

**A66 Northern Trans-Pennine Project  
TR010062**

**3.4 Environmental Statement  
Appendix 14.7 Groundwater  
Dependent Terrestrial Ecosystem  
Assessment**

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**3.4 ENVIRONMENTAL STATEMENT  
APPENDIX 14.7 GROUNDWATER DEPENDENT  
TERRESTRIAL ECOSYSTEM ASSESSMENT**

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## 14.7 Groundwater Dependant Terrestrial Ecosystem Assessment

### 14.7.1 Introduction

14.7.1.1 A groundwater dependant terrestrial ecosystem (GWDTE) is defined as within the UKTAG report (UK Technical Advisory Group, 2004)<sup>1</sup>:

*"A terrestrial ecosystem of importance at Member State level that is directly dependent on the water level in or flow of water from a groundwater body (that is, in or from the saturated zone). Such an ecosystem may also be dependent on the concentrations of substances (and potential pollutants) within that groundwater body, but there must be a direct hydraulic connection with the groundwater body."*

14.7.1.2 GWDTE are protected under the Water Framework Directive (WFD) and are potentially sensitive receptors to the impacts of development. This document describes the assessment of risk to GWDTEs resulting from the construction and operation of the Project.

### 14.7.2 Methodology

#### *Groundwater dependent terrestrial ecosystems assessment*

14.7.2.1 An assessment of GWDTEs has been carried out in line with the guidance provided in Appendix B of *Design Manual for Roads and Bridges (DMRB) LA 113 Road drainage and the water environment (DMRB LA 113)* (Highways England, 2020)<sup>2</sup>.

14.7.2.2 The methodology has a stepped, risk-based approach which depends upon establishing linkages between potential impacts from the road development on the hydrological and hydrogeological regime and a GWDTE:

- Step 1 - Identify potential linkages
- Step 2 - Assess GWDTE importance (if required)
- Step 3 - Assess potential impacts (if required).
- Step 4 - Establish risk to GWDTE - importance (step 2) is combined with magnitude of potential impact (step 3)
- Step 5 - Assessment outcomes and actions.

#### *Study area*

14.7.2.3 The study area reflects the Phase 1 habitat survey study area, which is detailed further in Chapter 6: Biodiversity (Application Document 3.2), taken as 250m from the Order Limits which has been agreed with the Environment Agency and Natural England. This study area was

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<sup>1</sup> UK Technical Advisory Group (2004) Guidance on the identification and risk assessment of groundwater dependant terrestrial ecosystems (Working Draft Rev. 5) Available online. [Accessed April 2022]

<sup>2</sup> Highways England (2020) Design Manual for Roads and Bridges LA 113 Road Drainage and the Water Environment. Version 1.

expanded to 1km from the Order Limits when identifying statutory and non-statutory designated sites with the potential to support GWDTEs.

#### *Baseline methodology*

- 14.7.2.4 GWDTEs were identified using the Phase 1 surveys conducted for the Project, the National Vegetation Classification (NVC) habitat communities recorded at protected sites within the study area, and the Environment Agency GWDTE mapping (Environment Agency, 2020)<sup>3</sup>. The habitat communities present were compared with the communities listed in Annex 1 of the *UKTAG report*, identifying any with potential to be groundwater dependant. In the absence of detailed NVC communities and species data, soil and groundwater conditions were taken into consideration when classifying habitats as groundwater dependent.
- 14.7.2.5 Further details of the habitats present across the Project are outlined in Chapter 6: Biodiversity (Application Document 3.2) and details of existing soil profiles in Chapter 9: Geology and Soils (Application Document 3.2).
- 14.7.2.6 The hydrogeological conceptual model developed for the scheme is presented in ES Appendix 14.6: Hydrogeological Impact Assessment (Application Document 3.4) and was used to identify potential linkages.
- 14.7.2.7 The cuttings assessment presented in ES Appendix 14.6: Hydrogeological Impact Assessment (Application Document 3.4) identified the areas that were most at risk from groundwater drawdown due to the Project. Potential GWDTEs within the cuttings Zone of Influence (Zoi), detailed on ES Figure 14.13: Cutting Assessment Zoi (Application Document 3.3) were assessed in detail in collaboration with suitably qualified ecologists to assist in determining the potential impacts and risks.

#### *Assumptions and limitations*

- 14.7.2.8 The Project did not carry out NVC mapping of the full study area, and therefore Phase 1 habitat mapping was used when identifying areas with the potential to support GWDTEs. Phase 1 habitat mapping does not have the same detail as NVC mapping and results in a more conservative baseline for the assessment.
- 14.7.2.9 The potential for the Phase 1 habitats to support GWDTEs was assessed based on professional judgement from a suitably qualified ecologist, using the maximum depth range of topsoil (further details provided in Chapter 9: Geology and Soils (Application Document 3.2)), and peak winter groundwater levels recorded from within the superficial deposits layer (ES Appendix 14.6: Hydrogeological Impact Assessment (Application Document 3.4)).

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<sup>3</sup> Environment Agency (2020) Groundwater Dependent Terrestrial Ecosystems (England only) dataset. Available Online [Accessed April 2022]

- 14.7.2.10 The cuttings assessment presented in ES Appendix 14.6: Hydrogeological Impact Assessment (Application Document 3.4) assumes that groundwater is at surface level at all points due to a lack of detailed information on groundwater levels across the Project. The drawdown zone of influence has been calculated for cuttings in excess of 1.0m, as documented in ES Appendix 14.6: Hydrogeological Impact Assessment (Application Document 3.4).
- 14.7.2.11 Whilst surface level groundwater may be the case in some locations close to watercourses, this is unlikely to be representative of conditions across the Project. However, in the absence of this information, this conservative assumption has been applied.
- 14.7.2.12 GWDTE's downgradient of cuttings may not be located within the drawdown zone of influence, however, they may be impacted by a reduction in baseflow caused by the capture of surface water and groundwater upgradient of the GWDTE's. As additional groundwater monitoring and ecological survey data is collated, GWDTE's at risk from a reduced baseflow should be re-assessed to quantify the risk to the features and mitigation measures required.
- 14.7.2.13 Due to the above assumptions, where there is no direct interaction with the footprint of the Project and the habitat area, it has been assumed that the magnitude of potential impacts from the Project, prior to mitigation, may be moderately adverse. 'Moderately adverse' impact on a GWDTE is defined by *DMRB LA 113* as:
- 'Partial loss of groundwater flow or change in ground water level or quality at the GWDTE such that there are measurable effects on the habitat or flora and fauna of the GWDTE, but which are insufficient to lead to a change in its status or classification under the WFD or prevent it from reaching favourable condition.'*
- 14.7.2.14 Where there is direct interaction with the footprint of the Project and the habitat area, it has been assumed that the magnitude of potential impact from the Project, prior to mitigation, may be 'Major Adverse' as defined by *DMRB LA 113* as:
- 'Total or partial loss of ground water flow or changes in ground water quality such that the GWDTE is no longer supported or is prevented it from reaching favourable condition or reduction in classification under the WFD.'*
- 14.7.2.15 This assessment considers the loss or degradation of GWDTEs due to changes to groundwater levels. Losses to habitat from the proposed design footprint are assessed within Chapter 6: Biodiversity (Applicant Document Number 3.2).

### 14.7.3 Baseline

#### *Identified GWDTEs and potential GWDTEs*

- 14.7.3.1 A review of the designated sites citations within the Project study area indicated that six protected sites have the potential to be dependent on

groundwater, these vary in their groundwater dependency level and are detailed in Table 1: Protected sites within the Project study area that have the potential to support GWDTE, presented in ES Figure 14.18: Potential GWDTEs within study area (Application Document 3.3)

14.7.3.2 The Project Phase 1 survey data includes a number of areas of habitat that have the potential to be groundwater dependant, these are:

- A1.1.1 Semi-natural broad-leaved woodland
- B5 Marsh/marshy grassland
- D2 Wet dwarf shrub heath
- E2.2 Basic flush
- F1 Swamp
- F2.2 Inundation vegetation
- G1 Standing water
- G1.1 Eutrophic standing water
- G1.2 Mesotrophic standing water.

14.7.3.3 Plant communities that are dependent on groundwater are listed within *UKTAG report* using the NVC and are assigned associated groundwater dependency scores. The NVC score, indicating dependence on groundwater, is separated into three groups (3 = low, 2 = moderate, 1 = high).

Table 1: Protected sites within the Project study area that have the potential to support GWDTE, based on NVC communities present

Site name	Nearest scheme	NVC community	Groundwater Dependency
Skirsgill Woods County Wildlife Site (CWS)	M6 Junction 40 to Kemplay Bank	<i>M27 Molinia caerulea -Crepis paludosa mire</i>	Moderate
River Lyvennet Floodplain CWS	Temple Sowerby to Appleby	<i>M27 Molinia caerulea-Crepis paludosa mire</i>	Moderate
Acorn Bank Woods and Garden CWS	Temple Sowerby to Appleby	<i>W6 Alnus glutinosa-Urtica dioica woodland</i>	Moderate
Tricklebanks Wood CWS	Appleby to Brough	<i>W7 Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum woodla</i>	High
Sandford Mire CWS	Appleby to Brough	<i>M23 Juncus effusus/acutiflorus-Galium palustre rush-pasture</i> <i>M25 Molinia caerulea-Potentilla erecta mire</i> <i>S25 Phragmites australis-Eupatorium cannabinum tall-herb fen</i>	High
North Pennine Moors SAC/Bowes Moor SSSI	Bowes Bypass	<i>M3 Cratoneuron commutatum - Festuca rubra spring</i> <i>M38 Cratoneuron commutatum - Carex nigra spring</i>	High



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- 14.7.3.4 A review of Phase 1 habitat mapping undertaken for the Project within the study area indicated that a number of the habitats have the potential to support GWDTEs, these habitats are detailed in Table 2: Phase 1 habitats with the potential to support GWDTE and shown on ES Figure 14.18: Potential GWDTEs within study area (Application Document 3.3), along with the cuttings Zol and borehole locations.
- 14.7.3.5 Groundwater level and topsoil depths have been established from ground investigation (GI) data, further details can be found in Chapter 9: Geology and Soils (Application Document 3.2).

Table 2: Phase 1 habitats with the potential to support GWDTE

Nearest scheme	ID	Phase 1 Habitat	Groundwater Dependency and Importance	Approximate Area within Zol (hectares)	Nearest borehole Groundwater level (m bgl)	Proven depth of topsoil (m bgl)
M6 Junction 40 to Kemplay Bank	41	A1.1.1	Low	0.06	4	0.00 - 1.2
	38	A1.1.1	Low	0.03		
	37	A1.1.1	Low	0.13		
	40	A1.1.1	Moderate	1.27	0 to 7	
	64	A1.1.1	Low	0.93	18	
Penrith to Temple Sowerby	62	A1.1.1	Low	0.88	14	0.00 - 1.2
	63	B5	Low	0.23		
	61	B5	Low	0.06		
	2	A1.1.1	Low	0.30	5	
	1	G1.1	Low	0.39	10	
Temple Sowerby to Appleby	3	B5	Low	1.04	4-5	0.00 - 1.2
Appleby to Brough	35	D2	Moderate	0.17	3	0.00 - 1.05
	34	B5	Moderate	0.24		
	36	B5	Low	0.06		
	43	B5	Low	0.07		
	42	B5	Low	0.13		
	45	B5	High	2.5		
	44	A1.1.1	High	0.1		
	48	F2.2	High	0.13		
	47	G1.1	High	0.05		
	46	G1.1	High	0.6		
	5	A1.1.1	Moderate	0.12	2	

Nearest scheme	ID	Phase 1 Habitat	Groundwater Dependency and Importance	Approximate Area within Zol (hectares)	Nearest borehole Groundwater level (m bgl)	Proven depth of topsoil (m bgl)	
	6	B5	Moderate	0.04	0.6-1		
	7	G1	Moderate	0.07			
	4	B5	Moderate	0.12			
	10	A1.1.1	Moderate	0.33	6-8		
	52	B5	Low	0.03			
	54	A1.1.1	Low	0.60			
	53	B5	Low	0.24			
	51	A1.1.1	Low	1.36			
	50	A1.1.1	Low	0.15			
	33	B5	Low	0.19			
	65	A1.1.1	Low	0.18			
	32	A1.1.1	Moderate - spring 50m east so conservative that GW levels higher for this woodland	0.12			3-8
	60	B5	High - Potential spring fed fen	0.98			
	27	B5	Low	0.18			
	26	B5	Low	0.18			
	25	B5	Low	0.29			
	23	B5	Low	6.8			
	24	B5	Low	2.17			
18	G1	Low	0.02				

Nearest scheme	ID	Phase 1 Habitat	Groundwater Dependency and Importance	Approximate Area within Zol (hectares)	Nearest borehole Groundwater level (m bgl)	Proven depth of topsoil (m bgl)
	19	G1	Low	0.02		
	20	G1	Low	0.02		
	21	G1	Low	0.02		
	22	G1	Low	0.02		
	17	B5	Low	0.03		
	31	E2.2	Low	0.06		
	30	G1	Low	0.13	14	
	29	B5	Low	0.13		
	28	A1.1.1	Low	0.10		
	57	A1.1.1	Low	0.11	2	
Bowes Bypass	49	B5	Low	0.17	2-7	0.00-0.70
	59	G1.1	Moderate	0.02	0-3	
Stephen Bank to Carkin Moor	55	A1.1.1	Low	0.18	Unknown	0.00 - 0.50

## Geology

- 14.7.3.6 The geology underlying the Project varies, and with that so does the permeability of the bedrock and superficial deposits. The assessment used the underlying geology in the study area to better understand the potential groundwater to surface interactions that exist, as well as to give context to the hydrogeological conceptual model.

### *Bedrock geology*

- 14.7.3.7 The Project is underlain by three main bedrock geological groups, from youngest to oldest, presented in ES Figure 9.3: Published Geology - Bedrock Geology (Application Document 3.3):
- Cumbrian Coast Group – Permian shales and mudstones with local beds of gypsum and anhydrite
  - Appleby Group – Permian interbedded red aeolian sandstones, fluvial sandstones and breccias
  - Yoredale Group – Carboniferous repeated upward-coarsening sedimentary cycles including the Alston Formation and Stainmore Formation.

### *Superficial geology*

- 14.7.3.8 Superficial deposits are located along the route, presented in ES Figure 9.2: Published Geology - Superficial Geology (Application Document 3.3), and comprise of:
- Alluvium – Unconsolidated clays, silts, sands and gravels
  - River Terrace Deposits – Stratified, well sorted sands and gravels
  - Glaciofluvial Deposits – Stratified, well sorted sand and gravels
  - Peat – Partially decomposed semi-carbonised vegetation which has grown under anaerobic conditions
  - Glacial Till – Generally stiff silty sandy clay with areas of medium and fine-grained sands and gravels.
- 14.7.3.9 Glacial Till is the most extensive unit along the route, with the majority of the Project anticipated to be located on a mixture of cohesive and granular Glacial Till deposits. The majority of cuttings are anticipated to be primarily located within Glacial Till deposits.

## 14.7.4 Assessment

### *Step 1 and 2 - Identify potential linkages and GWDTE importance*

- 14.7.4.1 The hydrogeological conceptual model presented in ES Appendix 14.6: Hydrogeological Impact Assessment (Application Document 3.4) identifies where areas of groundwater drawdown may occur due to the Project. The cutting Zol is mapped and shown on ES Figure 14.13: Cutting Assessment Zol (Application Document 3.3). The cutting Zol indicates that the drawdown in groundwater levels associated with cuttings along the Project does not extend to any of the protected sites detailed in Table 1: Protected sites within the Project study area that have the potential to support GWDTE. Therefore, there are no linkages

and no effects on protected sites. Magnitude is considered negligible and overall risk is negligible, no further assessment is required.

14.7.4.2 *UKTAG guidance (2004)* recognises that most:

*“water dependent terrestrial ecosystems lie along a continuum between always only groundwater dependent and always only surface water dependent [...]. The source of water supply for some wetlands does not appear to be critical, therefore the task of identifying dependence upon groundwater is sometimes complex”.*

14.7.4.3 The cuttings Zol encroaches on a number of different habitats across the Project, some of which have the potential to support GWDTE. These areas have been detailed in Table 2: Phase 1 habitats with the potential to support GWDTE.

14.7.4.4 The groundwater dependency and GWDTE importance has been established using Appendix B of *DMRB LA 113* and associated UK TAG document, in collaboration with a suitably qualified ecologist. The classifications are based on Phase 1 Habitats and context taken from the surrounding environment, as such they are considered to be conservative.

*Step 3 and 4 - Assess potential impacts and risks*

14.7.4.5 The assessment of impacts from groundwater on potential GWDTEs has been assessed using Table B.2 and Table B.3 within Appendix B in *DMRB LA 113*. It is considered that for all cuttings, there is the potential to impact on the groundwater level and flow/flux prior to any mitigation. It is not considered likely that the Project will have an impact on groundwater quality following the mitigation outlined in the Environmental Management Plan (Application Document 2.7).

*M6 Junction 40 to Kemplay Bank*

14.7.4.6 The assessment of impacts for M6 Junction 40 to Kemplay Bank is presented in Table 3: Assessment of impact and risk to GWDTE for M6 Junction 40 to Kemplay Bank study area. The likely impact on the habitats with the potential to support GWDTE is a change in groundwater level and groundwater flow as a result of the Project.

Table 3: Assessment of impact and risk to GWDTE for M6 Junction 40 to Kemplay Bank study area

ID	Phase 1 Habitat	Groundwater Dependency and Importance	Magnitude of potential impact	Risk to GWDTE prior to mitigation
41	A1.1.1	Low	Moderate adverse	Negligible risk
38	A1.1.1	Low	Moderate adverse	Negligible risk
37	A1.1.1	Low	Moderate adverse	Negligible risk
40	A1.1.1	Moderate	Moderate adverse	Moderate risk
64	A1.1.1	Low	Moderate adverse	Negligible risk

### Step 5 - Outcomes and actions

- 14.7.4.7 Habitats which have the potential for moderate and significant risk are described in the following paragraphs in more detail. Mitigation to reduce the magnitude of the potential impact is outlined, and the residual risk reported.
- 14.7.4.8 Woodland habitat (ID 40) located south of Chainage 10+900 has the potential to be impacted by drawdown of groundwater level and interruption of groundwater flow as a result of the Project. The habitat has been conservatively classified as having moderate groundwater dependency due to ground investigations indicating that groundwater levels can be at surface level in the surrounding area. Therefore, it is considered that there is a moderate risk to any GWDTE that this habitat area may support.
- 14.7.4.9 At detailed design, further ecological surveys will be completed to collect NVC data for this area and confirm any presence or likely absence of GWDTE. A localised detailed assessment of potential groundwater dependency and risk to the GWDTEs should then be completed, if necessary, with further ground investigations data to give a more accurate representation of potential drawdown and associated impacts. At this stage, mitigation may be required to reduce the risk to the GWDTE such as lining of cuttings to prevent groundwater ingress with an appropriate drainage blanket beneath/surrounding which will enable continued groundwater flow to the GWDTE with limited mounding or drawdown.

#### Penrith to Temple Sowerby

- 14.7.4.10 The assessment of impacts for Penrith to Temple Sowerby is presented in Table 4: Assessment of impact and risk to GWDTE for Penrith to Temple Sowerby study area. The likely impact on the habitats with the potential to support GWDTE is a change in groundwater level and groundwater flow as a result of the Project.

Table 4: Assessment of impact and risk to GWDTE for Penrith to Temple Sowerby study area

ID	Phase 1 Habitat	Groundwater Dependency and Importance	Magnitude of potential impact	Risk to GWDTE prior to mitigation
62	A1.1.1	Low	Moderate adverse	Negligible risk
63	B5	Low	Moderate adverse	Negligible risk
61	A1.1.1	Low	Moderate adverse	Negligible risk
2	A1.1.1	Low	Moderate adverse	Negligible risk
1	G1.1	Low	Moderate adverse	Negligible risk

- 14.7.4.11 The assessment concludes that there is no significant risk to GWDTEs expected within the Penrith to Temple Sowerby study area as a result of the Project.

### Temple Sowerby to Appleby

14.7.4.12 The assessment of impacts for Temple Sowerby to Appleby is presented in Table 5: Assessment of impact and risk to GWDTE for Temple Sowerby to Appleby study area. The likely impact on the habitats with the potential to support GWDTE is a change in groundwater level and groundwater flow as a result of the Project.

Table 5: Assessment of impact and risk to GWDTE for Temple Sowerby to Appleby study area

ID	Phase 1 Habitat	Groundwater Dependency and Importance	Magnitude of potential impact	Risk to GWDTE prior to mitigation
3	B5	Low	Moderate adverse	Negligible risk

14.7.4.13 There is no significant risk to GWDTE expected within the Penrith to Tempe Sowerby study area as a result of the Project.

### Appleby to Brough

14.7.4.14 The assessment of impacts for Appleby to Brough is presented in Table 6: Assessment of impact and risk to GWDTE for Appleby to Brough study area. The likely impact on the habitats with the potential to support GWDTE is a change in groundwater level and groundwater flow as a result of the Project.

Table 6: Assessment of impact and risk to GWDTE for Appleby to Brough study area

ID	Phase 1 Habitat	Groundwater Dependency and Importance	Magnitude of potential impact	Risk to GWDTE prior to mitigation
35	D2	Moderate	Moderate adverse	Moderate risk
34	B5	Moderate	Moderate adverse	Moderate risk
36	B5	Low	Moderate adverse	Negligible risk
43	B5	Low	Moderate adverse	Negligible risk
42	B5	Low	Moderate adverse	Negligible risk
45	B5	High	Moderate adverse	Significant risk
44	A1.1.1	High	Moderate adverse	Significant risk
48	F2.2	High	Moderate adverse	Significant risk
47	G1.1	High	Moderate adverse	Significant risk
46	G1.1	High	Moderate adverse	Significant risk
5	A1.1.1	Moderate	Moderate adverse	Moderate risk
6	B5	Moderate	Moderate adverse	Moderate risk
7	G1	Moderate	Moderate adverse	Moderate risk
4	B5	Moderate	Moderate adverse	Moderate risk
10	A1.1.1	Moderate	Moderate adverse	Moderate risk
52	B5	Low	Moderate adverse	Negligible risk
54	A1.1.1	Low	Moderate adverse	Negligible risk
53	B5	Low	Moderate adverse	Negligible risk
51	A1.1.1	Low	Moderate adverse	Negligible risk



ID	Phase 1 Habitat	Groundwater Dependency and Importance	Magnitude of potential impact	Risk to GWDTE prior to mitigation
50	A1.1.1	Low	Moderate adverse	Negligible risk
33	B5	Low	Moderate adverse	Negligible risk
65	A1.1.1	Low	Moderate adverse	Negligible risk
32	A1.1.1	Moderate	Major adverse	Significant risk
60	B5	High	Major adverse	Significant risk
27	B5	Low	Moderate adverse	Negligible risk
26	B5	Low	Moderate adverse	Negligible risk
25	B5	Low	Moderate adverse	Negligible risk
23	B5	Low	Moderate adverse	Negligible risk
24	B5	Low	Moderate adverse	Negligible risk
18	G1	Low	Moderate adverse	Negligible risk
19	G1	Low	Moderate adverse	Negligible risk
20	G1	Low	Moderate adverse	Negligible risk
21	G1	Low	Moderate adverse	Negligible risk
22	G1	Low	Moderate adverse	Negligible risk
17	B5	Low	Moderate adverse	Negligible risk
31	E2.2	Low	Moderate adverse	Moderate risk
30	G1	Low	Moderate adverse	Negligible risk
29	B5	Low	Moderate adverse	Negligible risk
28	A1.1.1	Low	Moderate adverse	Negligible risk
57	A1.1.1	Low	Moderate adverse	Negligible risk

14.7.4.15 Habitats which have the potential for moderate and significant risk are described in the following sections in more detail. Mitigation to reduce the magnitude of the potential impact is outlined, and the residual risk reported.

#### Dyke Nook Fen

14.7.4.16 A fen habitat has been identified north of Dyke Nook, at the proposed Sandford Junction (Chainage 42+100). This habitat consists of areas of woodland, wet grassland, standing water, and inundation zone vegetation (IDs 45, 44, 48, 47, 46) and has been indicated by Natural England to be a highly valuable habitat. There is the potential for this area to be impacted by groundwater drawdown and the interruption of groundwater flow. The dependency of this habitat on groundwater is assumed to be high, however this has not been established through surveys or detailed groundwater conceptual models.

14.7.4.17 At detailed design, further ecological surveys will be completed to collect NVC data for this area and confirm any presence or likely absence of GWDTE. A localised detailed assessment of potential groundwater dependency and risk to the GWDTEs should then be completed, if

necessary, with further ground investigations data to give a more accurate representation of potential drawdown and associated impacts.

- 14.7.4.18 If after further surveys and assessment, should a significant risk and significant adverse impact still be predicted, then mitigation to reduce groundwater ingress to the cutting to maintain the hydrogeological regime in the area will be implemented to ensure that the fen habitat is not degraded. This will be achieved by the lining of cuttings to prevent groundwater ingress with an appropriate drainage blanket beneath/surrounding which will enable continued groundwater flow to the GWDTE with limited mounding or drawdown.
- 14.7.4.19 If, for any reason this mitigation is not feasible or detailed assessment demonstrates it may not be effective, the Order Limits and the Limits of Deviation for the design at this junction allow for the junction design to be adjusted to avoid the area completely (to be informed by detailed groundwater assessment of the area following further survey). Similarly, land has been included in the Order Limits to allow the adjacent drainage pond to be located and shaped in a suitable area so as to avoid any interactions with the hydrology of the fen. This mitigation is secured in the Project Design Principles (Application Document 5.11) which is certified as part of the DCO and by way of the Limits of Deviation as set out in the DCO.
- 14.7.4.20 Following mitigation, it is considered that there will be a negligible risk to the fen habitat in this area as a result of the Project.  
**Potentially impacted habitats at Chainage 43+100 to 44+200**
- 14.7.4.21 The collection of habitats (IDs 5, 6, 7, 4, 10) around Chainage 43+000 to Chainage 44+200 have been conservatively categorised as 'Moderate' importance and dependency due to groundwater levels being recorded within 1m below surface level for that area. The areas of grassland, woodland, and standing water may potentially be dependant or partially dependant on groundwater resources, and so have the potential to be impacted by drawdown of groundwater level and interruption of groundwater flow. Therefore, it is considered that there is a moderate risk to any GWDTE that this habitat area may support.
- 14.7.4.22 At detailed design, further ecological surveys will be completed to collect NVC data for this area and confirm any presence or likely absence of GWDTE. A localised detailed assessment should then be completed, if necessary, with further ground investigations data to give a more accurate representation of potential drawdown and associated impacts. At this stage, mitigation may be required to reduce the risk to the GWDTE such as lining of cuttings to prevent groundwater ingress with an appropriate drainage blanket beneath/surrounding which will enable continued groundwater flow to the GWDTE with limited mounding or drawdown.
- 14.7.4.23 Following mitigation, it is considered that there will be a negligible risk to the fen habitat in this area as a result of the Project.

### Potentially impacted habitat Chainage 45+500

- 14.7.4.24 One area of woodland (ID 32) at Chainage 45+500 has been conservatively categorised as 'Moderate' importance and dependency due to groundwater levels being recorded at 3m below surface level in the area, and the presence of a spring 50m upgradient. This habitat may potentially be dependant or partially dependant on groundwater resources, and so has the potential to be impacted by drawdown of groundwater level and interruption of groundwater flow. Therefore, it is considered that there is a moderate risk to any GWDTE that this habitat area may support.
- 14.7.4.25 At detailed design, further ecological surveys will be completed to collect NVC data for this area and confirm any presence or likely absence of GWDTE. A localised detailed assessment of potential groundwater dependency and risk to the GWDTEs should then be completed, if necessary, with further ground investigations data to give a more accurate representation of potential drawdown and associated impacts. At this stage, mitigation may be required to reduce the risk to the GWDTE such as lining of cuttings to prevent groundwater ingress with an appropriate drainage blanket beneath/surrounding which will enable continued groundwater flow to the GWDTE with limited mounding or drawdown.
- 14.7.4.26 Following mitigation, it is considered that there will be a negligible risk to the fen habitat in this area as a result of the Project.

### Potentially impacted habitat Chainage 39+900

- 14.7.4.27 An area of wet heath (ID 35 and 34) at Chainage 49+900 has been conservatively categorised as 'Moderate' importance and dependency due to groundwater levels being recorded at 3m below surface level in the area and the potential for peat soils. This habitat may potentially be dependant or partially dependant on groundwater resources, and so has the potential to be impacted by drawdown of groundwater level and interruption of groundwater flow. Therefore, it is considered that there is a moderate risk to any GWDTE that this habitat area may support.
- 14.7.4.28 At detailed design, further ecological surveys will be completed to collect NVC data for this area and confirm any presence or likely absence of GWDTE. A localised detailed assessment of potential groundwater dependency and risk to the GWDTEs should then be completed, if necessary, with further ground investigations data to give a more accurate representation of potential drawdown and associated impacts. At this stage, mitigation may be required to reduce the risk to the GWDTE such as lining of cuttings to prevent groundwater ingress with an appropriate drainage blanket beneath/surrounding which will enable continued groundwater flow to the GWDTE with limited mounding or drawdown.
- 14.7.4.29 Following mitigation, it is considered that there will be a negligible risk to the fen habitat in this area as a result of the Project.

### Flitholme Fen

- 14.7.4.30 A sensitive habitat was identified to the east of Flitholme (Chainage 45+900). This habitat consists of an area of wet grassland that is assumed to be fed by the spring in the area (ID 60) and has been indicated by Natural England to be a highly valuable habitat. The dependency of this habitat on groundwater is assumed to be high, however this has not been established through surveys or detailed groundwater conceptual models. This area of potential fen will be directly impacted by the Project footprint, resulting in the direct loss of this habitat.
- 14.7.4.31 At detailed design, further ecological surveys will be completed to collect NVC data for this area and confirm any presence or likely absence of GWDTE. Compensation for the loss of this habitat through creation of new habitat and commitment to a Landscape Environmental Management Plan that sets out long term management to maximise opportunities for biodiversity, is outlined in Chapter 6: Biodiversity (Application Document 3.2).
- 14.7.4.32 Currently mitigation for this area of potential fen cannot be guaranteed, as such it is considered there will be a significant risk to the habitat as a result of the Project.

### Flitholme Woodland

- 14.7.4.33 A sensitive habitat was identified to the east of Flitholme (Chainage 45+900). This habitat consists of an area of woodland (ID 32) that is precautionarily categorised as moderate dependency due to a known spring in the vicinity, however this has not been established through surveys or detailed groundwater conceptual models. This area of woodland will be directly impacted by the Project footprint, resulting in the direct loss of this habitat.
- 14.7.4.34 At detailed design, further ecological surveys will be completed to collect NVC data for this area and confirm any presence or likely absence of GWDTE. Compensation for the loss of this habitat through creation of new habitat and commitment to a Landscape Environmental Management Plan that sets out long term management to maximise opportunities for biodiversity, is outlined in Chapter 6: Biodiversity (Application Document 3.2).
- 14.7.4.35 Currently mitigation for this area of woodland cannot be guaranteed, as such it is considered there will be a significant risk to the habitat as a result of the Project.

### Bowes Bypass

- 14.7.4.36 The assessment of impacts for Bowes Bypass is presented in Table 7: Assessment of impact and risk to GWDTE for Bowes Bypass study area. The likely impact on the habitats with the potential to support GWDTE is a change in groundwater level and groundwater flow.

Table 7: Assessment of impact and risk to GWDTE for Bowes Bypass study area

ID	Phase 1 Habitat	Groundwater Dependency and Importance	Magnitude of potential impact	Risk to GWDTE prior to mitigation
49	B5	Low	Moderate adverse	Negligible risk
59	G1.1	Moderate	Moderate adverse	Moderate risk

*Step 5 - Outcomes and actions*

14.7.4.37 Habitats which have the potential for moderate and significant risk are described in the following paragraphs in more detail. Mitigation to reduce the magnitude of the potential impact is outlined, and the residual risk reported.

14.7.4.38 An area of standing water (ID 59) located north of Chainage 51+300 has the potential to be impacted by drawdown of groundwater level and interruption of groundwater flow. The habitat has been conservatively classified as having moderate groundwater dependency due to ground investigations indicating that groundwater levels can be at surface level. Therefore, it is considered that there is a moderate risk to any GWDTE that this habitat area may support.

14.7.4.39 At detailed design, further ecological surveys will be completed to collect NVC data for this area and confirm any presence or likely absence of GWDTE. A localised detailed assessment should then be completed, if necessary, with further ground investigations data to give a more accurate representation of potential drawdown and associated impacts. At this stage, mitigation may be required to reduce the risk to the GWDTE such as lining of cuttings to prevent groundwater ingress with an appropriate drainage blanket beneath/surrounding which will enable continued groundwater flow to the GWDTE with limited mounding or drawdown.

14.7.4.40 Following mitigation, it is considered that there will be a negligible risk to the fen habitat in this area as a result of the Project.

*Stephen Bank to Carkin Moor*

14.7.4.41 The assessment of impacts Stephen Bank to Carkin Moor is presented in Table 8: Assessment of impact and risk to GWDTE for Stephen Bank to Carkin Moor study area. The likely impact on the habitats with the potential to support GWDTE is a change in groundwater level and groundwater flow as a result of the Project.

Table 8: Assessment of impact and risk to GWDTE for Stephen Bank to Carkin Moor study area

ID	Phase 1 Habitat	Groundwater Dependency and Importance	Magnitude of potential impact	Risk to GWDTE prior to mitigation
55	A1.1.1	Low	Moderate adverse	Negligible risk

14.7.4.42 There is no significant risk to GWDTE expected within the Stephen Bank to Carkin Moor study area as a result of the Project.

## 14.7.5 Conclusions

- 14.7.5.1 The Project may result in varying risk to areas that have the potential to support GWDTE. There is not expected to be any risk to the designated sites detailed in Table 1: Protected sites within the Project study area that have the potential to support GWDTEs. However, there may be impacts to identified areas of Phase 1 habitat across the Project.
- 14.7.5.2 Moderate risk to five areas of moderately dependant habitat that have the potential to support GWDTEs have been identified across three schemes; M6 Junction 40 to Kemplay Bank, Appleby to Brough, and Bowes Bypass. Additionally, the Project has the potential to cause significant impacts and risk to an area of fen habitat at Dyke Nook Fen and Flitholme Fen (both within the Appleby to Brough scheme study area), both of which have been categorised as highly groundwater dependant.
- 14.7.5.3 After further data collection and detailed assessment during the detailed design phase of the Project, mitigation for these areas will be considered that may include the lining of cuttings to prevent groundwater ingress with an appropriate drainage blanket beneath/surrounding which will enable continued groundwater flow to the GWDTE with limited mounding or drawdown.
- 14.7.5.4 Due to the high importance of Dyke Nook Fen, further mitigation including the redesign Sandford Junction and the drainage basin adjacent to the junction within the Order Limits and the defined Limits of Deviation to avoid any potential impacts on the fen habitat and water sources will be undertaken if it is established that lining the cuttings will not be sufficient to prevent an impact on the water flow to the fen. This mitigation is secured in the Project Design Principles (Application Document 5.11) which is certified as part of the DCO and by way of the Limits of Deviation as set out in the DCO.
- 14.7.5.5 The loss of Flitholme Fen and Flitholme Woodland is unavoidable as it will be directly impacted by the footprint of the Project. At detailed design further surveys will be carried out to confirm the importance of this habitat and at detailed design opportunities to reduce the loss of this habitat are undertaken if possible. Compensation for the loss of this habitat through creation of new habitat and commitment to a Landscape Environmental Management Plan that sets out long term management to maximise opportunities for biodiversity, is outlined in Chapter 6: Biodiversity (Application Document 3.2).
- 14.7.5.6 Mitigation outlined in this assessment is detailed in the Register of Environmental Actions and Commitments (REAC) within the EMP (Application Document 2.7) and is secured in the Project Design Principles (Application Document 5.11) which is certified as part of the DCO.