A1 in Northumberland: Morpeth to Ellingham

Scheme Number: TR010041

6.7 Environmental Statement – Appendix 10.6 Road Drainage and the Water Environment DMRB Sensitivity Test

Part A

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

June 2020

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

The A1 in Northumberland: Morpeth to Ellingham
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Environmental Statement - Appendix

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TABLES

1. INTRODUCTION

1.1. UPDATED DMRB GUIDANCE

1.1.1. The assessment reported in **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this Environmental Statement (ES) (**Application Document Reference: TR010041/APP/6.2**) has been undertaken in accordance with the methodology detailed within Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10 (HD 45/09) (**Ref. 10.1**). This guidance document has been replaced by DMRB LA 113 Road Drainage and the Water Environment (**Ref. 10.2**), which was released in March 2020.

1.1.2. The purpose of this Appendix is to report the findings of the following, which supports the sensitivity test outlined in **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this ES (**Application Document Reference: TR010041/APP/6.2**):

a. A hydrogeological assessment which has been undertaken for Part A to identify any changes to the groundwater assessments in light of the updated DMRB guidance (LA 113) (Section 2).
b. A high-level piling risk assessment in line with LA 113 (Section 3).

2. HYDROGEOLOGICAL ASSESSMENT

2.1. INTRODUCTION

2.1.1. The objective of this Appendix is to supplement original work undertaken in the ES by determining the implications of the updated guidance (LA 113) (**Ref. 10.2**) to the conclusions of the ES. The changes in the guidance refer to more detailed assessments of groundwater flow impacts and subsequent receptors (e.g. groundwater dependent terrestrial ecosystem (GWDTEs)). The scope of this updated assessment is summarised as follows:

a. No impacts on groundwater dependent terrestrial ecosystems were identified due to lack of such ecosystems and lack of groundwater flow impacts (this element is therefore scoped out).
b. Loss of groundwater recharge from increased hard surface area is scoped out due to the low permeability of the underlying geology and the extra hard surface area being negligible compared to the catchment area.
c. There are six bridges proposed for Part A, for which it is assumed piling works would extend to a maximum depth of 15 m. Exact design details are not available, but it is understood that no piling would take place within a Source Protection Zone (SPZ). However, further consideration is required as the piles may intercept groundwater-bearing layers within the bedrock.
d. There are 18 new culverts proposed for Part A which locally reduce the interaction between groundwater and surface water. Their limited extent and depth are unlikely to cause significant changes to the groundwater regime but are given high-level consideration below in order to reduce their impact further as much as possible.
e. As part of the drainage strategy for Part A, a number of lined detention basins extending below groundwater table and a swale storage area are proposed. These require further consideration as there is the potential for impact on groundwater flow.

2.1.2. The following sections focus on assessing the potential impacts of the lined detention ponds/swale storage area, bridge foundations and culverts on groundwater flow. The overall impact assessment is undertaken in line with the approach adopted in the ES where the significance of the impacts of the aforementioned features on groundwater is identified based on the magnitude of change and the importance of the affected receptor. Changes to assessments of drainage discharges to surface water and the requirement for a Water Framework Assessment are not considered in this Appendix.

2.1.3. This Appendix should be read in conjunction with the following chapters of this ES:

a. **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this ES (**Application Document Reference: TR010041/APP/6.2**)
b. **Chapter 11: Geology and Soils, Volume 2** of this ES
c. **Appendix 11.2, Ground Investigation Report, Volume 7** of this ES (**Application Document Reference: TR010041/APP/6.7**).
d. **Appendix 10.5: Drainage Strategy Report, Volume 7** of this ES
e. **Appendix 10.2: Water Framework Directive Assessment, Volume 7** of this ES
f. **Appendix 9.1: Extended Phase 1 Habitat Survey Report, Volume 7** of this ES

2.2. BASELINE CONDITIONS

GEOLOGY

2.2.1. The proposed route for Part A is underlain by superficial deposits comprising alluvium and sands and gravels (associated with minor watercourses) beneath which are extensive glacial deposits. The glacial deposits comprise predominantly cohesive glacial till interbedded with glaciolacustrine laminated clays and glacial sands and gravels.

2.2.2. The cohesive glacial till (up to 4.6 m thick) is described as firm to stiff silty to very silty, slightly sandy to very sandy clay with fine to medium gravel and pockets and bands of fine to medium sand. The glacial sands and gravels were encountered as discrete layers within the cohesive till with an average thickness of 0.85 m. The glaciolacustrine deposits (average thickness 2.5 m) were predominantly encountered in the north of Part A.

2.2.3. The underlying bedrock is the Stainmore Formation which was generally encountered at between 1.4 and 3.1 metres below ground level (mbgl). This comprises interbedded mudstones, siltstones, sandstones and limestone with minor coal seams also present. The uppermost layer of the bedrock is completely weathered to gravelly clay.

HYDROLOGY AND HYDROGEOLOGY

2.2.4. A number of surface watercourses cross the alignment of Part A, including two rivers (most notably the River Coquet in the north of Part A), a number of burns and other minor watercourses. These are summarised in **Section 10.7** of **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this ES (**Application Document Reference: TR010041/APP/6.2**).

2.2.5. The majority of the superficial deposits (the cohesive glacial till) are classified as a Secondary (Undifferentiated) Aquifer. The alluvium and glaciofluvial deposits are classified as Secondary A Aquifers The majority of the bedrock is classified as a Secondary A Aquifer. The southern-most part of this section of the site lies within an SPZ 3.

2.2.6. The 2018 ground investigation has revealed there to be shallow groundwater in the superficial deposits, typically around 3 mbgl but ranging between about 1 mbgl and 13 mbgl. Groundwater levels in the bedrock ranged between 4.9 m to 9.3 m bgl or 58.4 m to 60.2 m OD.

2.2.7. Six soakaway tests were undertaken in the cohesive glacial till, all recording minimal or no infiltration. Two (historical) falling head tests performed in BH1018 and BH1023 gave permeabilities of 1.3 x 10-7 and 1.7x10-7 m/s indicating very low permeability material.

2.3. DESIGN DETAILS

DETENTION BASINS/SWALE STORAGE AREA

2.3.1. The minimum base levels used in this assessment for the proposed detention basins and swale storage area are given in the table below. Their locations are indicated in the drainage strategy report (**Appendix 10.5: Drainage Strategy Report, Volume 7** of this ES (**Application Document Reference: TR010041/APP/6.2**)).

2.3.2. It has also been assumed that the basins and the swale would be lined and would be discharging into local watercourses, not to groundwater. **Table 2-1** below summarises relevant construction details of the features relative to estimated groundwater levels.

Table 2-1 - Detention Basin Details

Detention Basin Reference	Detention Basin Base Level (mAOD)	Geology	Metres Below Current Ground Level (max depth)	Detention Basin Position Relative to Water Table
S1	92.9	Cohesive till	2-7 m	1 m below
DB2	105.754	Cohesive till	4 m	5 m below
DB4	84.614	Cohesive Till	3-5 m	4-6 m below
DB6	81.815	Cohesive Till	3 m	2 m above
DB7	88	Cohesive Till	2 m	= or 7 m above
DB9	83	Cohesive Till/River Terrace deposits	4 m	4 m below
DB12	77.3	Cohesive Till	2-3 m	1 m below
DB13	62.7	Cohesive Till	2 m	= / 1 m below
DB15	54.05	Cohesive Till/Granular Till	5-6 m	1 m below
DB15a	58	Cohesive Till/Granular Till	2-3 m	2 m above
DB17a	57.862	Cohesive Till/Glaciolacustrine deposits	4 m	1 m below
DB17b	58.2	Cohesive Till/Glaciolacustrine deposits	4 m	=

Detention Basin Reference	Detention Basin Base Level (mAOD)	Geology	Metres Below Current Ground Level (max depth)	Detention Basin Position Relative to Water Table
DB17	57.302	Cohesive Till/Glaciolacustrine deposits	3 m	1 m below *
DB18	53.86	Bedrock (weathered)	5 m	=
DB19	49.228	Cohesive Till/Glaciolacustrine deposits	4 m	= to 6 m below
DB20	82.03	No GI information available, assumed cohesive till for this assessment	Unknown but assumed to be within the range of DB2-19	Unknown but assumed to be within the range of DB2-19
Based on available GI information; exploratory holes may not always be at the exact location of the feature, depth below ground level/above/below water table are approximate; = at water table, * water table in bedrock				

2.3.3. Based on the information gained from the geological long sections in the ground investigation report it is understood that the base levels are proposed to be between 2 m and 7 m below current ground level, the majority being between 2 m and 4 m below current ground level, as detailed in **Table 2-1**.

2.3.4. The majority of the detention basins are founded in low-permeability, clay-rich cohesive glacial till; with only DB18 encountering bedrock. The base elevation of most of the basins is generally close to or slightly (1-2 m) below the groundwater table in the superficial deposits, although at 3 locations the basins are potentially up to 7 m below groundwater, although this may be localised high groundwater perched within sands/gravels within the low permeability glacial till. The superficial geology is variable on a local level and depending on the exact location of individual basins they may intercept higher permeability layers in the till.

BRIDGE PILING

2.3.5. It is understood that piling along Part A would be associated with the following structures:

a. River Coquet Bridge
b. Causey Park Overbridge

c. Highlaws Junction
d. West Moor Junction
e. Fenrother Junction
f. Burgham Underbridge

2.3.6. Only high-level design information is available at this time and therefore this assessment is also high-level.

2.3.7. No specific design details relating to the exact depth, width or spacing of piles have been provided for the proposed bridges. No piling is proposed within the SPZ 3 and it is understood that piling would typically be to a maximum depth of 15 mbgl. This could intercept the sandstones and limestone layers (water bearing strata) within the bedrock with the potential to create additional pathways for groundwater flow.

CULVERTS

2.3.8. The design details of the following proposed culverts have been considered in the context of the local geology and hydrogeology within the assessment: Parkwood Subway and Culvert, Paradise Culvert, Priests Bridge Culvert, Causey Park Culvert, Bockenfield Culvert, Glenshotton Culvert, Burgham Culvert, East and West Cotting Burn Culvert, North Fenrother Burn Culvert, South Fenrother Burn Culvert, Earsdon Burn Culvert, New Houses Farm Culvert, Little Causey Park Culvert, Wildlife Eshott Burn Culvert.

2.3.9. The majority of the culverts have outlets close to or slightly below the groundwater table and are less than 50 m in length.

2.4. ASSESSMENT

IMPORTANCE OF THE RECEPTOR

2.4.1. The importance of receptors has been determined using Table 3.70 in the updated guidance (LA 113) (**Ref. 10.2**).

2.4.2. The groundwater in the cohesive glacial till, as a secondary undifferentiated aquifer is classified as a receptor of low importance.

2.4.3. The groundwater in gravels within the till and the bedrock (both of which are Secondary A Aquifers) are classified as a receptor of medium importance.

2.4.4. Therefore, for the assessments the overall importance of the receptor (shallow groundwater) is deemed to be medium.

POTENTIAL IMPACTS

Detention Basins

2.4.5. The detention basins would be mostly based within low permeability deposits; lined and situated close to or below the water table. There is therefore the potential the basins to act as a barrier to groundwater flow, which, due to the generally shallow groundwater in the superficial deposits could cause groundwater upwelling beneath or around the basins.

Bridge Foundations

2.4.6. The bridge foundations could impede groundwater flow in the higher permeability layers in the superficial layers and in the water bearing strata of the bedrock. The associated piling works could cause a change in connectivity of different groundwater bearing layers leading to a change in groundwater flow conditions.

Culverts

2.4.7. Below ground structures have the potential to obstruct groundwater flow and discharge to surface water courses.

LIKELY SIGNIFICANT EFFECTS

Detention Basins

2.4.8. Higher permeability material would be placed beneath or around the detention basins to allow groundwater to move freely around the lined basins. It is understood this would be incorporated into the detailed design as outlined in the **Outline Construction Environmental Management Plan** (**Outline CEMP**) (**Application Document Reference: TR010041/APP/7.3**). With the implementation of this mitigation, it is considered that there would be a permanent minor adverse magnitude of impact upon groundwater level and flows and the overall significance of effect would be **slight adverse** (**not significant**).

Bridge foundations

2.4.9. A piling risk assessment for the bridges is presented in **Section 3** below, this includes mitigation measures which would be applied.

Culverts

2.4.10. As a mitigation measure to reduce the potential magnitude of the impact of the culverts, a granular layer would be placed beneath proposed culverts in order to ensure groundwater can flow beneath them unimpeded thereby preventing potential groundwater rise and flooding. This is outlined in the **Outline Construction Environmental Management Plan** (**Outline CEMP**) (**Application Document Reference: TR010041/APP/7.3**). In addition, the culverts are:

a. Shallow, with the outlet level being at or close to that of the water table, (based on limited groundwater information at many locations)
b. Of limited length (most being <50 m)
c. Located beneath the proposed carriageway; an area of hardstanding which would reduce groundwater recharge locally

2.4.11. With implementation of this mitigation it is considered that there would be a permanent minor adverse magnitude of impact upon groundwater levels and flows and the overall significance of effect would be **slight adverse** (**not significant**).

3. PILING RISK ASSESSMENT

3.1. INTRODUCTION

3.1.1. Within Part A, six structures with piled foundations are proposed and it was considered that the piles could cause change in connectivity of different groundwater bearing layers or act as a groundwater flow barrier leading to a change in groundwater flow conditions. Based on available design information the magnitude of this impact was deemed to be potentially moderate adverse with the significance of the effect potentially being moderate.

3.1.2. It was recommended to undertake piling risk assessments for the proposed foundations based on more detailed information to demonstrate the magnitude of the impact is minor to negligible, resulting in an impact of slight significance.

3.1.3. The objective of this section is to present a high-level piling risk assessment in line with the updated DMRB guidance (LA 113) and with the approach adopted in the ES.

3.1.4. Little contamination was encountered during the ground investigation within an environment of generally low ground permeability, therefore groundwater cross-contamination caused by piling is not considered a significant risk. The focus of this section is on changes to groundwater flows and levels caused by below ground structures (piled foundations).

3.1.5. This Appendix should be read in conjunction with the hydrogeological assessment set out above in **Section 2** and the assessment in **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this ES (**Application Document Reference: TR010041/APP/6.2**)).

3.2. METHODOLOGY

3.2.1. A high-level piling risk assessment has been undertaken in line with the DMRB guidance and with the approach adopted in the ES. The significance of the impacts of the features under consideration on groundwater are determined based on the magnitude of change and the importance of the affected receptor.

3.2.2. Detailed quantification of the groundwater level changes is not possible in absence of detailed site monitoring data and detailed design information. In order to achieve this a detailed hydrogeological assessment would be required involving long term groundwater monitoring within the area of each proposed location. A professional judgement approach has therefore been adopted whereby a moderate magnitude rating for piles extending more than 1m below expected groundwater level is given where:

a. Layered aquifers (combination of high and low permeability layers) are present
b. The exact extent of these layers (in particular the water bearing strata) is unknown
c. The groundwater may not have a flow path around structures
d. The overall depth to which the piles penetrate the water table

3.3. BASELINE CONDITIONS

3.3.1. Baseline conditions including geology and hydrogeology are described in **Section 10.7** of **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this ES (**Application Document Reference: TR010041/APP/6.2**).

3.4. DESIGN DETAILS

3.4.1. The following (6) bridges/piled structures have been considered in this assessment:

a. River Coquet Bridge
b. Causey Park Overbridge
c. Highlaws Junction
d. West Moor Junction
e. Fenrother Junction
f. Burgham Underbridge

3.4.2. The general design details of the piles are as follows:

a. Pile diameter: 0.9 m
b. Pile spacing: (edge to edge): 1 m
c. Pile depth: typically, up to 15 m below existing ground level (to be confirmed at detailed design stage)

3.4.3. These numbers are general, not specific to individual piles/locations and the exact pile depth is unknown at present, therefore it has been assumed for this assessment that they penetrate to a depth of 15 m below ground level.

LOCAL GROUND CONDITIONS

3.4.4. **Table 3-1** details the local ground conditions in the vicinity of each piled structure taking into account the general design details.

Table 3-1 - Local Ground Conditions in the Vicinity of Piled Structures

Structure	Superficial deposits	Bedrock	Pile base*	Groundwater in superficial deposits	Top of bedrock	Pile penetration into superficial deposits	Pile penetration into bedrock	Pile depth below groundwater
River Coquet Bridge	Cohesive glacial till, granular alluvium, localised pockets of Glaciofluvial sand and gravel	Mudstone typically overlying sandstone and limestone	41 mOD	47-57 mOD	34-58 mOD	Up to 15 m	0 – 15 m	6-15 m
Causey Park Over-bridge	Predominantly cohesive glacial till with minor thicknesses of granular	Interbedded sandstone and mudstone	68 mOD	82 mOD (72 mOD in bedrock)	68 mOD	Up to 15 m	<1 m in the vicinity of the bridge but wider boreholes suggests could be 6 m	14 m (superficials) 4 m (bedrock)
Highlaws Junction	Predominantly cohesive glacial till, localised pockets of glaciolacustrine and granular glacial till	Interbedded mudstone, siltstone and sandstone.	95 mOD	108 mOD	93-97 mOD	Up to 15 m	0 – 2 m	13 m
West Moor Junction	Cohesive glacial till, occasional glaciolacustrine and granular glacial till deposits.	Coal bearing mudstone and undifferentiated sandstone, mudstone and siltstone	46 mOD	56-58 mOD	41-44 mOD	Up to 15 m	0 m	10-12 m
Fenrother Junction	Predominantly cohesive glacial till, occasional thinner bands of granular glacial till, localised glaciolacustrine cohesive alluvium	Interbedded sandstone, mudstone and limestone.	74 mOD	89 mOD (83 mOD in bedrock)	83 mOD	Up to 8 m	Up to 8 m	15 m (superficials) 9 m (bedrock)
Burgham Under-bridge	Predominantly cohesive glacial till, occasional thinner bands of granular glacial till, localised glaciolacustrine deposits, alluvium.	Not encountered within nearby exploratory locations.	45 mOD	60 – 62 mOD	Below 38 mOD	15 m	Not encountered	Up to 15 m

*based on the pile extending to 15 m below ground level

3.5. ASSESSMENT

IMPORTANCE OF THE RECEPTOR

3.5.1. The groundwater in the cohesive glacial till, as a secondary undifferentiated aquifer is classified as a receptor of low importance.

3.5.2. The groundwater in gravels within the till and the bedrock (both of which are Secondary A Aquifers) are classified as a receptor of medium importance.

3.5.3. Therefore, for the assessments the overall importance of the receptor (shallow groundwater) is deemed to be medium.

POTENTIAL IMPACTS

3.5.4. Below ground structures such as proposed structures which incorporate piling into their design have the potential to create a barrier to groundwater flow causing a rise in groundwater level or changes to groundwater flow. Due to the shallow water table along much of the route, the piles terminate up to 15 m below the water table. The piles have the potential to cause changes to groundwater flow or levels due to the shallow water table across much of these sites and with the spacing of the piles reducing the cross section for groundwater flow paths by approximately 50%.

LIKELY SIGNIFICANT EFFECTS

3.5.5. Considering that the piles extend to over 1 m below the water table within a layered aquifer in all cases, in order to reduce the magnitude of the impact to minor adverse, mitigation would be implemented in the form of shallow drains either side of the foundations which feed into the local surface water or drainage systems. This would mitigate against groundwater rise. Such mitigation would be considered at detailed design stage. With the implementation of this mitigation, there would be a permanent minor adverse magnitude of impact upon groundwater levels and flows and the overall significance of effect would be **slight adverse** (**not significant**).

4. CONCLUSION

4.1. CONCLUSIONS

4.1.1. The updated guidance LA 113 (**Ref. 10.1**) includes a number of key changes in the assessment methodology compared to DMRB HD 45/09 (**Ref. 10.2**) which it replaces. A number of the identified changes are considered unlikely to affect the conclusions of the road drainage and the water environment assessment presented in **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this ES (**Application Document Reference: TR010041/APP/6.2**). However, the following identified changes were considered to warrant further assessment:

a. An assessment of the impacts on groundwater levels and flows, previously not required and presented within this document.

4.1.2. The assessment has concluded that impacts from detention basins, bridge foundations and culverts would be mitigated. This would be through the implementation of mitigation in the form of placing higher permeability material beneath or around the detention basins; placing a granular layer beneath proposed culverts and use of shallow drains. Therefore, it is appropriate to conclude that adopting the LA 113 methodology would not change the conclusions of **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this ES (**Application Document Reference: TR010041/APP/6.2**).

4.1.3. The assessment has also concluded that impacts from below ground structures (piled foundations) would be mitigated through the implementation of mitigation in the form of shallow drains. Therefore, it is appropriate to conclude that adopting the LA 113 methodology would not change the conclusions of **Chapter 10: Road Drainage and the Water Environment, Volume 2** of this ES (**Application Document Reference: TR010041/APP/6.2**).

REFERENCES

Ref. 10.1 Highways Agency (2019) Design Manual for Roads and Bridges Volume 11, Section 3, Part 10 (HD 45/09).

Ref. 10.2 Highways England, Transport Scotland, Welsh Government, Department for Infrastructure (2020) LA 113 Road Drainage and the Water Environment. Available at: https://www.standardsforhighways.co.uk/dmrb/ [Accessed March 2020].

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