A1 in Northumberland: Morpeth to Ellingham

Scheme Number: TR010059

6.48 Borrow Pit Dewatering Assessment

Rule 8(1)(c)

Infrastructure Planning (Examination Procedure) Rules 2010

Planning Act 2008

May 2021

Infrastructure Planning

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Development Consent Order 20[xx]

Borrow Pit Dewatering Assessment

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1 INTRODUCTION

1.1 PURPOSE OF ES ADDENDUM

1.1.0. This Environmental Statement Addendum (this "ES Addendum") to the Environmental Statement Addendum: Earthworks Amendments for Change Request [**REP4-061]** supports a request to amend an application for development consent [**REP6-010** and **011**].

1.1.1. As detailed in Environmental Statement Addendum: Earthworks Amendments for Change Request [**REP4-061**], an amendment to the application was proposed ("Earthworks Amendments") at Deadline 4 of the Examination.

1.1.2. The Earthworks Amendments includes changes to temporary and permanent earthworks within the Order limits along both Part A and Part B in order to reduce earthwork movement.

a. The changes for Part A are:

i. An extension to Parameters 4 and 5 for Part A, as set out in **Chapter 2: The Scheme** of the ES [**APP-037**].
ii. Permanent changes in the gradient and height of proposed earthworks.
iii. Additional temporary storage areas.

b. The changes for Part B are:

i. Permanent changes in the gradient and height of proposed earthworks.
ii. Additional temporary storage areas.
iii. Borrow pits.

1.1.3. Further details of the Earthworks Amendments are described further in **Chapter 2: Earthworks Amendments** of Environmental Statement Addendum: Earthworks Amendments for Change Request [**REP4-061**] and shown in **Appendix A: Proposed Amendment to Temporary and Permanent Earthworks Schedule** and **Figure 1: Landscape Mitigation Masterplan Part A** and **Figure 2: Landscape Mitigation Plan Part B** in **Appendix B: Figures** of Environmental Statement Addendum: Earthworks Amendments for Change Request [**REP4-061**].

1.1.4. On 9 April 2021, the Examining Authority (ExA) accepted the proposed amendments as part of the application.

1.1.5. Chapter 7 of Environmental Statement Addendum: Earthworks Amendments for Change Request [**REP4-061**] sets out a groundwater assessment for Borrow Pits 4 (A2E-CH570-NB-BPT-4) and 5 (A2E-CH570-NB-BPT-5). The dewatering assessment was limited to those Borrow Pits due to their proximity to the Ellsnook Round Barrow Scheduled Monument burial site, as detailed at paragraph 7.4.3 of [**REP4-061**].

1.1.6. As set out in the Environment Agency's Deadline 5 Submission [**REP5-044**], the Environment Agency requested a dewatering assessment was undertaken. As detailed at item 5, Bullet Point 2 of Table1-1 in the Applicant's Response to Deadline 5 and 5a Submissions [REP6-040], the Applicant committed to providing a dewatering assessment

for Borrow Pits 1 (A2E-CH586-SB-BPT-1), 2 (A2E-CH591-SB-BPT-2) and 3 (A2E-CH590-SB-BPT-3) at Deadline 7, which is reported in this ES Addendum.

1.1.7. This ES Addendum should be read in conjunction with the following chapters of the ES and ES Addendum:

a. Environmental Statement Addendum: Earthworks Amendments for Change Request [**REP4-061**];
b. 6.1 Environment Statement Chapter 10 Road Drainage and the Water Environment Part B [**APP-051**];
c. 6.1 Environment Statement Chapter 11 Geology and Soils Part B [**APP-053**];
d. 6.3 Environmental Statement Appendix 11.3 Ground Investigation Report Part B [**APP-318**];
e. 6.3 Environmental Statement Appendix 10.5 Drainage Strategy Report Part A [**APP-258**];
f. 6.3 Environmental Statement Appendix 10.2 Water Framework Directive Assessment Part B [**APP-312**]; and
g. 6.3 Environmental Statement Appendix 9.1 Habitats and Designated Sites Part B [**APP-298**].

2 GROUNDWATER IMPACT ASSESSMENT

2.1 INTRODUCTION

2.1.1. **Chapter 10: Road Drainage and the Water Environment Part B** of the ES [**APP-051**] considers the likely significant effects of the Scheme on Road Drainage and the Water Environment. **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**] sets out the groundwater impact assessment for Borrow Pits 4 and 5. Borrow Pits 1, 2 and 3 are proposed near Charlton Mires within Part B. The design and location of these borrow pits are set out in the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**] and require further assessment to determine the potential impact on the groundwater.

2.1.2. The objective of this ES Addendum is to supplement the work undertaken in Chapter 10: Road Drainage and the Water Environment Part B of the ES [APP-051] and Environmental Statement Addendum: Earthworks Amendments for Change Request [REP4-061] with specific considerations for the proposed borrow pits (Borrow Pits 1, 2 and 3) and their impacts on the groundwater flow regime and ultimately the groundwater resources. The assessment considers the three proposed borrow pit locations along Part B of the Scheme and includes an estimation for the potential radius of influence and groundwater inflow at the three borrow pit locations during the construction phase. This ES Addendum then highlights those structures which may have a significant impact on the groundwater flow pathways, groundwater levels and requirements for groundwater dewatering, and identifies structures where additional mitigation measures are required. The assessment determines the impacts on licensed water supplies, private water supplies and groundwater dependent designations. Shallow groundwater levels have been identified within the Order limits, which may be affected by excavation works and newly introduced below ground structures. Additional focus has been given to these potential impacts in the updated DMRB guidance (LA113).

2.1.3. The **Drainage Strategy Report Part B** [**REP6-021**] sets out the changes to drainage discharges to surface water. As detailed in the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**] a scoping exercise was undertaken for the Earthworks Amendments and is set out in the **Summary of Proposed Changes to Application** [**AS-017**]. This scoping exercise indicated that there would be no anticipated water quality issues following mitigation during construction of the borrow pits. The drainage design would not be altered meaning there would be no changes to the water quality assessment for the operation phase of the Scheme. Therefore, a Water Framework Directive Assessment for the borrow pits has been scoped out.

2.2 COMPETENT EXPERT EVIDENCE

2.2.1. The competent expert evidence presented in **Table 7-1** on the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**] has not changed for the groundwater assessment in this ES Addendum.

2.3 LEGISLATIVE AND POLICY FRAMEWORK

2.3.1. The legislative and policy framework for groundwater assessment has not changed since the publication of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**]. Therefore, the text within **Section 10.3, Chapter 10: Road Drainage and the Water Environment Part B**, of the ES [**APP-051**] and **Section 7.3** of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**] remains valid for the groundwater assessment in this ES Addendum.

2.4 ASSESSMENT METHODOLOGY

2.4.1. The assessment methodology followed in the groundwater assessment within the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**] has not changed. Therefore, the text within **Section 7.4** of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**] remains unchanged and valid for the groundwater assessment in this ES Addendum.

2.4.2. For the purposes of this ES Addendum more detailed descriptions of the local hydrogeological conditions at the borrow pit locations have been developed to undertake basic groundwater assessment on groundwater flow changes and groundwater discharge rates into the proposed excavations. The assessments exclude mitigation measures for high groundwater inflow zones which may be determined at detailed design stage. The results therefore represent a reasonable worst-case scenario.

2.4.3. In line with the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**], the expansion of the Sichardt equation (CIRIA 750) was used to estimate the potential radius of influence (lateral extent of the groundwater drawdown) and the potential rate of groundwater inflow into Borrow Pits 1, 2 and 3 during construction dewatering.

2.4.4. The equation for a two-sided cutting was used, as the excavations will mostly intercept the groundwater through the western and southern faces, groundwater inflow could occur from all sides and the base of the structure, this is given as:

$$Q = ((0.73 + (0.27 * P / H)) * (k * x * ((H2) – (h2))) / L)$$

Where:

P = Penetration below original water table (m)

H = Initial piezometric level (m)

k = Assigned permeability based on GI and BGS info (m/s)

x = Linear length of cutting (m)

h = Piezometric level (drawn down) (m)

L = Distance of influence (m, derived using Sichardt equation, with an empirical calibration factor

2.5 ASSESSMENT ASSUMPTIONS AND LIMITATIONS

2.5.1. The assessment assumptions and limitations for the groundwater assessment remain the same as **Section 7.5** of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**], as set out below.

2.5.2. The following assumptions apply to the Sichardt Equation (CIRIA 750):

a. Aquifer is unconfined
b. Aquifer has an infinite areal extent
c. Aquifer is homogenous, isotrophic and of uniform thickness

2.5.3. The following assumptions/limitations apply to the equation used to determine dewatering volume (trench one side (UC) CIRIA 750):

a. Aquifer is unconfined
b. Initial water table is horizontal
c. Aquifer is homogenous, isotropic and of uniform thickness
d. Lo is obtained using the Sichardt formula, taking C as between 1500 - 2000, the default value for C used in this spreadsheet is 2000. However, in high permeability soils where very large values of Lo are calculated, caution is needed. Chapmans equations were developed for ratios L0/H of <5 and may not be suitable for application where Lo is very large; flow rates may be significantly underestimated
e. Cuttings are only partial penetrating the unconfined aquifer below the original water table
f. Calculation assumes the cut area is completely dewatered
g. Recorded groundwater level (for a GI location) is assumed to be the original water table
h. Aquifer thickness may not have been proven in GI. If this is the case, a value that best represents conditions on site, based on experience and judgement, will be applied as is the case here
i. The equation assumes that the impact from dewatering affects the full aquifer thickness. In reality a minor cut (i.e. 5m into a 30m thick aquifer) is unlikely to impact the full aquifer depth beneath the base of the cut. In a deep or thick aquifer and for anisotropic conditions where Kv<Kh the influence of partial penetration on the yield of a well (or cut) is likely to be significantly diminished. This is not considered in the equation adopted.
j. Permeability may vary along the cut i.e. variable lithologies and variations in measured values may occur and there may not be fully represented by available GI data or the simplified approach to estimate discharge
k. Only groundwater inflow into the structures from the sides have been calculated. No consideration has been made for rainfall and runoff data.

2.6 STUDY AREA

2.6.1. As for the assessment presented in **Chapter 7** of **Environmental Statement Addendum: Earthworks Amendments for Change Request [REP4-061]**, the study area for the Road Drainage and the Water Environment assessment has not changed for the groundwater assessment. Therefore, the text within **Section 10.6** of **Chapter 10: Road Drainage and the Water Environment Part B** of the ES [**APP-051**] and **Section 7.6** of **Environmental**

Statement Addendum: Earthworks Amendments for Change Request [REP4-061] remains unchanged and valid for the groundwater assessment in this ES Addendum.

2.7 BASELINE CONDITIONS

2.7.1. The geological and hydrogeological baseline data was assessed using in-situ borehole logs from the Ground Investigation data (**Appendix 11.3 Ground Investigation Report Part B** [**APP-318]**), British Geological Survey (BGS) Geoindex Webtool and DEFRA Magic Map webtool. The data presented below supplements the baseline presented in the **Section 7.7** of **Environmental Statement Addendum: Earthworks Amendments for Change Request [REP4-061]**, specifically addressing the geology and hydrogeology of the proposed locations of borrow pits 1, 2 and 3.

GEOLOGY

2.7.2. The Scheme is underlain by shallow superficial deposits comprising glacial till and glaciofluvial deposits. The thicknesses of the superficial deposits vary across the site and the borrow pit locations ranging from 1.8m to 4.75m, but locally ranging up to 20m (BH/17/06).

2.7.3. The glacial till and glaciofluvial sand and gravels deposits are predominately comprised of cohesive glacial till deposit, which is classified as generally firm to stiff, is described as sandy gravelly silty clay, with occasional granular layers of gravel, cobbles and boulders. Glaciofluvial deposits (comprising gravelly silty sand and gravels) were widespread at Charlton Mires.

2.7.4. The bedrock geology underlying the borrow pit structures is comprised of the Alston Formation, comprising of a sandstone, siltstone, mudstone and limestone succession with rare cyclical coal seams within the strata. No significant coal seams have been identified in the immediate vicinity of the Scheme.

2.7.5. No peat deposits have been identified in the onsite borehole logs within the borrow pit locations as referenced in the Ground Investigation Report 2019 (**Appendix 11.3 Ground Investigation Report Part B** [**APP-318**]).

HYDROGEOLOGY

2.7.6. A number of surface watercourses have been identified crossing the current carriageway alignment and within 100m of the proposed alignment. These surface water features include, Denwick Burn, Whitehouse Burn, Kittycarter Burn, Shiperton Burn, two unnamed watercourses and one unnamed drain. Denwick Burn is the largest surface water feature located in close proximity to the Scheme. All of the above-mentioned watercourses are flowing from east to west. These are summarised in **Section 10.7** of **Chapter 10 Road Drainage and Water Environment Part B** [**APP-051**]. Kittycarter Burn is located within 100m of the borrow pit structures as shown in figure **Appendix ii Figure 10.1 Water Constraints Plan Part B** [**REP6-019**].

2.7.7. The cohesive glacial till deposits underlying most of the site are designated by the Environment Agency as a Secondary Undifferentiated aquifer. The Environment Agency

define a Secondary Undifferentiated aquifer as "*assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.*" This indicates that groundwater is likely to be present within the deposits but may only yield small amounts of groundwater. The glaciofluvial deposits and bedrock Alston Formation present at the site are assigned as Secondary A aquifers. The Environment Agency define Secondary 'A' Aquifers as "*permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers". The peat deposits are designated by the EA as Unproductive Strata. The EA define Unproductive Strata as "rock layers or drift deposits with low permeability that have negligible significance for water supply or river baseflow*."

2.7.8. Groundwater strike was encountered at between 1.5mBGL – 3.36mBGL (TPA40, TP/17/25 & BH\17\06), during the 2018 Ground Investigation site works (**Appendix 11.3 Ground Investigation Report Part B** [**APP-318]**). The relatively shallow groundwater table was predominantly located in the superficial deposits; within glacial till, glaciofluvial deposits overlying bedrock.

2.7.9. The proposed route alignment of Part B is not located within a Source Protection Zone. There are no identified Groundwater Dependent Terrestrial Ecosystems (GWDTEs) located within the 1km buffer zone of the borrow pits. Four soakaway tests were undertaken in the cohesive glacial till, however very little infiltration was achieved indicating that the ground material has a very low permeability.

2.7.10. **Appendix ii Figure 10.1 Water Constraints Plan Part B** [**REP6-019**] shows the locations of the private and licensed water abstractions within a 1km buffer of the study area. One private water abstraction has been identified approximately 450m northeast of the Order limits and borrow pit structures.

2.8 POTENTIAL IMPACTS

CONSTRUCTION

2.8.1. During construction, the anticipated impacts as a result of Borrow Pits 1, 2 and 3 are:

a. Increased groundwater vulnerability; and
b. Potential changes to hydrodynamics through excavation activities (including groundwater dewatering measures where applicable) with subsequent effects on groundwater receptors (aquifers, groundwater level, licensed water supplies, private water supplies).

2.8.2. All other impacts during construction, detailed within **Section 10.8 of Chapter 10: Road Drainage and the Water Environment** of the ES **[APP-050 and APP-051]** and **Section 7.8** of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**], remain unchanged and are valid.

OPERATION

2.8.3. During operation, the anticipated impacts as a result of Borrow Pits 1, 2 and 3 are:

a. Potential changes to groundwater dynamics as a result of groundwater flow obstructions from below ground structures (impermeable liners) and fill material.

2.8.4. All other impacts during construction, detailed within **Section 10.8** of **Chapter 10: Road Drainage and the Water Environment** of the ES [**APP-051**] and **Section 7.8** of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**], remain unchanged and are valid.

2.9 DESIGN, MITIGATION AND ENHANCEMENT MEASURES

2.9.1. The Scheme wide mitigation requirements for groundwater proposed in the Outline CEMP [REP6-025 and 026] (and as updated at Deadline 7) already encompass measures in respect of Borrow Pits 1, 2 and 3. Therefore, the text within **Section 10.9** of **Chapter 10: Road Drainage and the Water Environment** of the ES [**APP-051**], **Section 7.9** of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**] and Outline Construction Environment Management Plan (CEMP) [**REP6 025 and 026**] (submitted at Deadline 7), remains valid. Further details are set out below.

2.9.2. Due to size and depth of the proposed borrow pits, significant dewatering activities are likely to be required during construction. A Ground Investigation will therefore be undertaken to collect more site-specific information which allows a suitable dewatering strategy to be developed and implemented. The Ground Investigation data will aim to determine the groundwater level, low flow (low permeability) and high flow (high permeability) layers at the proposed borrow pits locations. As already set out in Commitment ExA: EA-W100 of the **Outline CEMP** [**REP6-025 and 026**] (updated and submitted at Deadline 7), where high flow layers are identified further mitigation measures will be considered and implemented to reduce the abstraction rates during construction. These potential measures include but are not limited to sheet piling or adopted excavation methodologies (e.g. cut and fill sections) and may include returning abstracted water into the downstream aquifer. Details will be developed as part of the detailed design stage and monitoring requirements will be updated to demonstrate only a temporary localised impact related to the construction stage. Without further site data and a suitable dewatering strategy groundwater inflow into the excavations could be very high as outlined in the assessments below (reasonable worst-case calculations).

2.9.3. Implementation of the mitigation measures will also negate any potential impact on licensed water supplies, private water supplies and the Kittycarter Burn.

2.10 ASSESSMENT OF LIKELY SIGNIFICANT EFFECTS

CONSTRUCTION

2.10.1. Proposed subsurface intrusive features (borrow pits and lined basins) may require active groundwater dewatering to allow for construction activities. Changes to the hydrodynamics

(excavations and basins) below the water table or potentiometric surface may occur during the construction phase dewatering. Dewatering may alter groundwater levels, groundwater flow pathways and reduce groundwater resources locally.

2.10.2. The sensitivity of shallow groundwater aquifers in the superficial glacial cohesive till deposits is considered to be low, and the magnitude of change is considered to be minor. Therefore, there is likely to be a direct, temporary, short-term effect on groundwater resources of minor adverse significance. The sensitivity of groundwater aquifers in the glaciofluvial sand and gravel and bedrock geology are considered to be medium, and the magnitude of change is considered to be minor. Therefore, there is likely to be a direct, temporary, short-term effect on groundwater resources of minor adverse significance with the implementation of mitigation measures set out in **Section 2.9** of this document. Environmental Statement Addendum: Earthworks Amendments for Change Request [REP4-061] are unchanged and valid.

2.10.3. During the construction phase of the borrow pits (the site preparation, enabling works and construction) there would be a number of activities which would disturb the ground, leading to a potential increase of sediment load and potentially other contaminants (fuels, lubricants and hydraulic fluids) in runoff and shallow groundwater. This could reduce groundwater quality with respect to physical contaminants, including onsite spillages and leakages. The storage of construction materials on the Scheme along with other materials such as oils, fuels and other chemicals can pose risk to groundwater quality, particularly from leakage or spillage of such chemicals. Mobilised suspended solids through site runoff can also impact groundwater quality. Commitment S-W8 of the **Outline CEMP** [**REP6-025 and 026**] already addresses these potential issues.

2.10.4. The groundwater assessments for the dewatering of the borrow pits have concluded that there would be limited impact (5m - 14m radius of influence) on the Secondary A Aquifers and therefore it is unlikely to impact upon wider groundwater resources, licensed water supplies, private water supplies. Short term dewatering activities may lower the base flow temporarily of the Kittycarter Burn and groundwater level locally. It should be noted that the bedrock aquifer and permeable layers within the superficial aquifer are considered to be productive, potentially producing 3270 m^3/d – 6454 m^3/d of discharge. Mitigation measures have therefore been included under Section 2.9 (i.e. further Ground Investigation to confirm ground conditions and specific measures to restrict inflows into the excavations) to reduce the abstraction requirements.

2.10.5. There would be lined basins (detention ponds) following borrow pit construction to act as a barrier to groundwater flow, which, due to the generally shallow groundwater could cause groundwater upwelling beneath or around the basins, in particular for those that extends well below the groundwater table. Similar applies to the infill material of the borrow pits and the proposed embedded mitigation measures (i.e. high permeability layer and suitable fill material properties) would address this potential issue and is covered in Commitment EA-W2 of the **Outline CEMP** [**REP6-025 and 026**].

Borrow Pit Construction Details

2.10.6. Proposed subsurface intrusive features (the borrow pits) may require active groundwater dewatering to allow for construction activities. Changes to the hydrodynamics below the water table or potentiometric surface may occur during the construction phase dewatering. Dewatering may alter groundwater levels, groundwater flow pathways and reduce groundwater resources locally.

2.10.7. The minimum base levels used in this assessment for the proposed borrow pits are given in the table below. Their locations are indicated in **Appendix A: Proposed Amendment to Temporary and Permanent Earthworks Schedule** and **Figure 1: Landscape Mitigation Masterplan Part A** and **Figure 2: Landscape Mitigation Plan Part B** in **Appendix B: Figures** of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**].

2.10.8. The borrow pits would be reconstructed as lined detention basins and would be discharge captured surface water run-off into local watercourses, not to ground.

2.10.9. The groundwater assessment is considered as a conservative worst-case scenario based on the information available. **Table 2-1** summarises relevant construction details of the borrow pits relative to estimated groundwater levels.

Table 2-1 - Borrow Pit Details

Borrow Pit reference	Borrow pit base level (mAOD)	Geology	Pit Depth Approximate Metres below current ground level (maximum)	Borrow pit base elevation relative to water table
A2E-CH586-SB-BPT-1	87.43*	Topsoil, Cohesive Glacial Till, Glaciofluvial Sand and Gravel, Alston Formation (interbedded limestone, sandstone, siltstone & mudstone)**	5	3.5m Below
A2E-CH591-SB-BPT-2	87.43*	Topsoil, Glaciofluvial Sand and Gravel, Alston Formation	9	6.5m below

Borrow Pit reference	Borrow pit base level (mAOD)	Geology	Pit Depth Approximate Metres below current ground level (maximum)	Borrow pit base elevation relative to water table
		(interbedded limestone, sandstone, siltstone & mudstone)**		
A2E-CH590-SB-BPT-3	87.55*	Topsoil, Glaciofluvial Sand and Gravel, Alston Formation (interbedded limestone, sandstone, siltstone & mudstone)**	5	2.5m below

*Ground level is an average of the closest boreholes to the pit structures.

**Bedrock deposit only encountered in one borehole located in close proximity to the borrow pits. Geology is varied within 3m-5m distance but assumes to hit bedrock with depth (below the superficial deposits)

2.10.10. Based on the information gained from the geological long sections in the ground investigation report (**Appendix 11.3 Ground Investigation Report Part B** [**APP-318]**) the base levels are proposed to be between 5m and 9m below current ground level, as detailed in **Table 2-1** above and **Appendix A: Proposed Amendment to Temporary and Permanent Earthworks Schedule** and **Figure 1: Landscape Mitigation Masterplan Part A** of the **Environmental Statement Addendum: Earthworks Amendments for Change Request** [**REP4-061**]. All of the three borrow pits are founded in low permeability heterogenous superficial deposits with no definitive encounter with bedrock. The base elevations of the pits are located below the recorded and inferred groundwater table. Borrow Pit 2 would be constructed as a SuDS detention basin. The details of the basin are set out in the **Drainage Strategy Report Part B** [**REP6-021**]. It has been identified that the basin structure would be lined with an impermeable barrier and underlain by a permeable horizon to allow groundwater flow.

2.10.11. The groundwater levels may represent localised perched groundwater within the superficial deposits, which is assumed to generally have a low permeability based on the borehole log descriptions and literature values (Kruseman & DeRidder 2000). The superficial geology is

variable on a local level and depending on the exact location of individual pits they may intercept higher permeability layers in the till.

Reasonable Worst-Case Estimation of Groundwater Radius of Influence and Inflows

2.10.12. The Sichardt equation was implemented to estimate the potential rate of groundwater inflow into Borrow Pits 1, 2 and 3 and the potential radius of influence (lateral extent of the groundwater drawdown). Inflow estimations for the afore mentioned borrow pits have been calculated to determine potential groundwater dewatering requirements and due to their potential proximity to licensed water supplies and private water supplies, as identified by Northumberland County Council and the Environment Agency. The results of the calculation are presented in **Table 2-2**, **Table 2-3** and **Table 2-4** for Borrow Pit 1, 2 and 3 respectively. However, the groundwater inflow rates calculated therein should be regarded as potential inflow rates and such rates are unlikely to be sustained over any significant length of time.

Table 2-2 - Borrow Pit 1 Calculation Inputs and Results

Borrow Pit 1 (A2E-CH586-SB-BPT-1)	
Chainage	56800
Cutting Length (m)	285
Ground Level (mAOD)	87.43
Piezometric Elevation (Maximum Groundwater Level) (mAOD)	85.93
Borrow Pit Base Elevation (m)	82.43
Aquifer Base Elevation (mAOD)	-253
Hydraulic Conductivity (permeability) (m/s)	$1.16x10^{-6}$
Radius (distance) of Influence (m)	8
Flow Rate	6454 m^3/d
Approximate cutting length of the borrow pit footprint derived from RDP North A1 in Northumberland Earthworks Opportnuioties1-page summaries Revision 03 (Jacobs 2020), assumes that the BPT 1 200m long and 85m wide. Maximum groundwater level derived from GI information and is inferred for the borrow pit location. Aquifer base derived from BGS Lexicon, BGS Map Sheet 6 as the aquifer base was not proven by GI information. Hydraulic conductivity of sandstone bedrock formation, derived from Kruseman & DeRidder and taking into account the nearest borehole logs	

Table 2-3 - Borrow Pit 2 Calculation Inputs and Results

Borrow Pit 2 (A2E-CH591-SB-BPT-2)	
Chainage	59100
Cutting Length (m)	143
Ground Level (mAOD)	87.43
Piezometric Elevation (Maximum Groundwater Level) (mAOD)	84.93
Borrow Pit Base Elevation (m)	78.43
Aquifer Base Elevation (mAOD)	-253
Hydraulic Conductivity (permeability) (m/s)	1.16x10-6
Radius (distance) of Influence (m)	14
Flow Rate	3270 m^3/d
Approximate cutting length of the borrow pit footprint derived from RDP North A1 in Northumberland Earthworks Opportnuioties1-page summaries Revision 03 (Jacobs 2020), assumes that the BPT 2 93m long and 50m wide. Maximum groundwater level derived from GI information and is inferred for the borrow pit location. Aquifer base derived from BGS Lexicon, BGS Map Sheet 6 as the aquifer base was not proven by GI information. Hydraulic conductivity of sandstone bedrock formation, derived from Kruseman & DeRidder and taking into account the nearest borehole logs	

Table 2-4 - Borrow Pit 3 Calculation Inputs and Results

Borrow Pit 3 (A2E-CH590-SB-BPT-3)	
Chainage	59000
Cutting Length (m)	225
Ground Level (mAOD)	87.55
Piezometric Elevation (Maximum Groundwater Level) (mAOD)	85.05
Borrow Pit Base Elevation (m)	82.55

Borrow Pit 3 (A2E-CH590-SB-BPT-3)	
Aquifer Base Elevation (mAOD)	-253
Hydraulic Conductivity (permeability) (m/s)	$1.16x10^{-6}$
Radius (distance) of Influence (m)	5
Flow Rate	5154 m^3/d
Approximate cutting length of the borrow pit footprint derived from RDP North A1 in Northumberland Earthworks Opportnuioties1-page summaries Revision 03 (Jacobs 2020), assumes that the BPT 3 160m long and 65m wide. Maximum groundwater level derived from GI information and is inferred for the borrow pit location. Aquifer base derived from BGS Lexicon, BGS Map Sheet 6 as the aquifer base was not proven by GI information. Hydraulic conductivity of sandstone bedrock formation, derived from Kruseman & DeRidder and taking into account the nearest borehole logs	

OPERATION

2.10.13. The sensitivity of perched groundwater aquifers in the superficial glacial cohesive till deposits is considered to be low, and the magnitude of change, is also considered to be negligible. It can be assumed that the water bearing material would be drained and is therefore of neutral significance.

2.10.14. The sensitivity of groundwater aquifers in the glaciofluvial sand and gravel and bedrock aquifers are considered to be medium, and the magnitude of change is considered to be minor. Therefore, there is likely to be a direct, permanent, long-term effect on groundwater resources of minor adverse significance.

2.10.15. There would be lined basins (detention ponds) following borrow pits construction to act as a barrier to groundwater flow, which, due to the generally shallow groundwater could cause groundwater upwelling beneath or around the basins, in particular for those that extends well below the groundwater table. Similar applies to the infill material of the borrow pits and the proposed embedded mitigation measures (i.e. high permeability layer and suitable fill material properties) would address this potential issue and is covered in Commitment EA-W2 of the **Outline CEMP** [**REP6-025 and 026**].

2.10.16. No impact is expected on groundwater receptors (groundwater resources, licensed water supplies, private water supplies).

2.11 MONITORING

2.11.1. As set out in EA-W1 of the **Outline CEMP** [**REP6-025 and 026**] (updated and submitted at Deadline 7), groundwater level monitoring will be undertaken to supplement the dewatering appraisal.

2.12 UPDATED DMRB GUIDANCE

2.12.1. Since the assessments in the ES were completed, the DMRB methodology was superseded and replaced with updated guidance as detailed in **Section 10.4**, **Chapter 10: Road Drainage and the Water Environment Part B** of the ES **[APP-051**]. A DMRB sensitivity test for likely significant effects has been undertaken and can be found in **Appendix 10.6: Road Drainage and the Water Environment DMRB Sensitivity Test Part A** of the ES [**APP-259**] and **Appendix 10.5: Road Drainage and the Water Environment DMRB Sensitivity Test Part B** of the ES [**APP-315**]. The results of the DMRB sensitivity assessments remain valid for the assessment within this ES Addendum.

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