Yorkshire GREEN Project

Environmental Impact Assessment

Preliminary Environmental Information Report
Volume three Appendix 10B: Assessment of physical effects on groundwater (Focus Areas)

October 2021

nationalgrid

10B. Assessment of physical effects on groundwater (Focus Areas)

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1. Overton Area

1.1 2TW/YR 'Duck Under' Site

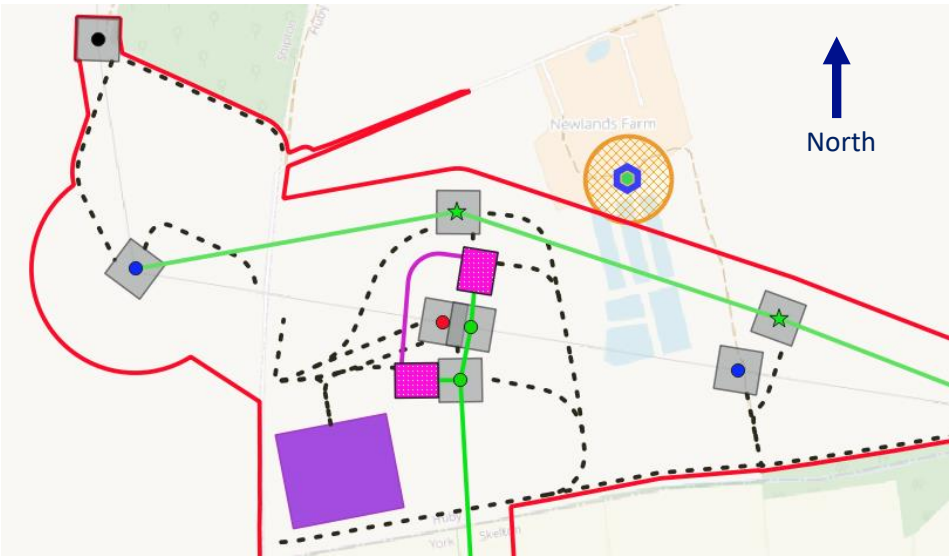


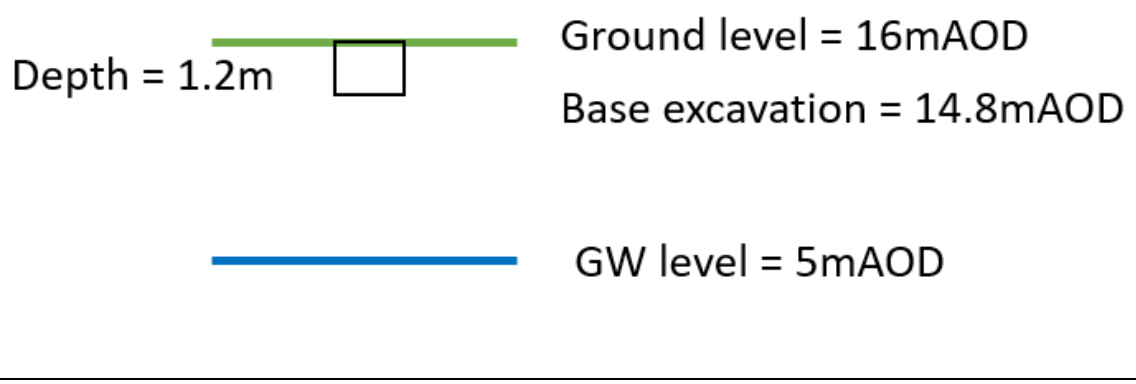
Figure 10B.1: Schematic layout of selected proposed infrastructure at the 2TW/YR duck under site

Pink line = underground cable, pink polygons = CSEC, purple polygon = construction compound, green circles = proposed pylons (permanent), green stars = proposed structures (temporary), grey polygon = pylon construction working areas, black dash = access tracks, red line = draft Order Limits, red circle = existing pylon to be removed, blue circles = existing pylons to be modified, black circles = existing pylons (unaffected), orange hatch with solid orange boundary = Source Protection Zone (SPZ1), blue hexagon = groundwater abstraction.

Conceptual Hydrogeological Site Model	
Site name	2TW/YR Duck Under
Coordinates	456626,459961
Infrastructure	
Infrastructure type and excavation depths	Infrastructure as shown above. Excavation depths/construction methods as described in **Chapter 3: Description of the Project**.
	Excavation depths (for example, for underground cables) assumed to be 1.2m below ground level (bgl).
Superficial geology at Site	
Unit	Alne Glaciolacustrine Formation.

Conceptual Hydrogeological Site Model			
Description	Laminated clay with silt (varved) and subordinate fine-grained sand beds, plus minor marginal sand and gravel.		
Thickness	Up to 22m.		
Bedrock geology at Site			
Unit	Sherwood Sandstone.		
Description	Sandstone, red, yellow and brown, part pebbly; conglomeratic in lower part; pebbles generally extraformational quartz and quartzite, with some intraformational clasts; subordinate red mudstone and siltstone.		
Thickness	Variable, maximum > 1,500m.		
Superficial aquifer	-		
Designation	Unproductive Strata.		
Hydraulic conductivity	10^{-9} to 10^{-6}m/s.		
Specific yield	0.08.		
Bedrock aquifer designation	Triassic Rocks (Undifferentiated)		
Designation	Principal.		
Description	Principal aquifer, sandstone up to 600m thick and yielding up to 125l/s. Quality good but hard and becomes saline beneath confining Mercia Mudstone.		
SPZ	Inner Zone (Source Protection Zone 1) located outside Project Red Line Boundary.		
Hydraulic conductivity	10^{-10} – 10^{-5}m/s.		
Storage	10^{-4} (confined) and <0.15 (unconfined).		
Specific Yield	0.27.		
Superficial groundwater levels	-		
Bedrock groundwater levels	~ 1 - 5m above ordnance datum (AOD).		
Surface water features			
Operational Catchment	Ouse Upper Yorkshire		
Location (distance from Site)	740m west	1.24km north	1.7km south-west
Type (spring, drain, river)	Stream (Moor Gutter).	Stream (Backrein Beck).	Drain (Pennels Drain).
BFI	0.45		
Abstractions			

Conceptual Hydrogeological Site Model	
Location (distance from Site)	167 north-east (Newlands Farm).
Type (PrWS, licenced abstraction)	Licensed abstraction – agricultural.
Abstraction rates	45m^3/day.
Geology	Sherwood Sandstone.
Radius of Influence (ROI) calculation	
Confined / unconfined	Confined.
Analytical equation used	Dupuit-Thiem (Confined Aquifer Conditions).
Diagram	



1.2 ROI Calculation

1.2.1 The aquifer in this location, the Sherwood Sandstone, is confined beneath a moderately impermeable superficial deposit layer (clay and silt). To best represent the laminated clay and sand deposits found here, hydraulic conductivity values within the basal till range were selected to derive the ROI. Inflow rates have also been provided under transient states, with a period of 30 days used. To install the proposed infrastructure, multiple excavations would be required, with the most substantial likely to be circa 1.2m deep trenching to install the proposed underground cable. The ROI under the above conditions would be expected to be between around 1m and around 40m. Excavation inflow rates are predicted to be less than 1l/s under all conditions.

Impacts of dewatering on the water environment

Abstractions and Groundwater

1.2.2 The closest abstraction is at Newlands Farm, which is 167m north-east of the northern proposed CSE compound at the 2TW/YR duck under site. The abstraction rate at this private water supply is 45m^3/day (0.52l/s) and is abstracting from groundwater in the Sherwood Sandstone aquifer. The bedrock aquifer groundwater level (5m AOD) is likely to be below the excavation depth (14.8m AOD). Therefore, there is sufficient evidence to suggest that any dewatering would be limited to the Alne Glaciolacustrine Formation so there will not be any effect on the groundwater in the bedrock aquifer or the abstractions.

Surface Water

1.2.3 It is possible that shallow dewatering from an excavation in the superficial deposits could affect baseflow to nearby streams, though this does not include comparative elevations between the excavation and nearby watercourses.

1.2.4 Identified surface water features are outside of the ROI and unlikely to be impacted – the ROI is a maximum of around 40m and the nearest surface water feature is the Moor Gutter 740m west. There is a low risk to the surface water catchment (Hurns Gutter from Source to River Ouse) at this site.

2. Overton Substation

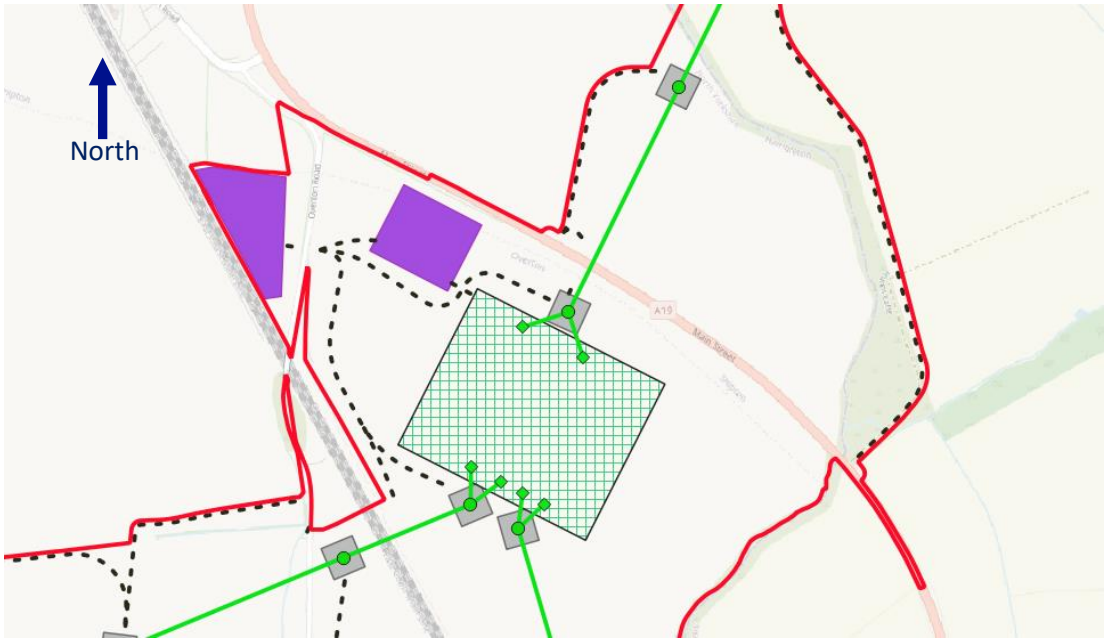


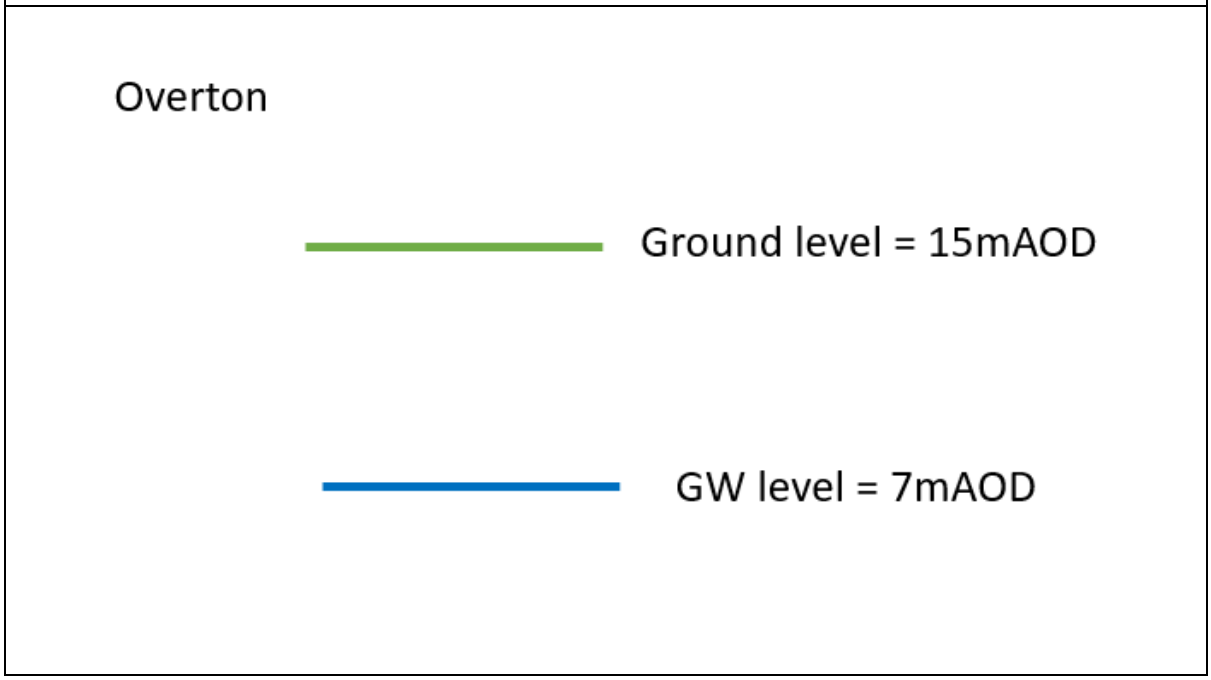
Figure 10B.2: Schematic layout of selected proposed infrastructure at the Overton Substation site

Green hatch = proposed Overton Substation, purple polygons = construction compounds, green circles = proposed pylons (permanent), grey polygons = pylon construction working areas, black dash = access tracks, red line = draft Order Limits.

Conceptual Hydrogeological Site Model	
Site name	Overton Substation.
Coordinates	455759, 457395
Infrastructure	
Infrastructure type and excavation depths	Infrastructure as shown above. Excavation depths for substation not known in advance of ground investigation, but reasonably assumed to be less than 4m as a worst-case, based on construction practicability.
Superficial geology at Site	
Unit	Alne Glaciolacustrine Formation.
Description	Laminated clay with silt (varved) and subordinate fine-grained sand beds, plus a little marginal sand and gravel.
Thickness	Up to 22m.
Bedrock geology at Site	

Conceptual Hydrogeological Site Model				
Unit	Sherwood Sandstone Group.			
Description	Sandstone, red, yellow and brown, part pebbly; conglomeratic in lower part; pebbles generally extraformational quartz and quartzite, with some intraformational clasts; subordinate red mudstone and siltstone.			
Thickness	Variable, maximum > 1,500m			
Superficial aquifer	-			
Designation	Unproductive Strata.			
Hydraulic conductivity	-			
Storage	-			
Bedrock aquifer designation	Triassic Rocks (Undifferentiated)			
Designation	Principal aquifer, sandstone up to 600m thick and yielding up to 125l/s. Quality good but hard and becomes saline beneath confining Mercia Mudstone.			
SPZ	-			
Hydraulic conductivity	10^{-10} – 10^{-5}m/s.			
Storage	10^{-4} (confined) and < 0.15 (unconfined).			
Specific Yield	0.27.			
Superficial groundwater levels	-			
Bedrock groundwater levels	~ 7m AOD.			
Surface water features				
Operational Catchment	Ouse Upper Yorkshire			
Location (distance from Site)	450m south-east	340m west	1.73km south-west	1km west
Type (spring, drain, river)	Hurns Gutter (stream).	Drain.	River Ouse.	Overton Wood.
BFI	0.45.			
Abstractions				
Location (distance from Site)	None (within 2km radius).			
Type (PrWS, licenced abstraction)	-			
Abstraction rates	-			
Geology	-			
Diagram				

Conceptual Hydrogeological Site Model



2.1 Context

2.1.1 The aquifer in this location, the Sherwood Sandstone, is confined beneath low permeability glaciolacustrine deposits which behave as an aquitard. The clay and silt content impedes vertical migration and has been recorded as having depths of up to 22m. There are no abstraction sites (licensed or private water supply) within 2km of the site so the cone of depression caused by the pumping/dewatering would not capture groundwater supply points. A drain and stream are within 500m of the site and critically, groundwater supply contributes to 45% of the flow within the catchment as a whole (Hurns Gutter from source to River Ouse).

2.2 Impact of dewatering on the water environment

Abstractions and Groundwater

2.2.1 Groundwater levels in this location are recorded as approximately 7m AOD. The dimensions and depths of substation construction excavations are not known in advance of ground investigation and detailed engineering design. A qualitative assessment suggests that there would only be groundwater ingress from the Sherwood Sandstone into the excavation if the excavation was taken to 7m AOD. This would be 8m bgl so this possibility is discounted (should foundations be required to this depth, then they would typically be piled rather than requiring excavation and dewatering).

Surface Water

2.2.2 It is possible that shallow dewatering from an excavation in the superficial deposits could affect baseflow to nearby streams. The design excavation depth is unknown at this stage, so a check of comparative elevations between the excavation and nearby watercourses cannot be made. However, the nearest watercourse is 340m away so the risk of a dewatering effect being experienced by that watercourse is low.

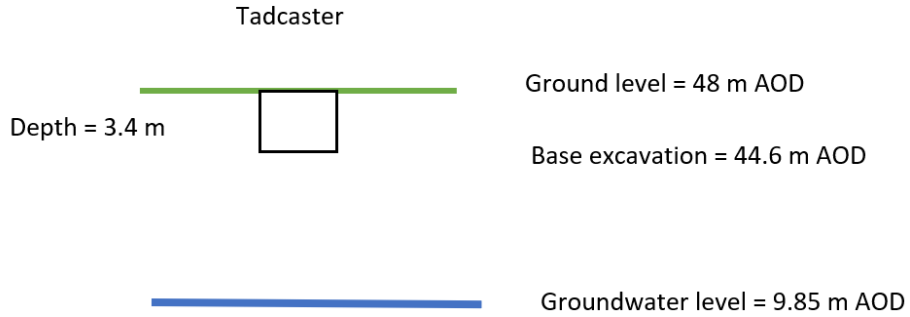
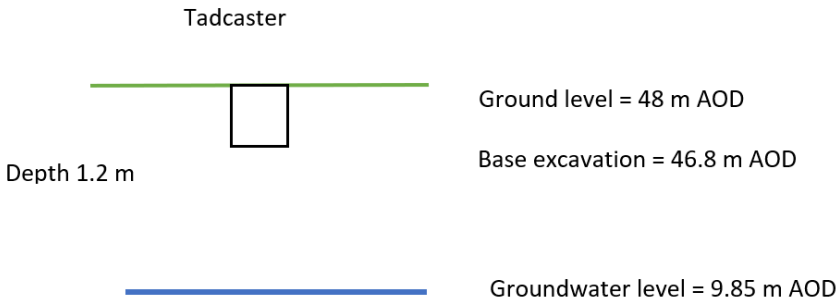
3. Tadcaster Area

Figure 10B.3: Schematic of selected proposed infrastructure at the Tadcaster Area

Pink line = underground cable, pink polygons = CSEC, purple polygons = construction compounds, green circle = proposed pylon (permanent), green stars = proposed structures (temporary), red circle = existing pylon to be removed, blue circles = existing pylons to be modified, grey polygons = pylon / cable construction working areas, black dash = access tracks, red line = draft Order Limits, blue cross = private water abstraction (Brick House Farm).

Conceptual Hydrogeological Site Model	
Site name	Tadcaster.
Coordinates	446223, 441679
Infrastructure	
Infrastructure type and excavation depths	Infrastructure as shown above. Excavation depths/construction methods as described in **Chapter 3: Description of the Project.**
	Specifically: The installation of foundations for new pylons will require four excavations of around 3.1m x 3.1m area and 3.4m depth per pylon (one excavation for each leg). Underground cables will involve 1.2m deep trenches. This is precautionary, as it may be that the cables are installed by horizontal directional drilling (HDD) due to the presence of underground utilities, in which case excavations would only be needed at starter pits. CSEC may require dig out / foundation excavations to a nominal 1.2m depth.
Superficial geology at Site	

Conceptual Hydrogeological Site Model	
Unit	Exposed bedrock.
Description	-
Thickness	-
Bedrock geology at Site	
Unit	Brotherton Formation.
Description	Limestone, dolomitic, grey with abundant Calcinema.
Thickness	0-20m.
Superficial aquifer	
Designation	Superficial deposits are mapped to be absent.
Hydraulic conductivity (m s^{-1})	-
Storage	-
Bedrock aquifer	Zechstein Group
Designation	Principal.
Description	Significant regional dolomitised limestone aquifer up to 300m thick near Durham. Locally yielding up to 50 l/s of very hard water.
SPZ	Zone III Total Catchment (SPZ3) and Zone II Outer Protection Zone.
Hydraulic conductivity (m s^{-1})	10^{-9} – 10^{-5}
Storage	3.4 x 10^{-6} to 4.0 x 10^{-3}.
Specific Yield	0.14.
Superficial groundwater levels	-
Bedrock groundwater levels	Long term groundwater level data taken from a borehole at Brick House Farm, dating from 1979 to 2004, show the groundwater level to be between around 10m AOD and 16.6m AOD. Groundwater level within magnesium limestone in the vicinity of the location is typically around 10m AOD.
Surface water features	
Operational Catchment	Wharfe Lower
Location (distance from Site)	1.84km south-east.

Conceptual Hydrogeological Site Model							
Type (spring, drain, river)	Stream (Cock Beck).						
Abstractions							
Location (distance from Site <2km)	1.08km south-east.	1.71km north-west.	1.3km south.	1.9km west.	140m east.	1.6km south-east.	1.9km south-west.
Type (Private Water Supply (PrWS), licensed abstraction)	Licensed Abstraction.	Licensed Abstractions (3).	Licensed Abstractions (PrWS).				
Abstraction rates	61.37m^3/day.	855m^3/day.	--				
Geology	Magnesian Limestone	Magnesian Limestone	Magnesian Limestone				
Diagram							
Pylon							
							
CSE							
							

3.1.1 To install the proposed infrastructure at the Tadcaster Area, various shallow excavations would be required (around 3.4m depth for pylons and nominally 1.2m depth for underground cables and CSEC). The site location is in a recharge area for the Wharfe Magnesian Limestone groundwater body, with discharge areas into the Cock Beck Catchment (a tributary of the River Wharfe to the north). Since there are no superficial deposits in this area or confining strata, the depth of the excavation would be (for the majority) directly into the Brotherton Formation.

3.1.2 The closest abstraction is at Brick House Farm, which is 138m east of the easternmost of the two proposed CSE compounds. The abstraction rate at this private water supply is unknown, but it is likely to be abstracting from the dolomite aquifer at greater depths. It is unlikely that the Brick House Farm well will influence groundwater ingress in the vicinity of the proposed infrastructure.

3.2 Impacts of dewatering on the water environment

3.2.1 Though the excavation would be into the bedrock, the potential for any effect on the groundwater resource from shallow dewatering can be discounted since the static groundwater elevation in this location is approximately 10m AOD, whereas the base of excavations would generally be around 45m AOD, well above the groundwater elevation in the aquifer. Dewatering in excavations would be to combat direct rainfall, as the groundwater body is much deeper and would not be encountered.

3.2.2 It is important to note that this assessment does not include comparative elevations between the excavation and nearby watercourses. However, the nearest surface water body is 1.84km south and is unlikely to be affected.

4. Monk Fryston Area

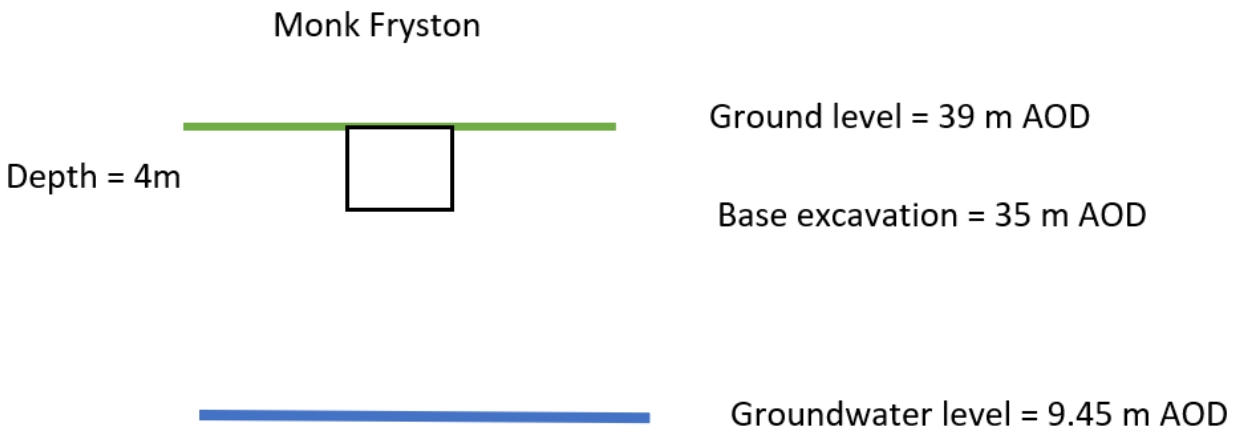
Figure 10B.4: Schematic of selected proposed infrastructure at the Monk Fryston Area

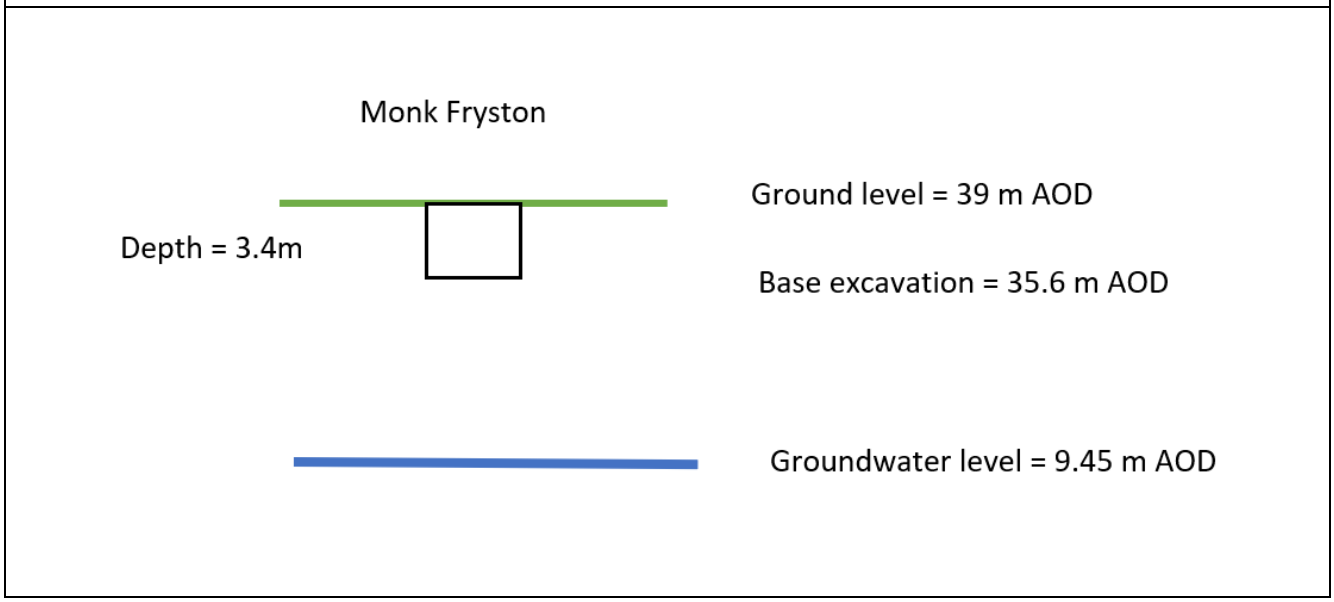
Purple polygons = construction compounds, green circles = proposed pylons (permanent), green stars = proposed structures (temporary), grey polygon = pylon construction working areas, black dash = access tracks, red line = draft Order Limits, red circles = existing pylons to be removed, blue circles = existing pylons to be modified, black circles = existing pylons (unaffected), blue hexagons = groundwater abstractions, blue cross = private water abstraction, orange hatch = proposed substation.

Conceptual Hydrogeological Site Model	
Site name	Monk Fryston.
Coordinates	448522, 429332
Infrastructure	
Infrastructure type and excavation depths	Infrastructure as shown above and in **Chapter 3: Description of the Project**. Excavation depths/construction methods as described in **Chapter 3: Description of the Project**. The infrastructure relevant to the assessment is the proposed substation and 6 new pylons (assuming on a precautionary basis that the temporary structure shown on **Figure 10B.4** will be a pylon). Pylon excavations will be around 3.4m deep, over an area of 3.1m x 3.1m (four excavations per pylon and limited by the depth at which piling would be a more suitable method).

Conceptual Hydrogeological Site Model	
	The excavation depth for the installation of substation foundations is not known in advance of ground investigation but is reasonably assumed to be less than 4m as a worst-case, based on construction practicability.
Superficial geology at Site	
Unit	Harrogate Till Formation.
Description	Slightly sandy clay with large local sandstone blocks.
Thickness	Up to 8m.
Bedrock geology at Site	
Unit	Brotherton Formation.
Description	Limestone, dolomitic, grey with abundant Calcinema.
Thickness	0-20m.
Superficial aquifer	
Designation	Secondary (undifferentiated).
Hydraulic conductivity (m s^{-1})	10^{-12} to 10^{-6}.
Specific Yield	0.06.
Bedrock aquifer designation	Zechstein Group
Designation	Principal (Aire and Don Magnesian Limestone)
SPZ	-
Hydraulic conductivity (m s^{-1})	10^{-9} to 10^{-5}.
Storage	3.4×10^{-6} to 4.0×10^{-3}.
Specific Yield	0.14.
Superficial groundwater levels	-
Bedrock groundwater levels	9.45m AOD.
Surface water features	
Operational catchment	Aire Lower
Location (distance from Site)	390m south-east and 960m south-east.

Conceptual Hydrogeological Site Model							
Type (spring, drain, river)	Drain.						
Abstractions							
Location (distance from Site)	1.25km east.	1.23km north-west.	1.53km south-west.	1.26km north-west.	1.61km south.	280m west, 1.9km north-east, 1.6km south-west.	1.1km south-west.
Type (PrWS, licensed abstraction)	Licensed Abstraction	Licensed Abstraction (2)	Licensed Abstraction	Licensed Abstraction	Licensed Abstraction	PrWs	Licensed Abstraction
Abstraction rates	200m^3/day	22.73 m^3/day	137 m^3/day	22.73 m^3/day	1233 m^3/day		137 m^3/day
Geology	Magnesian Limestone	Magnesian Limestone	Magnesian limestone	Magnesian Limestone	Magnesian Limestone		
Radius of Influence (ROI) calculation							
Confined / unconfined	Confined.						
Analytical equation used	Dupuit-Thiem (Confined Aquifer Conditions).						
Diagram							
Substation (where excavation depth taken as a nominal 4m)							



Conceptual Hydrogeological Site Model
Pylon pads (additional depth beyond 3.4m at corner pads for foundations, limited by depth at which piling would be more practicable)


4.1 Context

4.1.1 The site falls into the Aire Lower operational river basin catchment which extends from Goole to Otley. The river catchment in which the site is located is the Aire from River Calder to River Ouse, whose catchment envelops a 125km^2 area and extends 69km in length. The groundwater body underlying the site is confined by the Harrogate Till Formation which is up to 8m thick in some areas. Groundwater levels tend to coincide with the upper boundary of the dolomitised limestone. The site does not fall into a Source Protection Zone though the groundwater body is designated as having medium to high vulnerability. Nearby surface and groundwater receptors are drains within 1km of the site and a private water supply and two licensed abstractions (agricultural) 280m to the west of the nearest proposed pylon and up hydraulic gradient from the proposed excavation. The aquifer in this location, the dolomitised limestone of the Zechstein group, is confined beneath the Harrogate Till Formation which has a low permeability.

4.2 Substation

4.2.1 The dimensions and depths of the foundation excavations for the substation to be constructed at Monk Fryston are subject to determination following ground investigation and detailed engineering design, so a qualitative assessment has been carried out.

Impacts of dewatering on the water environment

Abstractions and Groundwater

4.2.2 Any groundwater encountered at shallower depths is indicative of a perched water body within the clay and dewatering would not impact abstraction points in the proximity of the site which abstract groundwater from the underlying Magnesian Limestone.

Surface Water

4.2.3 It is important to note that any shallow dewatering from the superficial geology could affect baseflow to water courses in the vicinity of the excavation. Additionally, this assessment does not compare the elevations in nearby watercourses with the excavation elevation.

4.3 Pylons

4.3.1 The construction of six pylons along a 1.19km path adjacent to the Selby Fork Interchange would entail six distinct excavation areas, one at each pylon. Each excavation area would be within a pylon footprint of approximately 10m x 10m (indicative only and may vary depending on pylon type). It would comprise four pylon foundation excavations of around 3.1 x 3.1m in plan by 3.4m depth; one at each corner of the footprint. Note that this assumes that pad foundations are used, rather than piles. This is a precautionary assumption when considering possible dewatering effects.

4.3.2 Using the Dupuit-Theim, an estimation of inflows into the anticipated excavations can be derived with a respectable degree of accuracy. Likewise, under the theorem's assumptions, we can obtain a ROI with regard to the dimensions of the pit. Inflow rates have also been provided under transient state with literature hydraulic conductivities for the geology and with a time period of 30 days.

4.3.3 Values for hydraulic conductivity were taken from literature to reflect the properties of the sandy clay found here. Preliminary inflow calculations suggest that an ROI between 0m and 30m (mean of 6m), dependent on hydraulic conductivity, would be reasonable to assume at this stage for four excavations (dimensions of 3.1m x 3.1m x 3.4m) at each pylon. Using the Dupuit-Theim analysis, inflow rates into the excavations are anticipated to be less than 1l/s under all conditions.

Impacts of dewatering on the water environment

Abstractions and Groundwater

4.3.4 The closest abstraction is west of the A1(M), directly south of the Selby Fork interchange (280m north-west of the nearest proposed pylon). The abstraction rate at this private water supply is not known although licensed abstractions in the vicinity currently abstract at a rate of 22.73m^3/day (0.26l/s) for agricultural use. The groundwater abstracted here is from the underlying magnesium limestone (fracture flow). Groundwater elevation in this area is around 9.45m AOD, which is well below the depth of the proposed excavation (37.5m AOD) and as such any shallow dewatering will have no effect on the groundwater in the bedrock aquifer or abstractions into the bedrock aquifer.

Surface Water

4.3.5 It is possible that shallow dewatering from an excavation in the superficial deposits could affect baseflow to nearby streams, though this assessment does not include comparative elevations between the excavation and nearby watercourses.

4.3.6 However, the nearest surface water feature (a drain, 390m to the south-east) is outside of the calculated ROI (maximum of 24m) so it is unlikely that dewatering of the superficial deposits will affect the baseflow of the water feature. Quantitative analysis

suggests that there is a low risk to surface water bodies as a result of shallow dewatering.