permitted drainage outfall rates from the site are not exceeded.

1.3.4 Creation of materials handling area

The creation of a materials handling area consists of the provision of a 0.34ha additional concrete paved hardstanding and access road as shown on drawing 40-ARI-WS-7100-CI-18-01063. Surface water run-off from the extractive material handling area will be captured in a drainage feature on the down gradient side. This drainage feature will take the form of a settlement ditch and attenuation storage, attenuating run-off to the greenfield run-off rate.

Earthwork embankments required to form the platform will be drained by a filter drain, with an outfall to Wetland C. This area is already accounted for in the sizing of the attenuation ponds.

The drainage system for the materials handling area has been designed to drain to either the attenuation ponds or the non-domestic wastewater treatment facility. This will be subject to on-site water quality testing to ensure that agreed surface water quality trigger levels are not exceeded. In periods of high rainfall, the drainage ditch will outfall directly into Wetland C and the main site attenuation ponds. This will be via a penstock which can be closed, and the water outfall diverted to the treatment facility if required. This is most likely during periods of low rainfall when any run-off from the hardstanding will comprise groundwater draining from the extractive material.

A storage volume of 326m^3 is provided based on a quick storage estimate calculation using the critical duration rainfall for a 1-in-20 year return period event assuming no outfall from the drainage feature during the event.

To reduce the risk of silty run-off from the platform discharging into the wider drainage network, the ditch is designed to collect surface water run-off and

encourage settlement of larger particles prior to the water flowing over a weir into an attenuation area.

The area will be used for the conditioning of extractive material prior to placement in the landscaping mounds. Only earthworks plant will be used within the area with similar procedures for the control of potential pollution as if the plant was being used on the earthwork mounds. It is therefore not proposed to provide an oil separator. However, in the event of an oil spill the penstock will be closed to control any oil discharge from the area and the surface water drainage diverted to the non-domestic wastewater treatment plant for treatment. No refuelling or servicing of plant will be undertaken within the area.

1.3.5 Installation of batteries

Batteries are proposed to be constructed on an area of existing hardstanding as defined on drawing 40-ARI-WS-7100-CI-22-01055. These are to be constructed on an area of existing hardstanding granular platform which is drained via an existing oil interceptor and outfalls via the main site attenuation ponds.

The area is an existing hardstanding area and therefore the construction of the batteries does not result in an increase in the drained hardstanding area already accounted for in the surface water drainage strategy.

As part of the battery installation, transformers will also be provided as detailed on the drawings. These will be constructed on bunded concrete slabs to ensure any leakage of oil is contained within the concrete bund and that it does not enter the surface water drainage system.

1.4 Compliance with conditions

The wording of planning condition 60, and where the necessary material has been provided within the report, is set out in the table below:

NYMNPA 60	**Compliance with Condition 60**
Surface water management at the Doves Nest Farm site during construction shall incorporate measures to slow water flow such that sediment settles out prior to surface water draining from the site into the Sneaton Thorpe Beck. Prior to the commencement of each Phase of Construction the design of the surface water management system at Doves Nest Farm shall be submitted to and agreed in writing by the MPA to ensure it incorporates measures that may be required to prevent sediment entering the Sneaton Thorpe Beck causing harm to the brown trout population present there.	Refer to this report and the Surface Water Management Plan in Section 4.

The wording of planning condition 79, and where the necessary material has been provided within the report, is set out in the table below:

NYMNPA 79	**Compliance with Condition 79**
Prior to the commencement of each Phase of Construction at Doves Nest Farm, a detailed Surface Water Drainage Scheme for that phase of construction, based on sustainable drainage principles and an	Refer to this report and appendices for the surface water drainage scheme.

assessment of the hydrological and hydro-geological context of the development, shall be submitted to and approved in writing by the MPA.	Refer to Sections 2 and 3 for details.
The drainage strategy must demonstrate that surface water run-off generated up to and including the 1 in 100 critical storm will not exceed the run-off from the undeveloped site following the corresponding rainfall event.	This element of condition 79 does not need to be discharged for the Phase 11 Works because the 1 in 100 critical storm is only applicable to the post construction, operational phase.
The scheme shall include: *Confirmation that the surface water drainage system is to be built first so that it is available to provide the drainage for the construction phase as well as the completed mine head, and is to be in accordance with information provided in the Supplementary Environmental Information report (specifically Section 15 and Appendix C). Details of the surface water drainage system will include a plan for silt management and reduction during the construction phase;*	Refer to the Surface Water Management Plan in Section 4. Additionally, refer to Sections 2 and 3.
The scheme shall include: *In order to construct the settlement facility/facilities some site preparation works have to be undertaken before the settlement facility/facilities are operational - details of temporary silt reduction and management measures shall be included;*	Refer to the Surface Water Management Plan in Section 4. Additionally, the site preparation works have been completed.
The scheme shall include: *Surface water discharge rates from the impermeable areas of the site are to be limited to greenfield Qbar flows as calculated in Section 4 of the submitted Baseline Surface Hydrology Report (an overall maximum surface water discharge of 119 litres per second distributed over three watercourses);*	Refer to Section 3 and Appendices C and D. As approved in the previous planning phases and in accordance with the Supplementary Environmental Information report, an overall maximum surface water discharge of 6.5 litres per second per hectare is applied to the surface water drainage design.
The scheme shall include: *Sufficient attenuation storage for up to and including the 1 in 100 year storm event plus a 30% allowance for climate change, and surcharging the drainage system can be stored on the site without risk to people or property and without overflowing into a watercourse;*	This element of condition 79 does not need to be discharged for the Phase 11 Works because the 1 in 100 critical storm is only applicable to the operational phase.
The scheme shall include: *Details of the design of the attenuation storage basins;*	Refer to Sections 2 and 3. The details of the storage basins have previously included as part of previous planning phases.
The scheme shall include: *Details of the outfalls to watercourse(s), including the provision of a penstock, erosion protection measures and measures to ensure velocities are limited to no more than 0.3m per second unless otherwise agreed by the MPA in consultation with the Environment Agency;*	Refer to Sections 2 and 3.
The scheme shall include: *Details of how the whole surface water drainage system will be designed so as to maximise its biodiversity benefits;*	This element of condition 79 does not need to be discharged for the Phase 11 Works because the final

	restoration of the site will occur during later phases of the project.
The scheme shall include: *Drainage from the landscaped areas is to drain into the proposed swales, upstream of a check dam where required to reduce velocities;*	Refer to Sections 2 and 3 and previous planning phases.
The scheme shall include: *Details of the proposed rainwater harvesting system;*	This element of condition 79 does not need to be discharged for the Phase 11 Works because no permanent buildings are to be constructed in this phase.
The scheme shall include: *The provision of permeable surfacing on areas where it can be demonstrated that the risk of pollution is low;*	This element of condition 79 does not need to be discharged for the Phase 11 Works because no permanent permeable surfacing is proposed during this phase.
The scheme shall include: *Details of how clean roof water shall be discharged to ground;*	This element of condition 79 does not need to be discharged for the Phase 11 Works because no permanent buildings are to be constructed in this phase.
The scheme shall include: *Details of how the entire surface water drainage system will be maintained and managed throughout the lifetime of the development, including the construction phase. This must include details of maintenance to deal with any siltation of the attenuation storage basins and any resultant loss of capacity; and*	Refer to the Surface Water Management Plan in Section 4.
The scheme shall include: *A timetable for the implementation of the Surface Water Drainage Scheme, including during the construction phase. This is to include details regarding the phasing of the construction works demonstrating that the storage available during construction is maximised (i.e. that the period of time that only the minimum 1 in 20 standard of protection is kept to the shortest possible).*	Refer to Sections 2 and 3 and the Surface Water Management Plan in Section 4.
Development shall thereafter proceed only in strict accordance with the approved Surface Water Drainage Scheme and the timetable included within it. Once implemented, the Surface Water Drainage Scheme shall be retained and maintained throughout the lifetime of the development such that it continues to function in the manner intended and so as to ensure identified limits are not breached.	Refer to the Surface Water Management Plan in Section 4.

1.5 Site and location

The Woodsmith Mine site is located approximately 5 km south of Whitby bounded by the B1416 to the West/South. The site is located in the River Esk catchment and at the very upper reaches of the Sneaton Thorpe Beck.

1.6 Other documents key to this report

BWB prepared the Baseline Surface Hydrology report, Ref: LDT/2021/BSH [2]. This has been used to inform the surface water drainage (SWD) design.

The SWD design follows the principles set out in the Surface Water Drainage Design Parameters report, Ref: LDT/2021/SWDS [3] and the Surface Water Drainage - Design Basis Report for Dove's Nest Site, Ref: REP-P2-CD-001 [4].

The design has been developed in parallel with the masterplan for the site which is shown on Phase 11 masterplan drawing 40-ARI-WS-7100-CI-22-01055 in Appendix A.

1.7 Design guidance

The design standards and guidance used in the SWD design for the site include:

- Sewers for Adoption (7th Edition, 2012).
- BS EN 752 Drains and sewer systems outside buildings.
- DEFRA, Rainfall run-off management for developments – Report SC030219.
- Technical Guidance to National Planning Policy Framework (NPPF).
- Design Analysis of urban storm drainage – The Wallingford Procedure.
- CIRIA Report C697, The SuDS Manual, 2007.
- CIRIA Report C753, The SuDS Manual, 2015.
- CIRIA Report C609, Sustainable Drainage Systems – Hydraulic, Structural and water quality advice, 2004.
- CIRIA Book 14, The Design of Flood Storage Reservoirs, 1993.
- CIRIA Report 156, Infiltration Drainage – Manual of Good practice, 1996.
- Environment Agency and Department for Environment, Food & Rural Affairs, Pollution prevention for businesses, 12 July 2016.
- BRE Digest 365, Soakaway Design 2012.
- Environment Agency Guidance on Outfalls: Flood Defence Information Sheet No. 3.
- Fluvial Forms and Processes, A New Perspective, David Knighton, 1998.
- Open-channel hydraulics: New York, McGraw-Hill, Chow, V.T., 1959.

2 Phase 11 - Surface water drainage scheme

2.1 Design principles

The Phase 11 Works provides a continuation of the drainage principles incorporated and approved as part of the previous planning phases. The addition and expansion of the drainage network resulting from the proposed Phase 11 works follows the principles outlined in Report 40-ARI-WS-71-PA-RP-1050, (Phase 3 Works, NYMNPA 60 and 79 Surface Water Drainage Scheme) and Report 40-ARI-WS-7100-CI-RP-01001 (Phase 7 Works, NYMNPA 60 and 79 Surface Water Drainage Scheme and Report).

This report provides an update on how the drainage network constructed in the previous planning phases is adapted to meet the drainage requirements for the Phase 11 works. This report provides an updated standalone Surface water management plan and replaces the previous documents.

The document is also updated to include the principles agreed as part of the Environmental Permit, reference EPR/MB3399VR for the discharge of run-off and basal drainage of bunds at Woodsmith Mine.

2.1.1 General arrangement

The masterplan for the Phase 11 Works, drawing 40-ARI-WS-7100-CI-22-01055 is included in Appendix A.

2.1.2 Drainage features

A drainage plan of the Phase 11 works, drawing 40-ARI-WS-7100-CI-22-01057, is included in Appendix B. The drainage plan shows the principal drainage infrastructure for the drained areas during Phase 11, including silt fences, swales, ditches, check dams, carrier pipes, filter drains, oil separators, silt removal facilities, attenuation ponds, surface water treatment facility, wetlands and outfalls.

2.2 Surface water drainage catchments/sources

The SWD scheme has been designed to drain the hard-standing areas, the access road and the landscaped areas so that the development does not increase the flood risk to the surrounding area and manages flood risk at the site. The run-off from developed and disturbed areas during construction will be directed to a series of attenuation ponds prior to outfall to Sneaton Thorpe Beck.

The surface water drainage scheme is divided into a number of different catchment areas which are defined on the figure below.

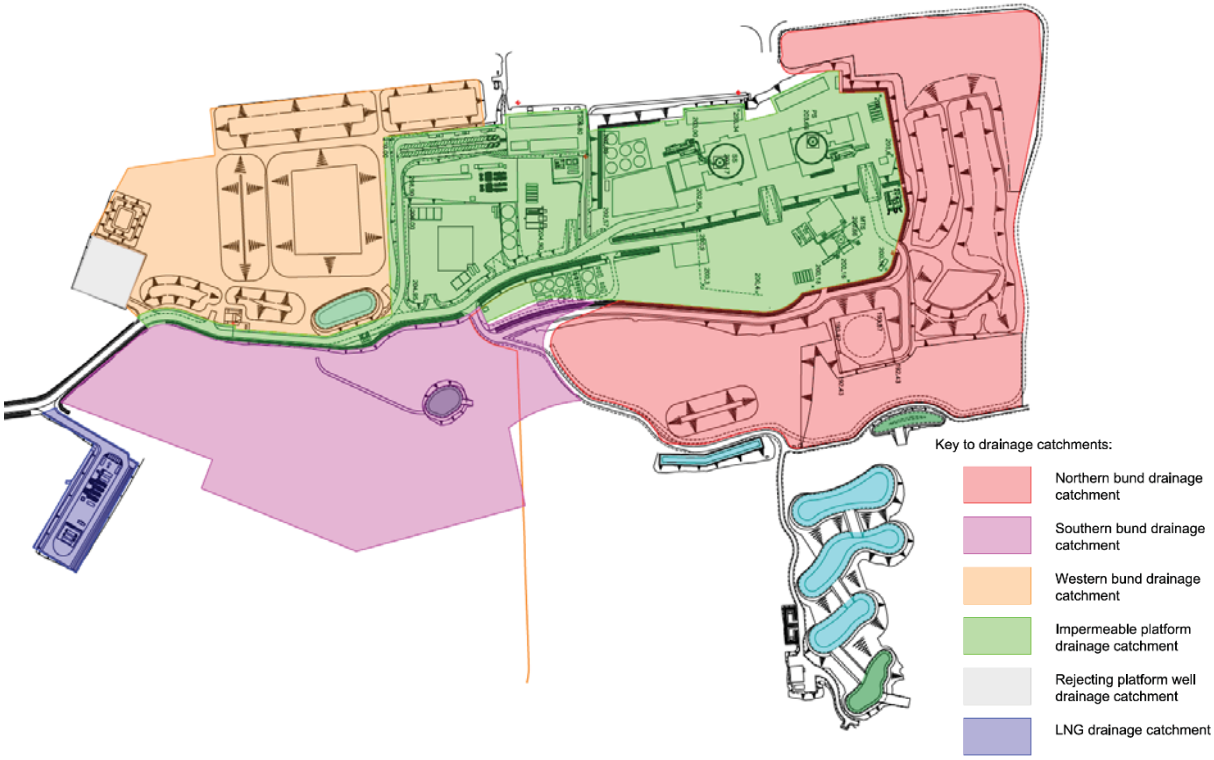


Figure 1: Woodsmith catchment areas

2.2.1 Impermeable platform / access road

All hardstanding and platform areas drain via gravity to the main site attenuation ponds located to the north eastern side of the site. Surface water run-off from the platforms and roads is collected in a series of ditches and swales which surround the platform areas.

The only exception to this is the areas around Haxby Plantation. There is a short section of the main site access road through Haxby Plantation which cannot gravitate to the main attenuation ponds, and as such is treated locally before discharging to the tributaries of Sneaton Thorpe Beck. The Liquified Natural Gas (LNG) facility and the reinjection well platform do not discharge to the main site attenuation ponds as described in sections 2.2.2 and 2.2.3 below.

Where the potential for contamination of surface water run-off by hydrocarbons has been assessed to be sufficiently high, the surface water run-off from these areas passes through an oil separator before being passed first to a silt removal facility and then through the site attenuation ponds and wetlands before discharging into the local watercourse.

Oil separators are provided on all SWD systems installed to collect and convey run-off from hard standing areas, with the exception of the extractive material handling area as described in Section 1.3.4 above. The separators are designed in accordance with the Environment Agency's "Pollution Prevention for Businesses" guidance. The locations of the separators are shown on drawing 40-ARI-WS-7100-CI-22-01057.

2.2.2 LNG facility

An LNG generator facility is located within Haxby Plantation as shown on the general arrangement layout drawing 40-ARI-WS-7100-CI-22-01055. This consists of an impermeable hardstanding area/platform with surface water run-off being captured in a drainage ditch on the down-gradient side. This drainage feature takes the form of an attenuation ditch, attenuating run-off to the greenfield run-off rate, prior to outfall into an adjacent watercourse. Therefore, the surface water drainage from this facility is kept separate to all other drainage catchments on the site.

The risk of silt laden run-off from the platform once constructed is low due to the entire platform been constructed with an impermeable concrete surfacing, however the attenuation ditch is maintained to remove any silt that does build up.

In case of oil spillage on the platform a small oil separator is located after the attenuation ditch prior to outfall. The outlet from the oil separator discharges into an existing small watercourse that runs through Haxby Plantation. The drainage strategy retains the pre-development hydrological regime as run-off from the platform area currently drains to this watercourse.

2.2.3 Reinjection well platform catchment

A small construction platform is located adjacent to the access road and Haxby plantation. This consists of a granular platform which is drained to platform boundary ditches / filter drains. Prior to discharge into an adjacent small watercourse, the surface water run-off passes through a small oil interceptor.

2.2.4 Permanent landscape screening bunds - northern catchment

The northern landscape screening bunds drainage catchment includes the landscape screening bunds in the northern half of the site and includes Bunds A and F (refer to planning drawing YP-P2-CX-032_11 Earthworks for bund locations. Surface water and basal drainage from the bunds is conveyed via a series of toe drains around the perimeter of the bunds.

During the construction phase the catchment drains through the main site attenuation ponds and surface water treatment facility. During the operational phase the catchment outfalls directly into an adjacent watercourse through wetland C.

2.2.5 Permanent landscape screening bunds – southern and western catchments

The western drainage catchment drains the temporary storage bunds constructed as part of the previous planning phases. Drainage from the temporary bunds is conveyed via a series of toe drains around the perimeter of the bunds and outfalls via Pond D and Wetland B into the main site attenuation ponds and surface water treatment facility.

The southern drainage catchment has not been constructed at this stage.

2.2.6 Temporary earthwork storage bunds

During the works to form the permanent landscape screening bunds there will be a requirement to provide temporary earthwork stockpiles (including topsoil and subsoil bunds) within the boundaries of the northern, western and southern landscape screening bund drainage catchments. Surface water run-off from these temporary bunds will be collected in a perimeter swale and conveyed through either the northern or southern landscape screening bunds drainage catchments and through the main site attenuation ponds.

Silt fences will be constructed at the base of all bunds to reduce sediment getting into the run-off. Check dams will also be constructed within the downstream toe drains to capture sediment.

2.3 Flood risk / surface water drainage attenuation

Flood risk is controlled across the site utilising a number of different drainage features described in sections 2.3.1 to 2.3.5 below:

2.3.1 Attenuation ponds

Attenuation ponds and wetlands are provided to the northern extents of the site and receive run-off from the hard-standing platform, laydown areas and landscape screening bunds under construction.

The ponds have been sized such that the greenfield run-off rate is not exceeded during the 1-in-20-year return period critical duration rainfall event. The drainage network has been designed such that no surface flooding occurs on the site during the 1-in-20-year return period critical duration rainfall event. If a rainfall event exceeds the design capacity, an emergency overflow is incorporated to allow water to discharge from the ponds without compromising their integrity. This is achieved by the width and gradient of the overflows and the erosion protection on the overflows.

During the construction phase, the discharge rate from the site is limited to the QBar greenfield run-off rate for return periods up to the 1-in-20-year rainfall event for the critical duration. The method of calculating QBar is detailed in the BWB Baseline Surface Hydrology report, Ref LDT/2021/BSH. [2].

During the construction phase, surface water drainage from the western drainage catchment area is temporarily diverted through an overland carrier pipe connecting to the main site attenuation ponds. This is to enable run-off from this area to receive final treatment in the surface water treatment facility to help minimise silt laden water being discharged off site.

2.3.2 Wetlands

Wetlands are proposed as part of the drainage network and form the final stage of SuDS treatment before discharge to the tributaries of Sneaton Thorpe Beck.

During the construction, the main site attenuation ponds outfall through a downstream wetland prior to outfall to Sneaton Thorpe Beck. This is a permanent wetland constructed to provide the final stage of treatment for run-off from the

hard-standing platform and laydown areas after passing through the attenuation ponds.

During the construction phase, all site surface water run-off, including from the landscape screening bunds will drain through this wetland prior to outfall off site.

2.3.3 Swales/ditches

Swales and ditches are to be used to collect surface water run-off at the toe of all landscaping screening bunds and around the perimeter of the hardstanding platform areas. There will be no change in the design principles for the already constructed swales and ditches in the previous phases. Refer to the general arrangement drawing in Appendix B.

All swales will incorporate check dams to create a terraced ponding effect, thus helping to attenuate the flow and capture sediment. Energy dissipation / erosion protection will be provided where required, downstream of the check dams across both the base and sides of the swale/ditch.

Swales and ditches will also be used to intercept any run-off from undisturbed areas so that this water does not flow onto disturbed areas of the construction. Where possible, these swales/ditches will direct the run-off to local ditches/streams without going through the attenuation ponds in order to mimic the natural and existing hydraulic characteristics of the site.

2.3.4 Flow controls

The discharge from all attenuation ponds, with the exception of Pond C in the main site attenuation ponds, will be controlled by flow control devices such as orifice plates. The attenuation ponds provided will ensure that the maximum allowable rate of discharge, equating to 6.5 litres per second per hectare, is not exceeded.

2.3.5 Outfalls

Outfalls from the surface water drainage system are designed to ensure velocities are kept to a minimum. Outfalls from wetlands typically comprise a wide weir with a gentle gradient slope to the watercourse. Water from the wetlands will trickle over this weir and onto the slope, which will have erosion protection to assist vegetation to establish.

Where small outfall headwalls are provided, these are designed to minimise outfall velocities and include small stilling basins / concrete upstands incorporated into the headwall unit where applicable.

2.4 Earthworks bunds drainage

2.4.1 Basal drainage

A basal drainage system is to be provided as shown on drawing 40-ARI-WS-7100-CI-22-01060. The basal drainage management system will comprise a

herringbone network of drainage pipes laid within drainage trenches surrounded by clean gravel.

The basal profile of each bund will be designed to encourage the flow of basal drainage towards a piped collection system. The base will be profiled to fall from the edges towards a series of carrier drains which typically fall in an easterly direction and outfall in the bund perimeter drainage swale. All carrier pipes will consist of 225mm internal diameter non-perforated HDPE pipes.

Lateral drains will fall towards the carrier drains and will comprise 150mm internal diameter HDPE perforated pipe. The maximum spacing of the lateral drains will be 60m with a total coverage of 0.75% of the total bund area.

The fall of the pipes will vary depending upon location but will not be less than 1 in 100 for the lateral and carrier drains. All pipes will be jointed using welded joints.

The carrier drain will drain under gravity to the bund perimeter swale. During the construction of the bund and for a period of approximately two years following completion of the mound, the drainage from the bund and perimeter swale will be routed through the main site attenuation ponds.

2.4.2 Earthwork surface drainage

A surface water drainage collection system will be installed below the restoration soil layer as shown on drawings 40-ARI-WS-7100-CI-22-01065 and 01066. The drainage system will consist of a series of 150 / 225mm internal diameter twin wall perforated filter drains installed across 3% of the bund surface area. The filter drains will be installed before placement of the restoration sub soil and top soil across the bund in a series of filter trenches constructed at the base of the sub soil layer.

The surface water drainage system will drain and outfall into the bund perimeter drainage swale where it will combine with any drainage from the bund basal drainage system.

2.4.3 Mound construction surface water management

The landscape screening bunds will be formed in a series of one-hectare areas. Initially top soil and sub soil will be stripped to a total depth of 0.7m with extractive material with low pollution potential then being placed within the prepared one-hectare area. Any surface water run-off from the area during construction will be collected and discharged into the bund perimeter swale where it will be conveyed and collected in the site attenuation ponds. Any basal drainage will also be routed to the attenuation ponds where it will be diluted with other surface water drainage.

On completion of a one-hectare area the bund will be restored. At the same time an adjacent one-hectare area will be prepared, and extractive material placed within this new area, at any one time on site, a one-hectare area will be receiving extractive material with low pollution potential and an additional one hectare area will be in the process of being restored.

2.5 Surface water drainage quality

2.5.1 Oil Separators

Oil separators are provided on all SWD systems that are installed to collect and convey run-off from hard standing areas. The separators are designed in accordance with the Environment Agency's "Pollution Prevention for Businesses" guidance. The locations of the oil separators are shown on the drainage general arrangement drawing.

2.5.2 Silt removal facility

As part of the hardstanding platform drainage network, a silt removal facility is incorporated into the network prior to outfall into the main site attenuation ponds. This incorporates a lined, long, flat treatment ditch designed to settle out fine sediments that get past the silt fences and check dams. The ditch is lined with concrete canvas to enable easier dredging operations and incorporates a control valve on the outlet, so that dredging can be undertaken without sediment laden water escaping downstream to the attenuation pond.

The temporary connection of the western network discharges in the upstream end of the silt removal facility, thus providing additional settlement and retention time for the run-off from the western drainage network.

2.5.3 Surface water treatment facility

To further minimise the risk of surface water with a high concentration of suspended solids discharging from the site, a surface water treatment facility is incorporated into the site surface water management system between the discharge from Pond C and Wetland A. The function of the treatment facility is to aid sediment removal, in addition to the other measures already present on site.

This consists of a package treatment plant provided by Siltbuster, which uses a coagulant and settlement to remove suspended solids from the site run-off. In addition to suspended solids, the surface water treatment facility allows for the pH to be managed within permitted limits by dosing the treatment stream with carbon dioxide.

The Siltbuster plant has a total throughflow capacity of 67l/s. Of the three attenuation ponds in the northern catchment, ponds A and B provide enough passive storm run-off attenuation to ensure the peak flow rate, having a 1-in-20-year critical duration storm, remains below the permitted discharge rate for drainage.

Pond C then provides further attenuation to limit this peak flow rate to the available Siltbuster capacity of 67 l/s. This is achieved by automatically starting the pumps supplying the Siltbuster when the water depth in pond C reaches 300mm, and only stopping them when the water level reaches a specified minimum level. If the pond and plant capacity is exceeded, the run-off will bypass the Siltbuster and discharge via the Pond C spillway to the downstream Wetland A. This will be diluted in the wetland by the treated water stream before discharging to the watercourse.

2.5.4 Additional sediment control

In addition to the silt removal facility, attenuation pond, swales / ditches and check dams, there will be further sediment control techniques and features such as silt fences provided at the toe of the bare landscape screening bunds.

2.5.5 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.

Table 2.0 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		

2.5.6 Basal drainage water quality

In the event that through testing it is shown that the outfall water quality does not meet the agreed quality standards, the basal drainage system is designed to enable it to be isolated and any basal drainage collected separately from the surface water drainage system. Catchpit manholes are provided prior to the outfall into the bund perimeter drainage ditch as shown on drawing 40-ARI-WS-7100-CI-22-01064. These catchpits are also linked together by the provision of the basal drainage network. Flows through the system are anticipated to be small, enabling this to be a safe operation.

In the event of the surface water quality triggers being breached the basal drainage system can be isolated with the provision of bungs in the outfall pipe on the downstream side of the catchpit. The drainage will then be pumped out of the catchpits identified on drawing 40-ARI-WS-7100-CI-22-01064. In dry conditions, water pumped from the catchpits may be recirculated onto the active extractive material management area. Otherwise, the water will be either treated in the non-domestic wastewater treatment plant prior to discharge or tankered off site.

Refer to the surface water management plan in Section 4 for further details.

2.6 Groundwater drainage

Prior to the commencement of construction on site two separate areas of groundwater seepage were evident on the eastern boundary of the site. These ground water seepages have effectively been cut off and have largely dried up as a result of developing the construction platforms and earthworks on site. Any small residual flows from these areas which will be collected by the basal drainage system and outfall into the bund perimeter swales and surface water drainage system. No other ground water will be drained through the surface water drainage system.

3 Modelling / calculation results

3.1 Calculation methodology

The layout for the Woodsmith Mine site has been assessed and the required attenuation volumes calculated.

The allowable rates of discharge from the ponds have been calculated based on the QBar greenfield run-off rate for the total contributing area.

For the Construction Phase, a 1-in-20 year return period design storm with no climate change allowance has been applied to a MicroDrainage model of the proposed networks. 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 on the networks and the attenuation is sufficient.

3.2 Design principles

For the impermeability values used in the design for the different area types, refer to Table 3.0. These values are conservative and have been derived using the Surface Water Drainage Design Parameters report, (reference LDT/2021/SWDS) [3], which is in accordance with BS EN 752.

Table 3.0: Specific impermeability for different area types

Area	Percentage Impermeable
Hard standing	100%
Disturbed bare soils	80%
Granular Access Road	80%
Not Vegetated Landscaped Bunds (temporary)	80%
Vegetated Landscaped Bunds	30%
Undisturbed Fields/grass	30%

Only surface water run-off is to be directed to the attenuation ponds, other sources of water, such as groundwater and wastewater, will not discharge to the attenuation ponds.

During the construction phase, the discharge rate from all the drained areas on site will be limited to the theoretical QBar greenfield run-off rate for return periods up to the 1 in 20 year event for the critical duration. This is in accordance with the sustainable drainage principles outlined in the Surface Water Drainage Design Parameters report, (reference: LDT/2021/SWDS) [3] and has been agreed by the Environment Agency in a letter dated 13th March 2014 (reference: RA/2014/127863/01-L01).

During the operational phase, the discharge rate will be limited to the theoretical QBar greenfield run-off rate for return periods up to the 1-in-100 year event for the critical duration.

3.3 Calculation results

The MicroDrainage model outputs in Appendix C and D demonstrate that the construction phase 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 QBar 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 without exceeding the allowable greenfield runoff rate.

Run-off Rates

The allowable QBar greenfield run-off rate is 6.5 l/s/ha, based on the Baseline Surface Hydrology report [2].

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.	131.8 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.

Volume of Attenuation

A summary of the MicroDrainage modelling results are shown in Table 3.2 and the modelling outputs are shown in Appendix C.

Table 3.2 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-22-01057 and Table 2.0 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 spillway).

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 131.8 l/s (Refer to Table 3.1 and Appendix C), which remains below the permitted discharge rate of 211.9 l/s.

3.4 Silt removal

As stated in the Surface Water Drainage Design Parameters report, Ref: LDT/2021/SWDS [3], a minimum of three stages of treatment have been provided to minimise the risk of sediments entering the tributaries of Sneaton Thorpe Beck. The Construction Phase incorporates silt fences, swales and ditches with check dams, filter drains, infiltration to ground, oil separators with silt traps, a silt removal facility; a series of attenuation ponds; a surface water treatment facility and wetlands.

Final treatment to remove silt occurs in the surface water treatment facility, which is designed to meet the following performance requirements prior to discharge of the treated water to Sneaton Thorpe Beck:

1. Total Suspended Solids (TSS) <50mg/l, and
2. Turbidity: 50FTU, and
3. pH STB 1 = 4.2 to 8.3
4. pH STB2,3A & 4A = 5.7 to 8.9

3.5 Outfall velocities

Appendix D contains an assessment of the existing tributaries of Sneaton Thorpe Beck downstream of the site. The assessment demonstrates that a maximum allowable velocity of 1.2m/s would be appropriate for these tributaries.

There are three outfalls to be used during the Construction Phase, as shown in the Surface Water Drainage Masterplan in Appendix B.

One of the outfalls drains the granular reinjection well platform, which will be drained via filter drains and a catchpit, through an oil separator and into the ditch via an outfall headwall. This has not changed since the previous phase and therefore the previous calculations remain applicable. The calculations show that using an outfall with an up-stand or “stilling basin” the maximum velocity discharging in the critical storm event is 0.59 m/s. This is less than the allowable discharge rate of 1.2m/s and therefore can be considered acceptable.

Another outfall drains the LNG platform in Haxby Plantation. This has not changed since the previous phase and therefore the previous calculations remain applicable. The calculations show that using an outfall with an up-stand or “stilling basin” the maximum velocity discharging in the critical storm event is 0.21 m/s. This is less than the allowable discharge velocity of 1.2m/s and therefore can be considered acceptable.

For the northern network the modelled peak velocity at the outfall for the critical storm event is 0.20m/s (refer to Appendix D). This is less than the allowable discharge velocity of 1.2m/s and therefore can be considered acceptable.

4 Surface water management and maintenance plan

The following section provides a surface water management plan for constructing the landscape screening bunds. There are a range of methodologies for managing sediment contaminated surface water run-off, with the method used being dependent on the volumes of surface water run-off and the levels of sedimentation. The surface water drainage masterplan is shown on drawing 40-ARI-WS-7100-CI-22-01057. This drawing shows the location of the main drainage network and the features to manage sediment. Typical details of the drainage features are shown on drawings 40-ARI-WS-71-CI-DR-3011 to 3014 submitted as part of previous planning phases.

4.1 Design Principles

As far as practicable, surface water run-off from areas of hard standing will be kept separate from those areas where sediment contaminated surface water run-off is anticipated. While run-off from areas of hard standing is not anticipated to generate large quantities of sediment, this surface water will be collected in hard standing perimeter ditches with check dams and passed through oil separators, a silt removal facility, attenuation storage ponds, a surface water treatment facility and a wetland before being discharged to the tributaries of Sneaton Thorpe Beck.

Surface water run-off from temporary earthwork bunds and permanent landscape screening bunds will be controlled by the aid of swales with check dams and cleansed with hay/heather bales and silt fencing before being passed through the treatment train of attenuation ponds, a surface water treatment facility and wetlands. There will be multiple secondary silt fences positioned downstream of some swales to intercept, slow and treat any water that seeps over the edge of the swales to mimic a more ‘natural’ response and avoid surface water ‘sheeting’ off the slopes.

The drainage of the main access road connecting the site entrance and the platform will combine with the drainage from the platform and drain through the treatment train. There is a short section of the access road near the main site entrance that cannot gravitate to the main attenuation pond. For this section of the access road, local measures will be applied within the water courses including the provision of check dams and heather bales.

4.2 Discharge Monitoring

The discharge from the wetlands will be monitored for suspended solids in accordance with the Groundwater and Surface Water Monitoring Scheme, using a combination of visual monitoring and turbidity meter monitoring in accordance with the Groundwater and Surface Water Monitoring Scheme. If the trigger levels are exceeded the appropriate plan of action will be implemented in accordance with the remedial action plan. Depending on the results a number of options are available:

- The penstock on the attenuation pond can be temporarily closed or partially closed to temporarily reduce the flow to the watercourse and

increase the retention time to allow the sediments to settle out. This will be particularly effective for short intense storms. These temporary measures can be put in place without compromising the overall drainage strategy. This would be actively managed so that the pond is empty before the next storm event occurs.

- Additional treatment such as hay/heather bales and silt fences could be put in place in the tributaries of Sneaton Thorpe Beck downstream of the outfall locations but still within the site boundary. An experienced drainage engineer or geomorphologist is to supervise the placement of these features to maximise sediment removal. These additional treatments will be readily available and stored local to the beck, should the need arise.
- An environmentally friendly coagulant can be used in specific check dams upstream of the silt removal facility to promote flocculation of the finer particles within the storage areas and speed up the settling rate.

In addition to inspections of the discharges, regular monitoring of the tributaries of Sneaton Thorpe Beck will be undertaken, as detailed in the Groundwater and Surface Water Monitoring Scheme, to ensure that the discharge is not causing discoloration, erosion of the bank or disturbance of the bed of the watercourse. Records of all monitoring will be kept along with actions that were taken in the event of issues arising.

4.3 Maintenance and Inspection

During the works all permanent landscape screening bunds and temporary soils storage bunds are to be grass seeded as soon as practicable to ensure that sediment laden surface water run-off is minimised. Erecting silt fences at source around these earthwork bunds, in combination with swales and check dams is the main method to prevent siltation getting into the drainage system. Silt fences are to be installed to manufacturer's recommendations.

Silt fences and check dams will be monitored through regular surveys. If silt builds up and 30% of the available storage is used up, then scraping, dredging or emptying and re-profiling will be undertaken to ensure the full storage volume is maintained.

The silt removal facility and attenuation storage will be monitored through regular surveys. If silt builds up to a depth of 200mm then scraping, dredging or emptying and re-profiling will be undertaken to ensure the full storage volume is maintained.

All check dams are to be regularly inspected, and any silt build up behind the dam will be removed to ensure that full storage volume and the effectiveness of the check dams are not compromised.

Throughout the Works, the surface water drainage system will be inspected on a daily basis to ensure that it is in good working order and when necessary all pipework, swales and other drainage elements, such as the oil separators and flow control devices, shall be cleaned out to guarantee unobstructed flow and prevent build-up of sediment. Any extracted sediment will be redistributed thinly over the works area to dry out and become integrated into the landscaping.

Due to the nature of the works, and their phasing, the drainage arrangements will alter during construction and as a result, the Surface Water Management Plan will be a live and flexible document. While the attenuation pond will be sized to take account of storm events, the flexibility of the Plan will also allow rapid response to weather conditions and unexpected events.

4.4 Basal Drainage

If through the monitoring of the outfall quality, trigger levels are being breached as a result of the basal drainage system the system is designed such that basal drainage can be diverted from discharging into the bund perimeter swale. This will include placing pipe bungs in the outfall pipe from the catchpits identified on drawing 40-ARI-WS-7100-CI-22-01064 to prevent any basal drainage leaving the basal drainage system.

Basal drainage can then be either recirculated back onto the active placement area for dust suppression or pumped from the catchpits identified on drawings 40-ARI-WS-7100-CI-22-01060 and 40-ARI-WS-7100-CI-22-01064 and transferred to the non-domestic waste water treatment plant prior to outfall or being tankered off site.

4.5 Materials Handling Area

The materials handling area is designed so that surface water run off can either be outfalled into the main site attenuation ponds or pumped to the non-domestic wastewater treatment plant for treatment prior to outfall. If through testing it is identified that outfall trigger levels are being breached a penstock is provided to enable the flows to be isolated and surface water runoff attenuated within the material treatment area for treatment.

5 Conclusions

This report and design demonstrates how the surface water drainage will be managed on site during the Phase 11 Works. The proposed arrangements will ensure that the site is not at risk of flooding and does not impact on flood risk elsewhere.

The MicroDrainage model outputs demonstrate that the design described in this report meets the requirements set out in the planning conditions. The discharge rates from the developed areas have been limited to the Q_{Bar} greenfield run-off rates and the volume of attenuation provided is sufficient to attenuate flows up to the 1-in-20-year return period event.

The design complies with the sustainable drainage strategy. An appropriate treatment train is proposed and the calculations demonstrate that the provision for sediment removal is sufficient prior to discharging to the watercourse and that the outfall velocity is appropriate to minimise the impact on the receiving water body.

This report demonstrates that the Surface Water Drainage design and management during the Phase 11 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 11 works, no new Land Drainage Consents will be required.

References

[1] North York Moors National Park Authority planning permission NYM/2014/0676/MEIA.

[2] Baseline Surface Hydrology, Ref LDT/2021/BSH, Revision F, BWB, 11/09/2014.

[3] Surface Water Drainage Design Parameters, Ref LDT/2021/SWDS, Revision D, BWB, 12/09/2014.

[4] Surface Water Drainage - Design Basis Report for Dove's Nest Site, REP-P2-CD-001, Rev 3, Arup, July 2014.

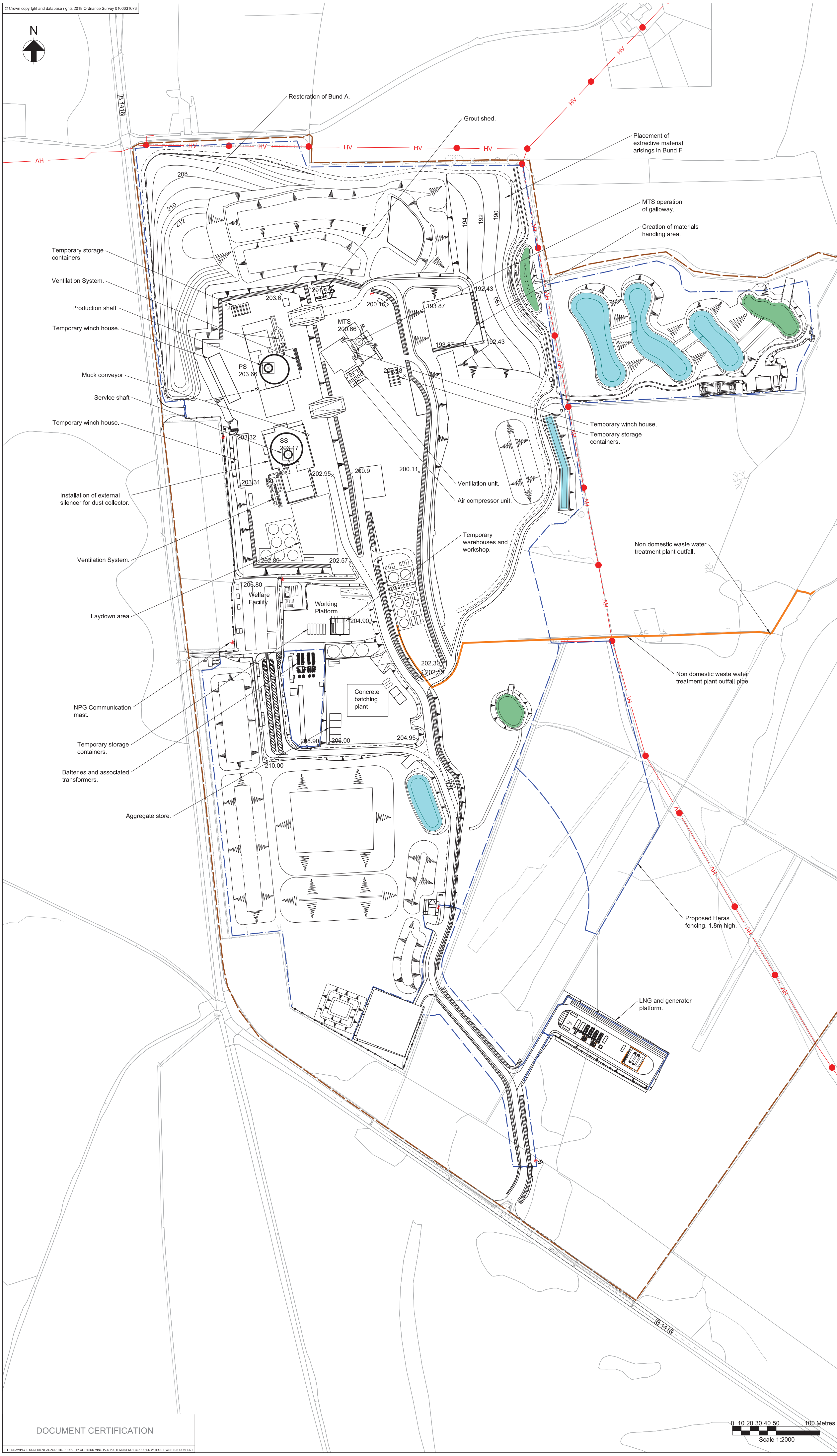
[5] Highway Improvement 2: Dove's Nest Farm Welfare Access B1416. Technical Note, TN-P10-DNF-CH-001, Rev A, Arup, November 2016.

[6] NYMNPA 60 and 79 Surface Water Drainage Scheme, 40-ARI-WS-71-PA-RP-1050, Rev 0, Arup, April 2017.

[7] Wastewater Management Strategy, 40-ARI-WS-7100-CI-RP-01002, Rev 0, Arup, August 2018.

Appendix A

Phase 11 Masterplan



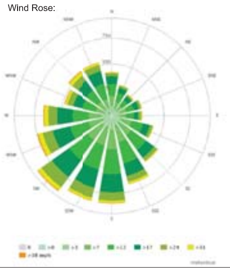
Key:

- Land ownership boundary
- Construction phase security fence
- 2.4m high palisade fence
- Topographical survey
- Proposed layout
- 3m high environmental barrier
- Proposed drainage ditch
- Surface water drainage attenuation pond
- Surface water drainage wetland
- Telecommunication mast
- Foreshaft / Shaft
- Temporary Heras fencing

Key to utilities:

- HV Existing Northern Powergrid electrical apparatus

Wind Rose:



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1	25/07/19	CG	JB	CW
	For issue			
0	19/07/19	KK	JB	CW
	For planning			
A	05/07/19	KK	JB	CW
	For comment			

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Drawing Title: Woodsmith Mine Construction Phase 11 Masterplan

SCALE: 1:2000

Job No: 253285

ARUP

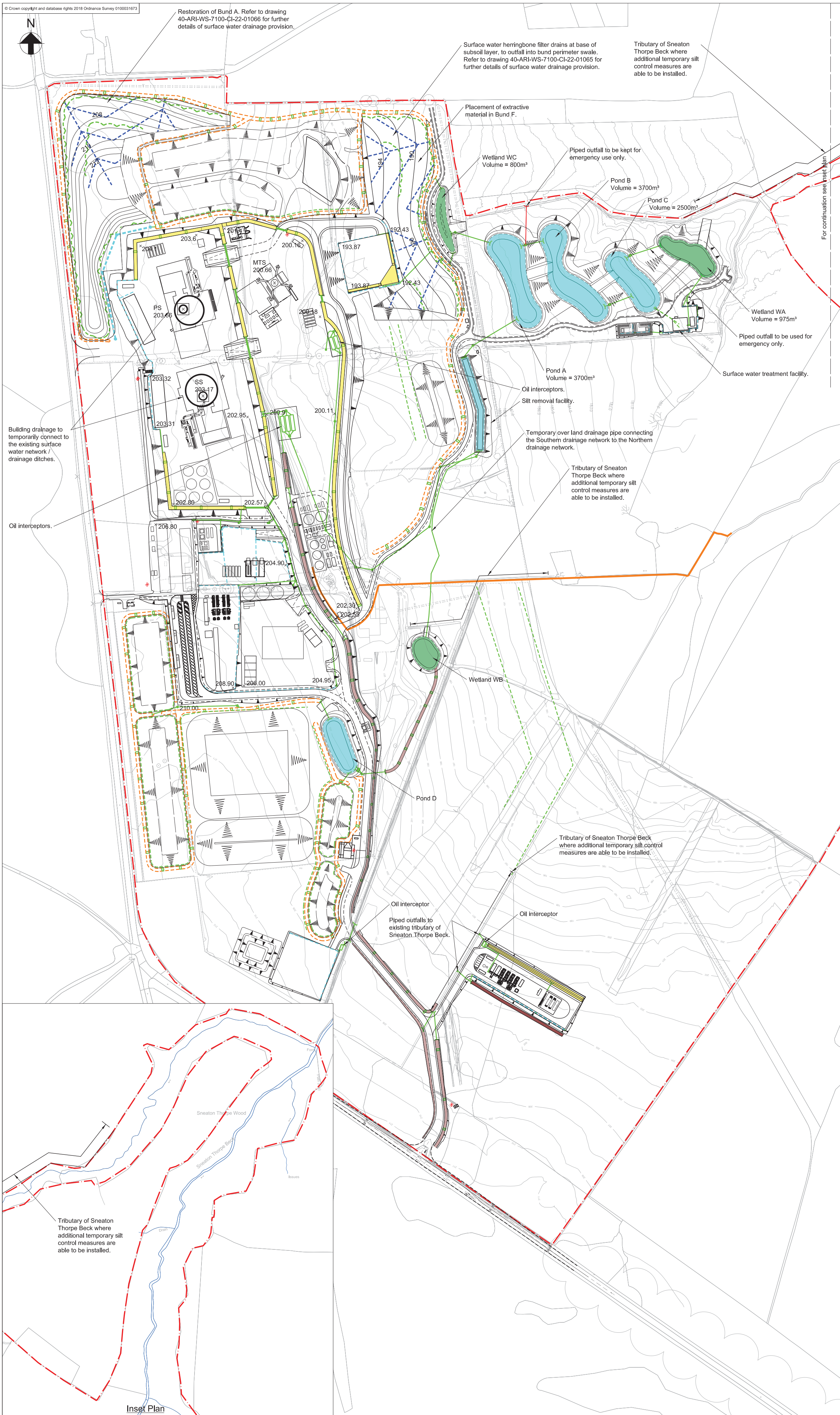
DRG No: 40-ARI-WS-7100-CI-22-01055

REV 1

DOCUMENT CERTIFICATION

Appendix B

Phase 11 Drainage Layout



DOCUMENT CERTIFICATION

THIS DRAWING IS CONFIDENTIAL AND THE PROPERTY OF SIRIUS MINERALS PLC IT MUST NOT BE COPIED WITHOUT WRITTEN CONSENT

Notes:

1. This drawing shows the proposed surface water drainage network for the Phase 11 works.

Key:

- Land Ownership Boundary
- Proposed General Arrangement layout
- Surface water drainage attenuation pond
- Wetland
- Existing watercourses / ditch
- Manhole and carrier pipe
- Swale
- Check dam
- Silt fence
- Ditch
- Ditch with impermeable liner
- Inlet / outlet headwall
- Filter drain
- Earthworks herringbone filter drain
- Non domestic waste water discharge pipe

\Global\europe\Leeds\Jobs\250000\253285-00\1-2 Arup - P10 Platform Redesign\0-20 CAD P10 - Platform Redesign\0_Drawings\Phase 11\40-ARI-WS-7100-CI-22-01057.dgn

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For issue				
0	19/07/19	KK	JB	CW
For issue				
A	05/07/19	KK	JB	CW
For comment				

SIRIUS MINERALS PLC

Drawing Title: Woodsmith Mine Site
Construction Phase 11
Drainage General Arrangement

SCALE : 1:2000

Job No: 253285

ARUP

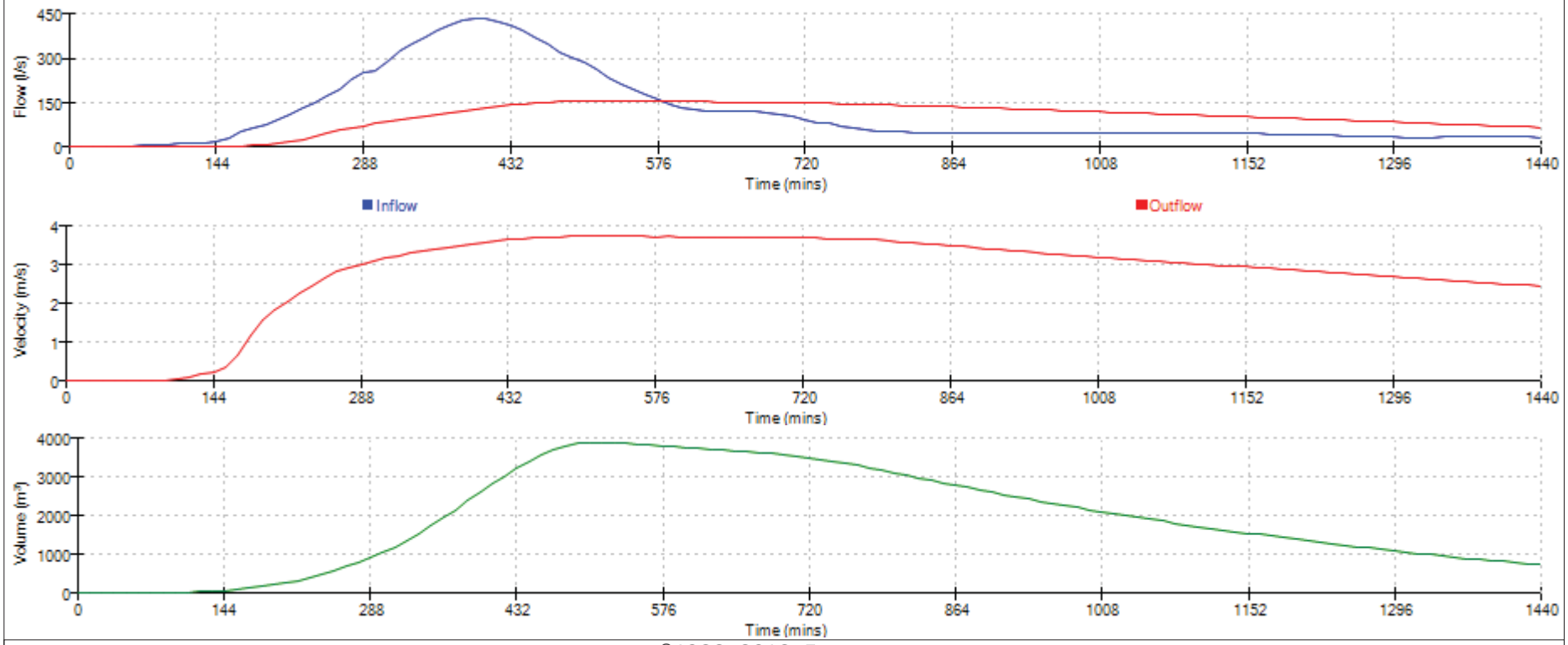
DRG No: 40-ARI-WS-7100-CI-22-01057

REV 1

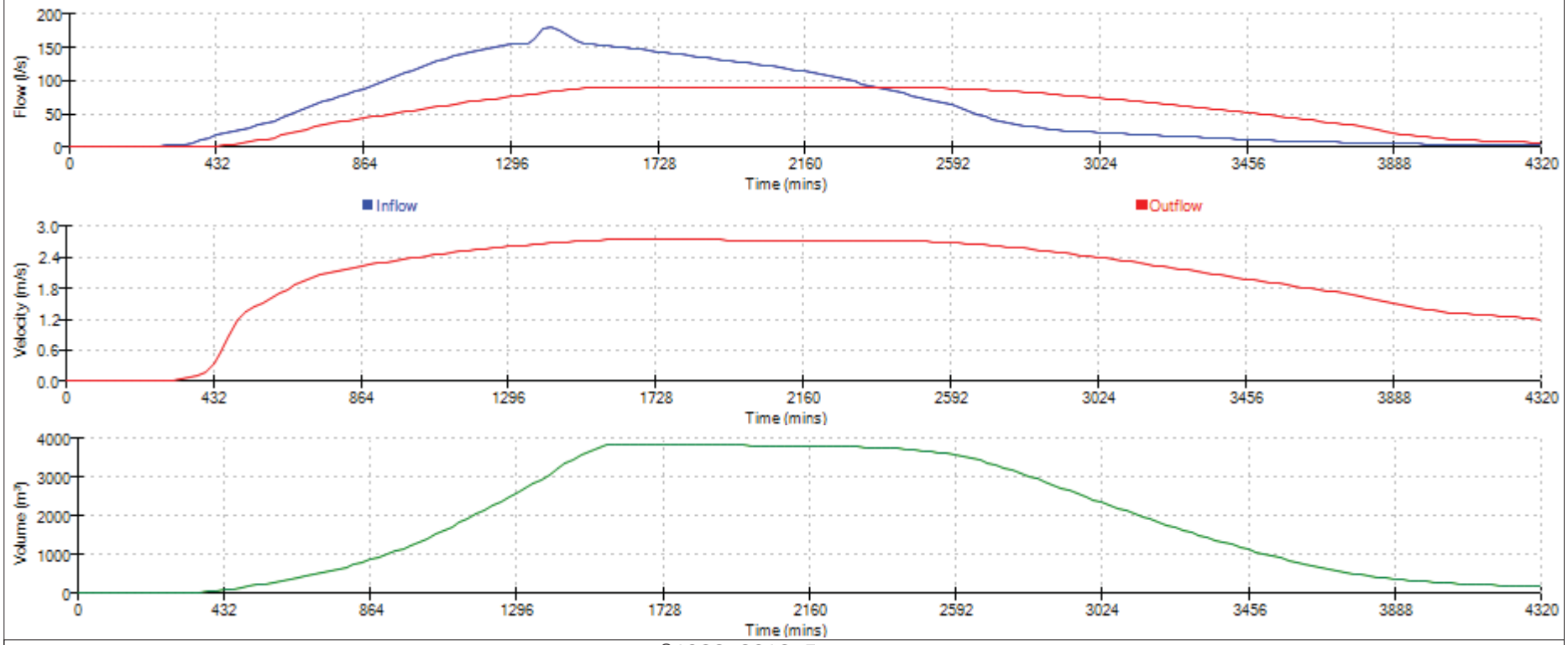
Appendix C

Micro Drainage Model Outputs

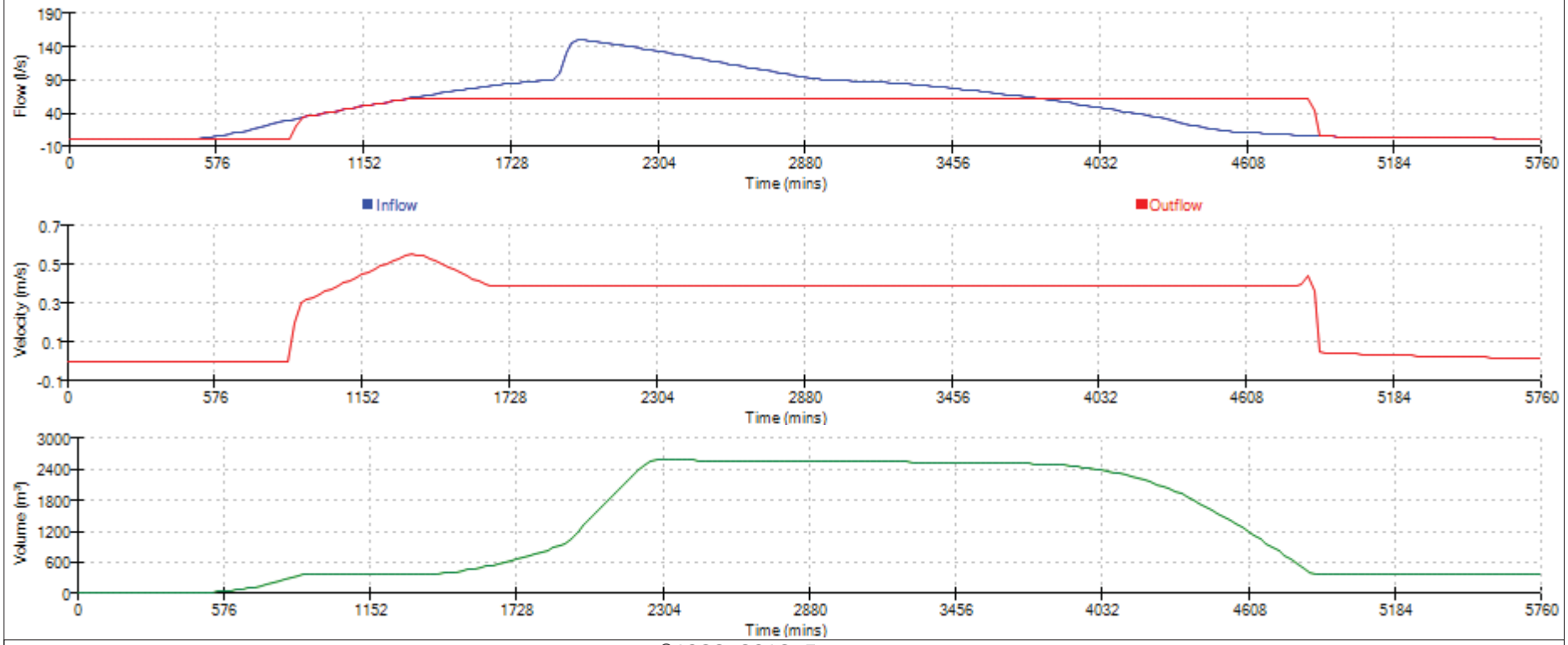
Graphs for Pipe PH3-N-1.036 US/MH PH3-N-1013 (Combined Networks)
720 minute 20 year Winter I+0%
Status: FLOOD RISK



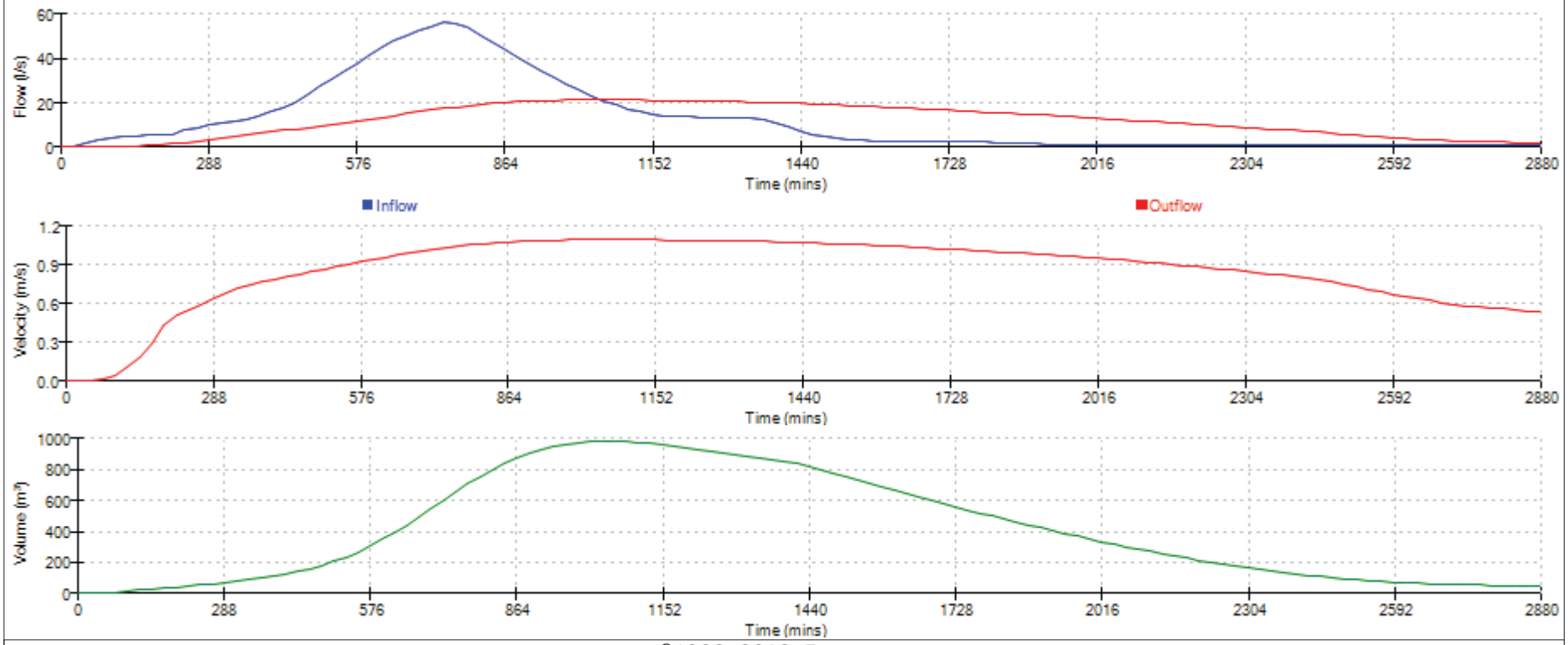
Graphs for Pipe PH3-N-1.037 US/MH PH3-N-1014 (Combined Networks)
2160 minute 20 year Winter I+0%
Status: FLOOD RISK



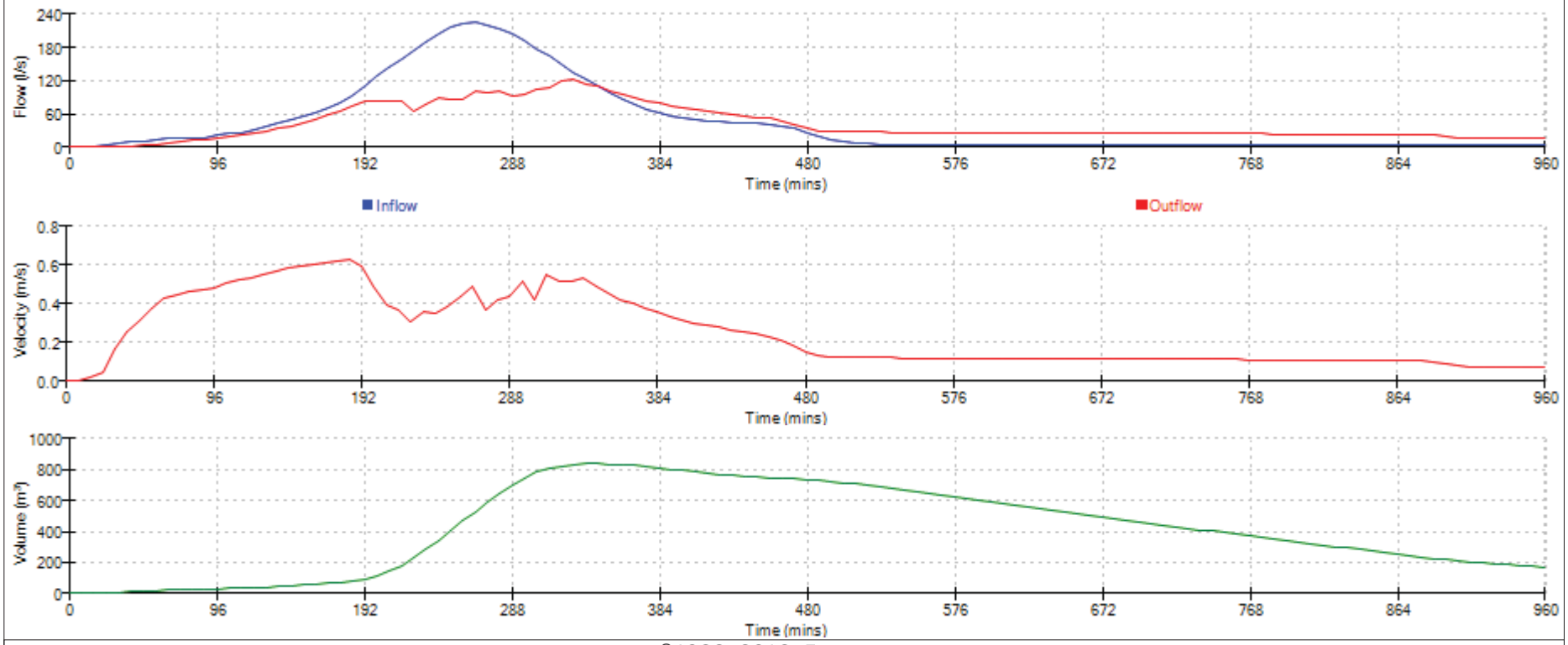
Graphs for Pipe PH3-N-1.038 US/MH PH3-N-1015 (Combined Networks)
2880 minute 20 year Winter I+0%
Status: FLOOD RISK



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



Graphs for Pipe PH3-N-24.029 US/MH PH3-N-610 (Combined Networks)
480 minute 20 year Winter I+0%
Status: FLOOD

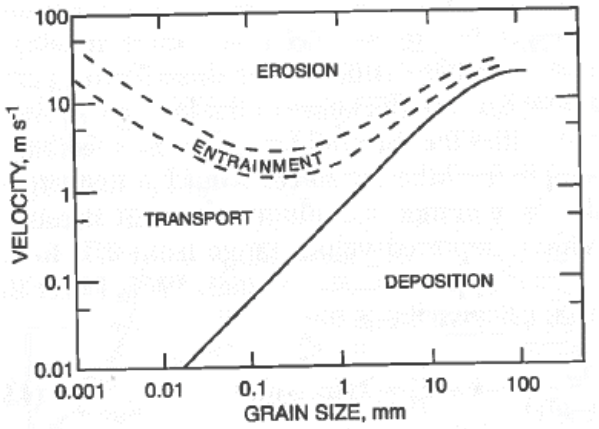


Appendix D

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*