

Appendix 12C

Draft Halite Risk Assessment

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WSP ENVIRONMENT & INFRASTRUCTURE SOLUTIONS UK LTD

HYNET NORTH WEST HYDROGEN PIPELINE PROJECT

HALITE RISK ASSESSMENT

AUGUST 2024

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DRAWINGS

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ST19815-010	Draft Order Limits and Brine Area	1:60,000
ST19815-011	Draft Order Limits and Superficial Geology	1:50,000
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APPENDICES

Appendix 1	Cheshire Salt Search Report dated 18 July 2022, reference GS-8910632
Appendix 2	British Geology Survey and Ian Farmers Borehole Records
Appendix 3	Summary of Brine Well Information
Appendix 4	Prescribed Notices of Damage Summary
Appendix 5	Northwich Mine Stabilisation Programme Top Bed Workings, reference 116965, Figure 2.12 obtained from Top Bed Salt Desk Study Report prepared by Arup.

1 INTRODUCTION

- 1.1 This report has been prepared in accordance with Wardell Armstrong's proposal letter dated 29 September 2022 (letter ref. ST19815-0001) and email dated 8 July 2024 and subsequent confirmation of instructions from David Kenyon of WSP in relation to the HyNet North West Pipeline Project. This report comprises a detailed Halite (rock salt and brine) subsidence risk assessment along the route of the proposed pipeline. This report provides an update on the report ref. ST19815-0001, dated April 2023 following changes to the route.
- 1.2 It is understood that the project seeks to facilitate the transportation of low carbon hydrogen in order to support the transition to net zero carbon emissions by 2050, involving the construction of approximately 100km of new below and above ground pipeline infrastructure. In addition to the construction of the pipeline, the project will involve the construction of various associated infrastructure including hydrogen storage.
- 1.3 The Draft Order Limits (DOL) represent the maximum development area boundary of the project and includes temporary works such as construction access/storage, in addition to permanent works such as the pipeline, hydrogen above ground installations (HAGI) and block valve installations (BVIs). The purpose of the HAGIs and BVIs is to control the flow and pressure of hydrogen at key points along the proposed pipeline. It is understood that there are several route options for the pipeline and location options for the HAGI and BVIs, all of which are included within the DOL.
- 1.4 The construction proposals show that the majority of the underground pipeline will be constructed using open trench excavation techniques, with trenchless methods being utilised where open trenching is not possible, such as in situations where the pipeline is required to cross roads, railways and waterways. The trenchless methods include auger boring, horizontal directional drilling (HDD), micro-tunnelling and direct pipe methods.
- 1.5 Part of the DOL passes through the Cheshire Brine Subsidence Compensation District and therefore potential risks may exist from subsidence caused by historical brine related activities. This halite risk assessment considers the potential risks in addition

to supporting the Environmental Impact Assessment (EIA) and Planning Process.

- 1.6 The DOL, where it passes through the Compensation District, extends from Partington in the north east, via Lower Whitley (c.6km north west of Northwich) and Bartington, towards Lach Dennis (c.5km south east of Northwich). The length of the proposed route (DOL) where it passes through the Cheshire Brine Subsidence Compensation District is in the order of approximately 45km and is illustrated on Drawing ST19815-010.
- 1.7 A Cheshire Salt Search (CSS) Report (Appendix 1) has been provided for the DOL which passes through the Compensation District, with the wider HyNet pipeline extending further to the north and north-west.
- 1.8 A limited intrusive ground investigation has been undertaken within the DOL by Ian Farmer Associates in 2023, focusing on proposed trenchless crossing locations. Where appropriate and applicable, these boreholes have been considered in preparing the report and attached at Appendix 2.
- 1.9 In preparing this risk assessment, consideration and reliance has been placed on the following information:
- Groundsure Cheshire Salt Search Report, reference GS-8910632, dated 18 July 2022;
 - Scoping Report prepared by WSP, dated August 2022;
 - Red Line Boundary of the DOL provided in Shapefile Format from WSP, provided in July 2024;
 - Publicly available British Geological Survey (BGS) Online Datasets (public sector information licensed under the Open Government Licence v3.0);
 - Historical Topographical Mapping provided by WSP;
 - BGS Geology of the Country around Chester and Winsford. Memoir for 1:50,000 geological sheet 109 (England and Wales);
 - Wardell Armstrong's in-house records including unique abandonment plan archives;
 - A Report on the Rocksalt Mines and Brine Shafts in the Cheshire Saltfield for the County Planner, Cheshire County Council, prepared by Peter Wharmby, dated July 1987;

- Northwich Mines Stabilisation Programme – Top Bed Salt Desk Study, prepared by Arup, dated February 2005;
- Cheshire Land Stabilisation Scheme Phase 1, prepared by WS Atkins Consultants Ltd, dated June 2002;
- Winsford Rock Salt Mine - Its History, Workings and Production, prepared by Compass Minerals;
- Consultations with the Cheshire Brine Subsidence Compensation Board (CBSCB) including access to their library of documents
- Ian Farmer Associates, Factual Report on Ground Investigation, ref. 2230746, dated May 2023.

1.10 This halite risk assessment has been prepared for the red line boundary provided by WSP in July 2024 (amended from the February 2023 red line boundary, principally by the exclusion of the Northwich branch and as reported on in our report ref. ST19815-0001, dated April 2024), which defines the Draft Order Limits (DOL) and includes the maximum extent of development within the Compensation District. The Cheshire Salt Search (CSS) report (Appendix 1) has been obtained by WSP and covers the original DOL reported on in April 2024 as well as an associated buffer. The CSS report has been used as a basis to request additional information, where required, from the Cheshire Brine Subsidence Compensation Board (CBSCB) and therefore certain information within the CSS report refers to areas outside the DOL in some instances. Should the DOL be altered at any stage, then this risk assessment would need to be reviewed and updated accordingly.

1.11 Opinions and views expressed within this report are based on available data and may be subject to review on receipt of further details.

1.12 This report considers the ground stability risks of the proposed pipeline as it pertains to the potential dissolution of Halite only. This report does not consider other potential geotechnical risks of ground instability that may occur such as, for example, poor ground conditions within the Superficial Deposits.

2 CBSCB AND PLANNING POLICY

- 2.1 The DOL is situated within the Cheshire Saltfield, which has been extensively exploited by brine pumping and rocksalt mining. Both brine pumping and natural dissolution of the salt deposits can result in the potential for subsidence. The CBSCB was established in 1952 by virtue of the Cheshire Brine Pumping (Compensation for Subsidence) Act (1952 Act) to compensate those not connected to the salt industry for any damage caused to land and property by brine pumping activities.
- 2.2 Since 1891, a compensation scheme had been in operation for Northwich but it was not until 1952 that the provisions were extended to other parts of Cheshire (establishing the Compensation District) which were also affected by brine pumping activities. It is confirmed that the DOL is located within the Compensation District. The 1952 Act also established the CBSCB as a statutory consultee with regard to planning applications and building control certification within prescribed areas. Those areas are identified by the CBSCB to relate to land that is subsiding or liable to subside as a consequence of brine pumping.
- 2.3 There is a statutory requirement, under Section 38(2) of the 1952 Act, to consult the CBSCB at both the planning application and building regulation approval stages of development within specified areas (known as Consultation Areas). The purpose of this consultation is to ensure that Developers are aware of the brine related ground stability risks and to establish minimum foundation requirements to new built property, having regard to the perceived brine pumping related risk. It is noted that the DOL does not fall within any of the above-mentioned Consultation Areas.
- 2.4 It is important to note that brine dissolution subsidence, brine pumping and brine wells/shafts are not confined solely to the CBSCB Consultation Areas. Additionally, insofar as the proposed development comprises a pipeline route, this form of development may not be captured by the Building Regulations / Building Control process, although the CBSCB should still be consulted on any application for planning consent that falls within the Consultation Area. Nonetheless, it is regarded to be good practice to assess the brine and halite related risk and to identify appropriate construction designs for any substantive developments or infrastructure projects within the Compensation District.

3 GEOLOGICAL SETTING

- 3.1 This risk assessment has been prepared for the DOL where it passes through the Cheshire Brine Subsidence Compensation District, as shown on Drawing ST19815-010. The wider DOL extends to the north, west and north-west outside of the boundaries of the Compensation District and is not considered as part of this report. The full extent of the DOL outside the district is not shown on Drawing ST19815-010.
- 3.2 Halite deposits within the Cheshire Saltfield occur in two main groups; historically these were named the Upper and Lower Keuper Saliferous Beds, now referred to as the Wilkesley and Northwich Halite Member respectively. These salt bearing deposits are present within the thick deposits of Mudstone previously known as the Keuper Marl and which are now identified as the Mercia Mudstone Group. Figure 3.1 summarises the geological strata within the Cheshire Saltfield.

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Group	Old Formation Name	New Formation Name	Typical Lithology in the Saltfield
Mercia Mudstone Group (Formerly Keuper Series)	Upper Keuper Marl	Brooks Mill Mudstone Formation	Red-brown mudstone gypsum/anhydrite nodules and a bed of anhydrite
	Upper Keuper Saliferous Beds	Wilkesley Halite Formation	Thick rocksalt (halite) with red-brown blocky mudstones
	Middle Keuper Marl	Wych Mudstone Formation	Blocky mudstone with gypsum/anhydrite nodules and thin rocksalt bands in the base
		Byley Mudstone Formation	Poorly laminated and blocky red-brown mudstone
	Lower Keuper Saliferous Beds	Northwich Halite Formation	Rocksalt with thin laminated mudstones
	Lower Keuper Marl	Bollin Mudstone Formation	Interlaminated red-brown and green-grey mudstones with some thin dolomitic siltstone laminae, with thin veins of gypsum
	Keuper Waterstones	Tarporley Siltstone Formation	Interlaminated and interbedded red-brown with green-grey mottled siltstones, mudstones and sandstones
Sherwood Sandstone Group (Formerly Bunter Series)	Lower Keuper Sandstone (LKS)	Helsby Sandstone Formation (HEY)	Sandstone with pebble beds and siltstone

Figure 3.1: Nomenclature & Classification of Triassic Strata in the Cheshire Saltfield

(Source: The Geological Society, Geoscientist Online, Geology and HS2)

- 3.3 The salt bearing strata have been subjected to extensive faulting, folding and erosion within the Cheshire Saltfield and as a result they vary considerably in thickness and

depth below the ground surface. Throughout the Saltfield, in parts, the solid bedrock is also overlain by Superficial Deposits comprising a mixture of granular and cohesive soils.

Natural Superficial Deposits

- 3.4 Published BGS geological mapping (publicly available online datasets) shows that Superficial Deposits, where present, comprise Glacial Till Deposits, River Terrace Deposits, Alluvium, Glaciofluvial Deposits, Peat and deposits of the Shirdley Hill Sand Formation. Superficial Deposits are present across the majority of the DOL with the exception of small areas in the southern corridor and larger areas within the northern corridor of the DOL, notably in vicinity of Lower Whitley, Higher Whitley, and Sworton Heath/High Legh. The distribution of Superficial Deposits is shown on Drawing ST19815-011 for reference.
- 3.5 In the southern corridor of the DOL, the majority of the Superficial Deposits comprise Glacial Till and Glaciofluvial Deposits with deposits of Alluvium and River Terrace Deposits generally confined to watercourses including in and surrounding the River Dane, Trent & Mersey Canal, the Weaver Navigation and a number of smaller surface water features which intersect the DOL, including drains and brooks etc.
- 3.6 Within the northern corridor (from Lower Whitley up to Partington in the north-east) the Superficial Deposits generally comprise a mixture of Glacial Till, Alluvium, Glaciofluvial Deposits, Peat and River Terrace Deposits, with the Shirdley Hill Sand Formation predominantly present beneath the northern extent of the corridor. The Alluvium and River Terrace Deposits are constrained to areas in and surrounding water courses; with the River Mersey and River Bollin representing the most significant surface water features in the northern corridor.
- 3.7 Deposits of Peat are reported to be present in two main areas in the northern corridor including in and surrounding Sink Moss (where the DOL crosses the M6 motorway) and in the extreme north-east where the DOL terminates in Partington.
- 3.8 Glacial Till deposits, which are prevalent across the majority of the DOL, are generally cohesive in nature comprising generally firm to stiff sandy gravelly clays.

Alluvium, River Terrace deposits and Glaciofluvial deposits are generally granular in nature consisting of sands & gravels (Glaciofluvial Deposits and River Terrace Deposits) and clay, silt, sand and gravel (Alluvium). The Shirdley Hill Formation is described by the BGS as *“moderately to well-sorted, fine-grained sand with peat layers in the lower part. The sediments are interpreted as coastal blown sands, possibly a coastal facies of the Seacombe Sand Formation”*.

- 3.9 An initial review of publicly available BGS borehole records shows that one borehole (BGS reference SJ66NE8) is present within a surface water pond to the south of Moulton, adjacent to the boundary of the DOL. This borehole was drilled to a depth of c.92m and did encounter the base of the Superficial Deposits, indicating that the thickness of these deposits is in excess of 92m in this area. A second borehole (reference SJ66NE2) drilled further to the west of the DOL, confirms that the Superficial Deposits are in the region of 65m thickness. However, the recent ground investigation undertaken in 2023 indicates the presence of Superficial Deposits down to a depth of between c. 5m and 15mbgl further north west, in the vicinity of the River Weaver.
- 3.10 BGS borehole reference SJ67NW114 (south-east of Acton Bridge), drilled to a depth of 137m, confirms that the thickness of Superficial Deposits in that area is in the order of 17m. Boreholes SJ57NE2 and SJ67NW1 drilled close to the Weaver Navigation, south of Bartington, confirm that the thickness of Superficial Deposits in that area is approximately 11m and 16.5m respectively. The 2023 ground investigation borehole BH021, approximately 1.8km north west, records the Superficial Deposits at c. 8.5m thick.
- 3.11 In the northern DOL corridor, where the DOL crosses the M6 motorway, the Superficial Deposits are recorded at between 2m and 3.8m thickness (WS32 to WS37). Further northeast, a BGS borehole (reference SJ78NW55) located south of Partington indicates that the Superficial Deposits are c. 5.1m in thickness. The 2023 ground investigation boreholes BH106 and BH114, approximately 1.8km southwest of SJ78NW55, recorded thicknesses of between 10m and 11m.
- 3.12 In general, the BGS borehole records show that the thickness of Superficial Deposits within the DOL is highly variable and is generally of a greater thickness in the south

of the DOL than the north/north-east of the corridor limits. In the southern extent of the corridor (extending to Moulton) there is limited BGS borehole information available; a number of borehole records are marked as being confidential or are missing and the remaining borehole records do not always extend deep enough to confirm the base of the Superficial Deposits.

- 3.13 The relevant BGS and Ian Farmer Associates ground investigation borehole records are provided at Appendix 2 for reference. The locations of the BGS boreholes are shown on Drawings ST19815-011 and ST19815-012 for reference.

Solid Bedrock

- 3.14 The published geological mapping (1:50,000 and 1:10,560 scale mapping) indicates that the DOL is underlain by bedrock comprising the Bollin Mudstone Member, Northwich Halite Member, Sidmouth Mudstone Formation, Tarporley Siltstone Formation, Helsby Sandstone Formation and the Wilmslow Sandstone Formation.
- 3.15 The majority of the DOL within the Cheshire Brine Compensation District is underlain by the Bollin Mudstone Member (BMM), particularly where the DOL passes through the western extent of the brine district. The BGS describe the lithology of the Bollin Mudstone as *“dominantly laminated, reddish-brown and greenish-grey mudstone with siltstones”*.
- 3.16 The south-eastern leg of the DOL, in the region of Bostock Green, is underlain by deposits of the Northwich Halite Member (NHM) and Sidmouth Mudstone Formation (SMF). The NHM comprises halite of varied purity with mudstone and gypsum partings. The SMF is predominantly red-brown mudstone and siltstone, and units of halite up to 400m thick are present at several stratigraphical levels in the thicker basinal sequences (including Cheshire). Breccias produced by contemporaneous solution of salt are common throughout the formation. In the Cheshire Basin, more recent salt solution gives rise to solution hollows and collapse breccias associated with the halite members. Gypsum/anhydrite also occurs throughout the formation as nodules and veins.
- 3.17 The BMM extends from Moulton (north of Meadowbank) to the north of High Leigh in the north-eastern DOL corridor. The BMM is also present within the DOL in the

spur extending towards Northwich town centre / Winnington, at which point deposits of the NHM are present underlying the DOL north-west of the Town Centre.

3.18 In the extreme north-eastern limits of the DOL (where the DOL terminates in Partington) the bedrock is heavily faulted and is characterised by repeated sequences of the NHM, BMM, Tarporley Siltstone Formation (TSF), Helsby Sandstone Formation (HSF) and the Wilmslow Sandstone Formation (WSF).

3.19 The Tarporley Siltstone Formation (TSF) is predominantly comprised of siltstones, mudstones and sandstones in equal proportions. The Helsby Sandstone Formation (HSF) is comprised of fine to medium grained sandstones which may be pebbly, particularly near the base of the formation. The Wilmslow Sandstone Formation (WSF) consists of generally pebble free, cross bedded sandstones, with sporadic siltstones.

3.20 The published mapping shows that the DOL is intersected by numerous geological faults. The solid geology of the DOL, including geological faults, is as shown on Drawing ST19815-012.

3.21 A BGS borehole record to the east of Acton Bridge (BGS reference SJ67NW114) indicates that the base of the Superficial Deposits is at a depth of 17m, at which point deposits of the BMM (previously Lower Keuper Marl) are encountered. The borehole log details that the mudstone is interbedded with gypsum and halite. Additional boreholes to the north of Acton Bridge (reference SJ57NE2 and SJ67NW1) indicates that rockhead is present at a depth of c.11m and 16.5m respectively. Deposits of the Keuper Marl (Bollin Mudstone Member) are recorded to be 629m in thickness at this location at which point the Lower Keuper Sandstone (Helsby Sandstone Formation) is encountered at a depth of 640m.

3.22 There is generally an absence of BGS borehole information in vicinity of the DOL to the north-east of Lower Whitley and up to Deansgreen (where the DOL crosses the M56 motorway). However, the 2023 ground investigation boreholes in this area indicates rockhead to between 2m and 3.8mbgl. BGS borehole references SJ78NW6 and SJ78NW7, approximately 384m and 530m east of the DOL respectively and east of Lymm, record rockhead at a depth of c.60m and c.54m, which is generally

described as Marl interspersed with Gypsum in addition to the presence of Sandstone.

- 3.23 Further to the north of the DOL, in the vicinity of Partington, borehole reference SJ79SW70 encountered Sandstone at a depth of approximately 4.5m while the 2023 ground investigation boreholes BH106 and BH114, recorded rockhead at between 10m and 11m.

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4 BRINE AND SUBSIDENCE RISK

Wet and Dry Rock Head

- 4.1 “Wet rock head” exists where salt bearing deposits, namely the Northwich Halite Member (NHM) and the Wilkesley Halite Member (WHM) subcrop beneath the Superficial Deposits. Because salt is readily soluble in water, it typically does not appear at outcrop, at the surface, as an insoluble strata typically would. “A Report on the Rocksalt Mines and Brine Shafts in the Cheshire Saltfield”, dated July 1987 and prepared by Peter Wharmby, a former mineral surveyor of the CBSCB, has been reviewed in the preparation of this risk assessment. “Wharmby” reports that there is no record of rocksalt ever having been found in Cheshire at depths shallower than 40mbgl. As the deposits of salt approach the ground surface, they are eroded by the action of naturally circulating groundwater and terminate in a solution surface some distance below the base of the Superficial Deposits. This scenario is depicted in Figure 4.1 below.

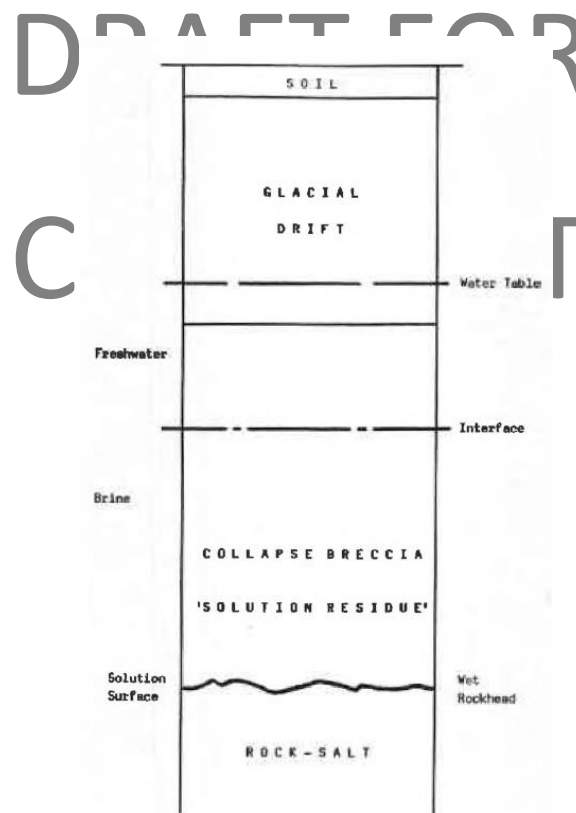


Figure 4.1: Typical Section through “Wet Rockhead”

Source: Wharmby, 1987

- 4.2 The dissolution of halite interbeds within the mudstone produces a brecciated deposit. This breccia is therefore present between the solution surface and the base

of the Superficial Deposits; these areas are known as “wet rockhead”. Further down dip, where the halite bearing layers are present at greater depths, the stratigraphy of halite and mudstone interbeds is preserved. These areas are known as “dry rockhead”, and are areas where no brine is present.

4.3 Typically, in the Cheshire Saltfield, “wet rockhead” is present where the halite deposits subcrop, and it is in these areas where rock salt deposits have been extensively exploited by brine pumping methods. The solution surface may present itself as an underground stream, which can extend up to 3-5km, and it is these areas where potential zones of intensive dissolution and subsidence can occur. Figure 4.2 illustrates the relationship between “wet and dry rockhead”.

4.4 The approximate areas of wet rockhead along the proposed route are shown in Drawing No. ST19815-013.

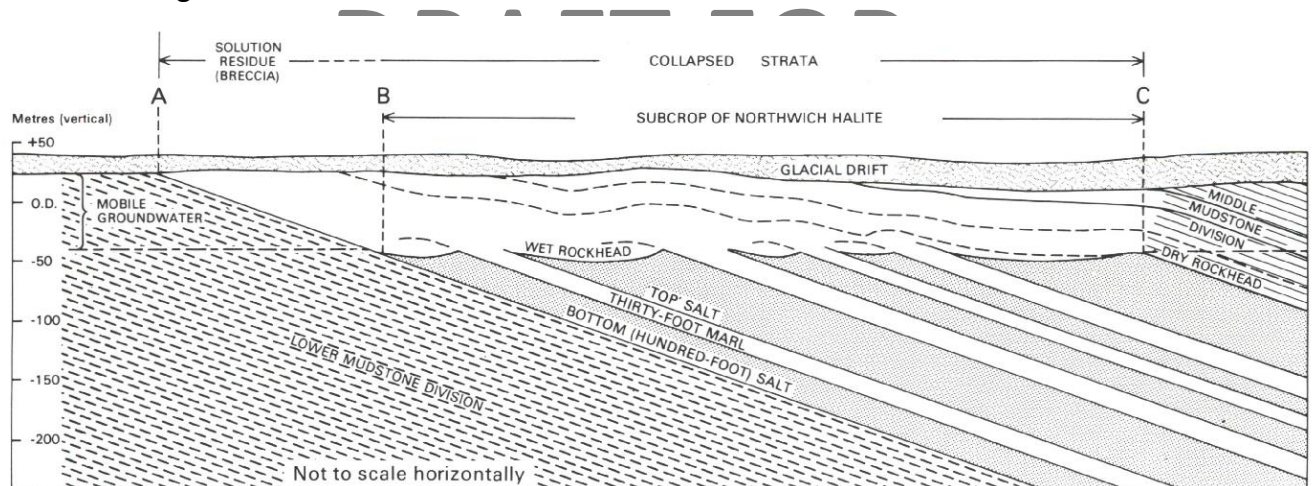


Figure 4.2: Relationship between “wet and dry rock head”. Source: Wharmby, 1987.

Natural Dissolution and Subsidence

4.5 Brine has not always been exploited by anthropogenic activities and historically brine found its way to the surface in the low levels of river valleys, creating natural brine springs. The natural dissolution of rock salt to form brine, and its replacement/recharge by freshwater is considered to be a slow process; once the saturation point is reached, the saturated brine layer protects against further dissolution and, as a result, there may be few instances of subsidence at the ground surface, including in areas of “wet rockhead”.

4.6 In the “wet rockhead” areas, a brine solution forms immediately above the highest remaining salt bearing bed and the dissolution of the salt forms fluid (brine) filled cavity. Overlying Mudstones and Superficial Deposits collapse into the void, thereby encouraging surface subsidence as a result. Subsidence due to the natural formation of brine has occurred in many places throughout the Saltfield including the linear subsidence hollows and crater like depressions and which follow the line of a “natural” solution channel in the subcrop. These are often referred to as a “brine run”. However, subsidence due to natural solution takes place very slowly and it is estimated that the average rate is less than 1mm per year along the active linear hollows formed by a brine run.

4.7 Prior to brine pumping, the early exploitation of brine was from springs occurring where natural seepages reached the surface; and it is thought that this would have little effect upon the natural regime of dissolution as the brine would have otherwise eventually flowed into rivers regardless.

Natural Brine Pumping

4.8 The discovery of saturated brine at rockhead effectively transformed the salt industry and it ultimately led to extensive damage from subsidence due to the large-scale pumping of rockhead brine (wild brine pumping) that exacerbated the dissolution of the salt surface, particularly at points of freshwater entry. This resulted in the modification of the established pattern of natural brine movement in the area. An artificial pattern of groundwater circulation was created from pumping which meant that brine levels were effectively lowered, drawing in freshwater into the system and greatly increasing the rates of dissolution.

4.9 The most severe subsidence occurred at the head and sides of the brine run where the freshwater was drawn in to replace the extraction of concentrated brine. As a consequence, the most severe surface subsidence often occurred at a significant distance from the pumping centre.

4.10 To tap the natural brine, a large diameter borehole or well was constructed to the level of the “wet rockhead” and which often continued a little way into the halite deposits below. The borehole or well was usually lined with steel casing for support and to prevent the ingress of weak brine or freshwater. The bottom section of casing

was perforated in order to allow concentrated brine to flow into the borehole from rockhead. The inside diameter of the boreholes was generally between 25 to 38cm throughout and a submersible pump was typically used to raise the brine to the surface.

- 4.11 In general, following the cessation of industrial pumping, the rate of ground subsidence/movement slows down after approximately 5 years and often returns to the much lower rates as are caused by natural dissolution.

‘Bastard’ Brine Pumping

- 4.12 The demand for brine eventually increased to the point that it exceeded the supply from natural rockhead sources. To meet this additional demand, reservoirs of “bastard” brine, which had formed in the flooded mine cavities, were tapped by pumping from the few shafts that remained intact, or more commonly, new shafts were sunk for the specific purpose of “bastard” brine pumping.

- 4.13 The brine which was pumped from the flooded mine workings was generally replenished by weak/low concentration brine or fresh water which ultimately promoted further dissolution of the sides, roof, floor and remnant pillars of the mine, thus enlarging the cavity and resulting in the reduction or complete removal of the salt pillars which were left behind. This process of “bastard” brine pumping, in some cases, led to mine cavity failure causing significant subsidence craters on the surface. This type of pumping from the abandoned mines continued until the 1930s which led to extensive subsidence as various mine complexes collapsed.

- 4.14 The failure of the mine cavities led to fluctuation of brine levels in the Northwich area, as brine was expelled by the collapsing workings or freshwater inrush occurred via fissures and craters which formed on the surface. These additional surges of water further exacerbated the subsidence problem, due to further dissolution that occurred as a result.

- 4.15 It is understood that “bastard” brine was pumped from the mine workings at Northwich, Lawton and possibly Winsford.

- 4.16 The severe subsidence due to “bastard” brine pumping which occurred in and

around Northwich, and to a lesser extent Lawton, from 1870 to the 1930s indicates that the introduction of significant volumes of freshwater caused by this form of pumping quickly led to failure at the ground surface. Damage is still evident today, but the absence of any such severe instances of subsidence since the 1930s suggests that further severe residual effects of “bastard” brine pumping are unlikely.

- 4.17 In the Northwich area, a number of the surface water features created as a result of “bastard” brine pumping (Witton Flash and Neumann’s Flash) were later used as settling lagoons for lime waste.

Rock Salt Mining

- 4.18 Halite was previously mined within the Cheshire Saltfield at Northwich, Rode Heath (Lawton) and more recently Winsford (Meadowbank Mine) and typically, subsidence due to salt mining operations takes place due to failure and collapse of the mine shaft column and/or total or partial collapse of the mine cavity by failure of the supporting pillars and the roof of the workings.

Brine Wells, Boreholes and Shafts

- 4.19 The failure of brine shafts was mainly limited to those that were sunk to tap brine from the flooded mine workings. A number of shafts were in such bad condition and deteriorated so rapidly that they had to be abandoned before the pumps could be installed. Records available indicate that only a very localised crater type subsidence feature was created when the shafts collapsed.
- 4.20 Records from within the “Wharmby” report indicate that the mine shafts which were utilised to pump “bastard” brine from the mines generally collapsed when the mine cavity collapsed.
- 4.21 The majority of the shafts and boreholes which pumped natural brine generally remained stable as a result of the borehole only extending to the top of the salt bed and therefore only exposing a minimum amount of salt. Of the shafts and wells that did collapse, the collapse occurred as a result of fine-grained material migrating into the shaft, thereby allowing settlement in the shaft column. For brine wells, the collapse was generally due to failure of the casing or water being introduced external to the casing and promoting dissolution of the rock salt around the base of the well.

- 4.22 In both of these cases, failure resulted in only localised subsidence in the immediate vicinity of the shaft or well.

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5 CHESHIRE SALT SEARCH

5.1 A Cheshire Salt Search report has been obtained for the DOL (provided at Appendix 1). It should be noted that an eastern limb extending to Northwich was included in this Cheshire Salt Search report, but has subsequently been removed from the proposed route. The Cheshire Salt Search reports the following brine related features within the DOL:

- The DOL is situated within the Cheshire Brine Subsidence Compensation District;
- No Consultation Areas are present within the extents of the DOL;
- Six prescribed notices of damage (PNODs) have been filed in respect of land within the DOL since 8 January 1959; all of which have been accepted and compensation has been paid for repairs/remediation to be undertaken (further information is provided in Section 8);
- In relation to the PNODs there have been no commutations of claims of property situated within the DOL. Since there has been no commutation of property or land within the DOL, if the land should suffer damage at a future date through subsidence due to brine pumping, then the compensation provisions of the Cheshire Brine Pumping Acts 1952 and 1964 would be expected to apply to the DOL;
- There are 2 brine wells/shafts situated within the boundaries of the DOL, or within 20m distance of the DOL (further information is provided in Section 7);
- There is a recorded area, line or point of weakness, related to historic brine pumping or natural dissolution, within 50m of the DOL. These often refer to the presence of 'subsidence hollows' at the ground surface identified on published mapping (further information is provided within Section 9);
- There is no current or proposed uncontrolled brine pumping within 3km distance of the DOL;
- The extent of the DOL is within, or within 200m of, an area that has been granted planning consent for brine pumping by controlled methods;
- Rock salt workings are recorded to have taken place historically, located within influencing distance of the DOL;
- The DOL is not present within the 'DM32' planning policy area, which places conditions on development within former mined areas;

- The extents of the DOL include land present within, or within 120m of, an area for which planning consent has been granted for rock salt extraction by underground methods (further information is provided in Section 10).

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6 NATURAL SUBSIDENCE RISK

- 6.1 It is considered that the natural solution of halite is mainly constrained to areas of “wet rockhead”, where deposits of the halite bearing rocks subcrop beneath the Superficial Deposits in the vicinity of mobile groundwater. The presence of saturated brine at rockhead will, to some extent, prevent further solution of the halite deposits and as a result, limit subsidence at the ground surface. In the absence of any current, ongoing uncontrolled brine pumping operations in the vicinity of the DOL, the likelihood of the removal of this protective saturated brine layer is considered to be low, leading to a reduced risk of further dissolution of the halite deposits.
- 6.2 The areas of “wet rockhead” in relation to the DOL are generally constrained to the areas where deposits of the Northwich Halite Member is reported to subcrop beneath the Superficial Deposits. The published geology is shown on Drawing ST19815-012 and which shows that there are three areas of the NHM underlying the DOL. The largest area underlies the southern corridor of the DOL roughly in the area of Bostock Green and Meadowbank. A second smaller area of the NHM underlies the DOL to the east of Lymm in the northern spur of the DOL. It is roughly in these areas that “wet rockhead” is reported to be present.
- 6.3 The likelihood of subsidence from natural solution is considered low likelihood however, the likelihood cannot be entirely discounted within these areas. Future natural dissolution of the halite is likely to be a result of fluctuating groundwater levels rather than through artificial processes.
- 6.4 Where the DOL passes through areas of “dry rockhead” the halite deposits are present at greater depths below the influence of mobile groundwater and the risk of subsidence developing in these areas is considered to be low. On Drawing ST19815-012 areas of “dry rockhead” are generally where deposits of the Sidmouth Mudstone Formation are shown to underlie the DOL, although there is some overlap with the deposits of the Northwich Halite Member, where “wet rockhead” extends further to the east, to where the DOL commences east of Bostock Green. For ease of reference the “wet rockhead” areas are depicted on Drawing ST19815-013.
- 6.5 Areas of the DOL which are recorded to be underlain by the Wilmslow Sandstone Formation, Helsby Sandstone Formation, Tarporley Siltstone Formation and the

Bollin Mudstone Member, as shown on Drawing ST19815-012, are considered to be at negligible risk from subsidence resulting from natural dissolution.

Mitigation

- 6.6 Where the DOL passes through areas of “wet rockhead”, the likelihood of residual surface settlement, although minimal, should not be discounted and it is recommended that further investigations are undertaken to assess this risk. This could comprise the establishment of settlement monitoring pins at areas where the DOL passes through the “wet rockhead” areas. Furthermore, the incorporation of precautions into the construction of the pipeline should be considered in order to mitigate against residual future ground movement.

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7 BRINE PUMPING RISK

Historical

- 7.1 'Wild brine' pumping has taken place extensively in Cheshire resulting in varying degrees of subsidence. This uncontrolled method of pumping, via brine wells, generally ceased by the early 1980's and associated movements are expected to have predominantly ceased by the 1990's. The last remaining 'wild brine' pumping continued at the New Cheshire Salt Works (Northwich) until June 2006 and the site has since been redeveloped. Any residual movements associated with this natural brine pumping would have expected to have ceased by now and therefore the risks to the DOL are considered to be low.

Current

- 7.2 There are currently no 'wild brine' pumping operations taking place within the Compensation District and it is considered unlikely that any new operations would be commenced in the foreseeable future. In September 1969, Cheshire County Council published a key document, "*Salt: a policy for the control of salt extraction in Cheshire*". This document initiated specific planning policy for the control of subsidence from brine pumping in the Compensation District by the gradual cessation of natural pumping and triggered a policy of no renewals of planning permission for anything other than controlled pumping operations.
- 7.3 Current controlled pumping operations are operated by British Salt Limited at Hill Top Farm (near Warrington) and at Holford (near Northwich) by Inovyn Enterprises. These operations are designed to avoid any surface subsidence damage. These 'controlled' pumping operations are located outside the DOL area.
- 7.4 Review of the Cheshire Salt Search (CSS) details that the DOL is situated within, or within 200m, of an area that has been granted planning consent for brine pumping by controlled methods. Further information provided within the CSS details that the current planning consent boundaries are likely to be significantly larger than the actual operational areas. As a result, it is considered that the potential risks from 'controlled' brine pumping are low.

Future

- 7.5 Whilst rock salt is present beneath the DOL and surrounding area, the CBSCB are not aware of any proposals for future brine pumping operations within or in the vicinity of the DOL (either as 'wild brine' or controlled pumping), and it appears that the prospect of future brine pumping operations to affect the site in the foreseeable future can be sensibly discounted.

Brine Wells/Boreholes

- 7.6 Due to the extensive route of the proposed pipeline through the Compensation District, a number of brine wells/boreholes are reported to be present within the DOL. The CSS records brine wells/boreholes to be present within the defined boundary, with a further 2 wells/boreholes present within 20m. However, it is noted that the red line boundary within the DOL also includes a sizeable buffer.
- 7.7 A further review of information provided within the CSS report details that there are no natural brine shafts situated within the boundaries of the DOL and one well located just outside the boundaries of the DOL, south of Moulton. The recorded location of the brine well is shown on Drawing No. ST19815-013.
- 7.8 For completeness, brine wells recorded within 100m of the DOL boundary have been included in this assessment and their reported locations are also shown on Drawing No. ST19815-013.
- 7.9 Information regarding these brine wells provided by the CBSCB and, where applicable, extracted from the "Wharmby" report is summarised in Appendix 3 and includes grid reference, current condition (i.e., filled, lined, buried etc), elevation, depth and source record, where this information is known.
- 7.10 Brine well reference 3-3-318 (named Moulton Hill) is reported to be located approximately 17m north of the DOL south of Moulton. This well is recorded to have been sunk to a depth of 92.35m bgl in 1881 and is reported to be located in the southern side of a pond in an agricultural field. Further information provided from the CBSCB reveals that this shaft is possibly filled but underwater. The location of this brine well is shown in Drawing No. ST19815-014.

- 7.11 Brine well reference 3-1-307 (named Meadowbank No.4 Shaft) is located approximately 73m south of the DOL and is recorded to be at a depth of 186.23m and developed in 1964.

Location Inaccuracy

- 7.12 The reported position of the brine wells has been obtained from numerous source plans of varying accuracy and reliability. These 'source plans' are recorded to show clear evidence of a brine well, however the plans may show little or no topographical information in which to correlate their position to modern day mapping. Therefore, there is uncertainty as to the precise location of the wells and their actual position (where their location is unproven) may differ from that recorded within the CSS report.
- 7.13 The source record for brine well 3-3-318 is reported to be a plan of Northwich and Witton Brook (1797) held at the ICI (Imperial Chemical Industries) archives and the 1:10,560 geological sheet (SJ66SE) respectively. Generally, it is considered that these plans are of lower reliability/accuracy than the OS source plan records.
- 7.14 Depending on the nature of the source record, each brine well may be assigned an associated 'departure'. The departure usually assigned for an OS plan source is 5m, and 10m is usually adopted for geological plan sources (1:10,000 scale). The departure for brine well 3-3-318 is considered to be 10m and it is therefore expected that the well would be situated within a 10m radius of the reported position. In respect to the ICI Archives plan source, consideration should be given to reviewing the associated departure on receipt and inspection of the plan, and it is possible that a departure for this source may be in excess of 10m.
- 7.15 The anticipated brine well departures are as indicated on the Drawings. The associated departure values for the additional brine wells located over 20m but within 100m distance of the DOL boundary, are provided at Appendix 3.

Area at Risk

- 7.16 Information obtained from the 'Wharmby' report indicates that 494 brine shafts/wells/boreholes have been identified within the "study area" (the Cheshire Saltfield) and it is possible that almost 40 percent of these have not been stabilised and made safe.

- 7.17 Whilst instances of well/shaft collapse are comparatively rare, an untreated brine well or shaft can represent a significant risk to the structural stability of any built development over or within influencing distance. There are considered to be two main risks that an untreated brine shaft/well may pose to any development. These are discussed below.
- 7.18 Firstly, collapse of the shaft/well column could lead to significant collapse or voiding at the ground surface including potential danger to people, livestock, land, buildings and infrastructure. Secondly, an open shaft provides a point of entry for surface water to enter the ground, and where the fresh water comes into contact with rock salt deposits, dissolution of the halite may occur, potentially leading to the formation of cavities and eventual collapse of the shaft and/or surrounding land.
- 7.19 The brine well at Moulton (3-3-318) is recorded not to have encountered halite deposits.
- 7.20 The collapse of brine shafts/wells has predominantly been restricted to those that were sunk in order to extract brine from within flooded mine workings. By review of the information within the "Wharmby" report and from the CSS, it is understood that of the brine wells reported to be situated within the DOL, none were used for "bastard" brine pumping.
- 7.21 The brine well reported within 20m of the DOL boundary are reported to be filled/terminated due to absence of rocksalt (3-3-318). A borehole record is available for brine well 3-3-318 from publicly available BGS Online Datasets (reference SJ66NE8) and is provided at Appendix 2. The borehole is recorded to have encountered "wet pond and gravel" from ground level to c.6.10mbgl, followed by Superficial Deposits to 92.35mbgl with no evidence of halite. The borehole record implies that it was drilled as a prospective brine well/ or shaft. In the absence of encountering any halite deposits, it is understood that the borehole was terminated, possibly backfilled, and remains underwater.
- 7.22 Of the brine wells which are reported to have been possibly filled, no details are provided regarding the specification of the infill material and the infill process.

Accordingly, it is possible that the wells have not been filled to a standard sufficient to protect against future ground loss and/or water ingress. Their current condition should therefore not be regarded as stable. The current condition of wells located greater than 20m distance of the boundary, where known, is summarised in Appendix 3.

- 7.23 The potential area at risk associated with brine well collapse is usually assessed by reference to the nature of the near surface deposits in the vicinity of the brine well. BGS borehole records in the vicinity of the DOL indicate that the thickness of overlying Superficial Deposits varies and can be up to 100m. However, in the absence of any recent intrusive investigation records, the thickness of the near surface deposits is unknown.
- 7.24 Nonetheless, for the purposes of this assessment, the thickness of Superficial Deposits has been determined from the closest available BGS borehole record in order to determine the area at risk (zone of potential ground instability) for each brine well.
- 7.25 By review of the publicly available BGS borehole records it is clear that a number of these are likely to represent the borehole record for the brine well, as they plot in relatively close proximity to one another. In these cases, they are referenced as follows:
- Brine Well Reference 3-3-318 → BGS Borehole Reference SJ66NE8 (Halite not proven).
- 7.26 Based on the above borehole data, it is anticipated that there is potentially between 60m - 100m of overlying Made Ground and Superficial Deposits beneath the DOL in the areas above and surrounding the reported brine wells. The anticipated thickness of overlying deposits for each reported brine well is summarised in Appendix 3.
- 7.27 Based on this assumption, in the unlikely event of the brine well collapse, the zone of potential ground instability (defined by the angle of repose of 45° from rockhead), extend for a radius of some 60m - 100m from the position of the brine well/shaft. In the case of brine well 3-3-318, the base of the Superficial Deposits was not encountered and therefore a potential zone of ground instability cannot be

accurately determined. In this case a potential zone of instability of at least some 92m may apply from the edge of the well (noting that the relevant borehole record does not report the base of the Superficial Deposits).

- 7.28 However, adoption of an angle of repose of 45° is considered to be a conservative assessment, particularly where the Superficial Deposits are comprised of over-consolidated Glacial Till, which would be likely to support a steeper angle of repose. Furthermore, in the event of well collapse, it may reasonably be anticipated that the area at immediate risk would be confined close to the well, and that area affected would then expand to occupy the full potential zone of ground instability over time, where mitigation or remedial actions are not taken in respect to the initial collapse.
- 7.29 Drawing No ST19815-014 shows the position of the reported brine well along with their respective departures and zones of potential ground instability (Zone of influence).
- 7.30 Of the reported brine wells located within, or within 100m distance of the DOL, all have departure and a potential zone of instability within the DOL.
- 7.31 It is understood that a scheme of ground investigation is ongoing. On receipt of this information, and confirmation of the underlying ground conditions (confirming the nature, thickness and geotechnical properties of any overlying Made Ground and/or Superficial Deposits) in vicinity of the reported wells, there is the possibility of reducing the potential zone of influence associated with each brine well. Should any of the investigation boreholes intercept the underlying halite, then measures must be taken to avoid introducing freshwater into the borehole and subsequent potential dissolution of the halite. This is discussed further in Section 11.
- 7.32 The “Wharmby” report has assigned a ‘hazard’ value to each of the reported brine wells, based upon the reported condition of the well and its location. The assigned ‘hazard’ values for each brine well are also included at Appendix 3.
- 7.33 Due to the age of the “Wharmby” report, prepared in 1987, it is possible that the condition of the brine wells may have since deteriorated. Therefore, the assigned

‘hazard’ values cannot be regarded to be definitive and have therefore not been utilised in the preparation of this risk assessment.

- 7.34 Whilst it is anticipated that there has been limited development above and in the immediate vicinity of the wells since the date of the “Wharmby” report, their current condition is unknown. Furthermore, any wells which are reported to have been infilled lack a record detailing the nature of any infilling work and therefore none of the wells can be considered currently stable. The brine wells and their respective potential zones of instability (where they fall within the DOL) as shown in Drawing No ST19815-014 should therefore be considered to remain a potential constraint in their current condition until demonstrated otherwise.

Mitigation Measures

- 7.35 Construction of linear infrastructure susceptible to differential settlements and high ground strain, such as a pipeline, should be avoided directly above the reported brine wells or shafts. To enable the safe development of the pipeline and associated infrastructure within close vicinity of the wells or shafts, further works would be required which would include both desk-based researches and intrusive investigations.
- 7.36 For each brine well/shaft, a desk-based assessment should be undertaken to verify the identity and position of the reported feature by obtaining the appropriate source plan records and confirming their “best plot” position. This exercise would aid in verifying the most likely position in relation to the DOL.
- 7.37 Once the “best plot” position has been determined for each feature, appropriate mitigation measures would typically involve proving the location of the feature by means of a suitable intrusive investigation. Depending on the results of the “best fit” exercise, intrusive investigation is likely only to apply to those features reported to be present within the DOL boundary. Preliminary indications suggest that none of the wells are located in the DOL.
- 7.38 The search area for the intrusive investigation would include the “best plot” position of the wells/shafts and the associated departure area (where present within the DOL). Typically, investigation measures are usually undertaken by excavation,

however this is dependent on the thickness of Made Ground deposits above and in the vicinity of the well/shaft. The investigations should aim to confirm the position, dimension and current condition of the wells, including the presence of lining, whether they are open, filled or collapsed and type of infill material if applicable.

- 7.39 If evidence of a brine well/shaft is located within the boundaries of the DOL, then further investigation and potential stabilisation may be appropriate. Typically, this would involve the redrilling of the well/shaft column to confirm its positive identification and to confirm the base of the feature. As the recorded wells are currently located outside the DOL, it is unlikely that stabilisation would be required (subject to further “best plot” exercise and investigation, if necessary).
- 7.40 If required, stabilisation would usually be via the process of stage grouting and the design and installation of a suitable well plug or reinforced concrete capping at an appropriate founding stratum. The grouting of the well/shaft column would prevent freshwater ingress and reduce the risk of further dissolution of any halite deposits that may be present within contact of the feature and which may cause collapse. The selection of drilling flush and grouting mixtures should consider the risk of introducing fresh water and, in order to reduce the risk of dissolution, the use of saturated brine as a flushing medium and within grouting mixtures may be appropriate.
- 7.41 It is typically preferred that reinforced caps are founded on bedrock however, where thicknesses of Superficial Deposits are excessive, this may not be a viable option. In these cases, it may be possible to construct reinforced caps on competent cohesive Superficial Deposits which, would provide a suitable founding stratum, however this would require confirmation by appropriate ground investigation and testing.
- 7.42 In instances where the brine wells/shafts are reported to be located outside the boundaries of the DOL, but the potential zone of instability encompasses the DOL, then further investigations may prove necessary. Based upon the findings of the “best plot” exercise and subject to land access consents, then further investigation and stabilisation (if required) may be undertaken to locate the brine well/shaft position and/or to disprove the presence of the feature within the DOL.

- 7.43 Alternative means to reduce the risk of ground loss may also be considered, such as reinforcement by the placement of a geogrid in the potential zones of ground instability beneath the proposed pipeline.
- 7.44 A summary of the recommended further works for the brine wells, shafts and boreholes within, and within influencing distance of the DOL, is attached at Appendix 3.

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8 PRESCRIBED NOTICES OF DAMAGE

- 8.1 The CSS report (Appendix 1) indicates that 7 Prescribed Notices of Damage (PNOD) have been filed against properties or land within the DOL. As with the brine wells and shafts, the PNODs within the CSS cover the land within the boundaries of the DOL and the associated buffer. Therefore, a number of the PNODs detailed within the CSS will not necessarily apply for land situated within the DOL. The PNODs were filed between 1959 and 2004, although not all have qualified for compensation payments. Therefore, only those qualifying for compensation and those which lie within the DOL boundaries are discussed further below. By review of the locations of the PNODs, it is clear that the majority of the accepted claims are within “wet rockhead” areas. Further information regarding the PNODs is summarised in Appendix 4.

PNOD 3075

- 8.2 This notice of damage relates to Heatley Heath Farm located approximately 2.5km east of the centre of Lymm, in the north-eastern route corridor. A notice of damage was first filed in 1959 with an additional two claims made in 1990 and 1991. The damage reported relates to agricultural fields and poor drainage/waterlogging; the fields lie adjacent to the Bridgewater Canal which bounds the property to the south-west and Spring Lane which bounds the field to the north-east and south-east.

- 8.3 The repairs undertaken included installing land drainage within field parcels 1293, 4300 and 2500 between the Bridgewater Canal and Spring Lane. The two additional claims involved further repairs being made to the field to improve ongoing drainage issues. Review of the DOL reveals that the proposed route passes through the field associated with recorded damage. The approximate area of the PNOD is shown on Drawing ST198815-016.

PNOD 2878

- 8.4 This notice of damage is not listed within the CSS report however, records from the CBSCB reveal that this notice relates to the same fields as at Heatley Heath Farm for PNOD 3075 discussed above. Two claims were made in 1991 and 1992 which involved replacing the land drainage system within the fields; it is possible that these relate to the additional two claims made at a later date under PNOD 3075.

PNOD 3798

- 8.5 This PNOD relates to land at Hillside Farm in Moulton, and includes brine well 3-3-318 which is reported to be present within a surface water pond. The notice was originally filed in May 1973 in respect to the land and buildings however, no claims were accepted on either the farm buildings or any of the outbuildings.
- 8.6 Two claims were subsequently accepted by the board including “claim 10” (1974/75) and “claim 22” (1975/76) in relation to installing and renewing land drains in fields. It is understood that the relaying of the drain was undertaken from the backfall and up to the pond. The approximate area of the PNOD is shown on Drawing ST198815-014.

Bostock Estate Claims PNOD 3178

- 8.7 A large majority of the claims relate to properties within the Bostock Estate which is present in and surrounding the southern corridor of the DOL. The Bostock Estate was previously owned by a single owner and a large number of claims were initially made under the same PNOD 3178 in June 1960 which led to several claims being settled for land drainage between 1964 and 1994. Claims made under PNOD 3178 are discussed further below by property name. The approximate PNOD locations are illustrated on Drawing ST19815-015 for reference.

Brook House Farm, Brick Kiln Lane

- 8.8 This prescribed notice of damage relates to a large proportion of land within the Bostock Estate named Brook House Farm. Information obtained from the CBSCB reveals that the initial notice of damage was filed in the 1960s (along with the rest of the Bostock Estate) and subsequently two claims were paid out (claims 13 & 16) in order to install new drainage at the farm in relation to four fields at the farm.
- 8.9 A review of the DOL boundary indicates that OS field numbers 0979, 0006 and 9311, in which these repairs were undertaken partly intersect the DOL boundary to the south of Bostock Green. It should be noted that the notice of damage extends both to the north and south of the DOL boundary.
- 8.10 It is understood that monitoring points were established at the farm within fields reference 6100 & 7500 in 1994, however no settlement surveys were followed up. Field references 6100 & 7500 are both fully present within the boundaries of the

DOL. A review of the CBSCB records indicate that two additional surveys were undertaken in 2008, six months apart, with the monitoring results suggesting there was no evidence of recent ground movement as a result of brine pumping operations.

Brook House Farm, King Street

- 8.11 Limited information is available from the CBSCB in relation to the prescribed notices of damage at Brookhouse Farm. However, it is understood that the claims at Brookhouse Farm were settled in conjunction with claims at another farm (Dairy Farm at Whatcroft) listed under PNOD 4161 discussed below. In respect of Brookhouse Farm, two claims were filed (15 & 40) in which compensation was paid out in 1976 and 1972 respectively.

Addashaw Farm

- 8.12 A notice of damage was filed in relation to land at Addashaw farm located to the south-west of Bostock Green and the south-east of Moulton. It is understood that in total three claims were made in relation to land and property at Addashaw Farm, one of which refers to land situated within the boundaries of the DOL (claim 76). Claim number 76 was filed in 1993/1994 and compensation was paid out totalling £7,381.63 to install drainage within field no.5678.

- 8.13 Further information provided from the CBSCB shows that further damages were reported and discussed with the board in 2013 which involved possible damage to the farmhouse building. An inspection undertaken by a Structural Engineer in 2014 concluded that the defects reported were more likely to be associated with structural deficiencies rather than subsidence and the CBSCB did not accept liability for this notice of damage.

- 8.14 In addition to the claims discussed above, it is understood that a further claim was paid out in relation to installing drainage in field nos. 2160 and 3665, which lie adjacent to the DOL boundary.

PNOD 4161

- 8.15 Notice of damage 4161 was filed in respect of land situated at Dairy Farm in Whatcroft, dated 2001/2002 under claim number 6 in which drainage repairs were undertaken at the farm. From discussions with the brine board, it is understood that

an additional two claims were settled, however these are outside the boundaries of the DOL.

- 8.16 The fields with reported damage under “claim 6” intersect the DOL to the east of the River Dane and south of Manor Lane. The affected area is reported to fully encompass the DOL as shown on Drawing ST19815-015, however this is shown as an area which is to be used as site access to the south of Bridge Farm (off Manor Lane).

PNOD 3023

- 8.17 This notice of damage was filed in relation to Jack Lane Farm located in Moulton. It is understood that the original notice of damage was filed in 1959, however no claims were paid out until 1973 and 1976 (claims 8 and 50) in relating to installing drainage in the fields at the farm. A review of the information reveals that the area affected only minimally encroaches into the boundaries of the DOL to the north of Jack Lane. The area affected is shown on Drawing ST19815-014 for reference.

Mitigation

- 8.18 Review of the PNOD information provided by the CBSCB shows that the majority of the accepted claims are constrained to the areas of “wet rockhead”. Subsidence in these areas was largely exacerbated by brine pumping which generally ceased by the early 1980s. The only brine pumping currently undertaken is by controlled pumping in order to avoid subsidence. Any significant residual movements associated with historical brine pumping are expected to have ceased by now. The absence of any new accepted claims since 2004 suggests that there is currently minimal movement in this area as a result of past brine pumping activities. However, it is considered prudent that consideration should be given to the inspection of areas of damage within the DOL identified by the PNODs to establish whether these have since deteriorated. However, it is considered that if this was the case, then a new PNOD would likely have been filed with the board.
- 8.19 As discussed in Section 6, the likelihood of residual movements associated with natural dissolution, although minimal, cannot be fully discounted within the areas of “wet rockhead”. Further mitigation measures could involve the establishment of settlement monitoring pins within the reported areas of damage in order to determine whether there is any ongoing residual movement as a result of natural

dissolution. Furthermore, the incorporation of precautions into the construction of the pipeline should be considered, where possible, in order to mitigate against residual future movements within the areas of “wet rockhead”.

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9 RECORDED SUBSIDENCE FEATURES

- 9.1 The British Geological Survey mapping published in the 1960's (1:10,560 scale) includes references to subsided land, damaged buildings and subsidence hollows which were visible to the field geologist at the time of mapping. These maps therefore provide an important record of the impact of brine pumping up to that date. The reported subsidence features within the DOL are shown on Drawing Nos ST19815-013, ST19815-014 and ST19815-015.
- 9.2 The majority of the subsidence features identified on the published geological mapping appear to be mainly constrained to the south of the Cheshire Saltfield and generally south of the DOL however, a number of subsidence features have been identified within the DOL boundary. These are discussed in more detail.
- 9.3 A subsidence hollow is reported to be located to the north of Meadowbank, surrounding brine well 3-3-318, which is recorded to be present within a surface water pond (Drawing No. ST19815-014). Information provided on the geological mapping indicates that the subsidence occurred as a result of the sinking of the brine well.
- 9.4 There are a further two reported subsidence features located to the north-east of Bostock Green which are referred to as a line of subsidence and a subsidence hollow respectively (Drawing No. ST19815-015). The line of subsidence trends in a roughly north-west to south-east orientation throughout the DOL. The subsidence hollow is approximately 250m north-east of the subsidence line. The subsidence line is present within an area of land that has previously been the subject of a successful PNOD claim, reference 3178.
- 9.5 Any suspected subsidence features which became apparent after the publication of the geological mapping in the 1960s would not be illustrated on the mapping. It is expected that any new significant subsidence features would have possibly been filed as an appropriate PNOD to the brine board.
- 9.6 The most recent PNOD to be accepted by the CBSCB is dated 2002/2004 and therefore this is potentially regarded to be indicative that there has been no significant observed, recent movement. Although the likelihood of minimal residual

movement at the ground surface as a result of natural dissolution cannot be discounted, it is considered that the potential formation of any significant new subsidence features is likely to be low.

- 9.7 It is recommended and considered prudent to undertake site visits and inspect the current condition of the subsidence features where they reside within the boundaries of the DOL. Additional mitigation measures, similar to those in areas of natural dissolution risk, may include the establishment of settlement monitoring pins as well as the incorporation of precautions within the construction of the pipeline to mitigate against such future possible movements within the reported areas.

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10 ROCK SALT MINING

Historical

- 10.1 Halite deposits were generally mined in the latter part of the 17th Century at Northwich, Rode Heath and more recently Winsford at the Meadowbank Mine. Rock salt mining was generally confined to the two lowest horizons in the Northwich Halite Member, which were named the “Top” and “Bottom” beds respectively. Due to erosion by groundwater the Top Bed varies in thickness but is typically between 16m and 26m thick with the base of the bed approximately 65m depth below ground level. The Bottom Bed has an average thickness of around 27m and is separated from the Top bed by a band of mudstone, approximately 9m thick, known as the ‘Thirty Foot Marl’.

Northwich Mines and Mine Stabilisation Programme

- 10.2 The ‘Wharmby’ report details that the Top and Bottom beds in the Northwich area were worked by a total of 90 mines with the workings extending over an approximate area of 123 hectares within an area of roughly 2.5 square kilometres to the north of the town.
- 10.3 A total of 61 mines worked the Top Bed at Northwich extracting an estimated area of 12.14 hectares. 57 of these mines have collapsed with 48 becoming buried beneath the limebeds or the realigned courses of the Weaver Navigation, Witton Brook or tributary streams and the remaining 9 mines located within or near development or highway infrastructure having been backfilled at some time in the past.
- 10.4 18 of the 29 identified Bottom Bed mines are known to have collapsed causing severe subsidence over an area of roughly 95 hectares. The craters which formed became water filled and over time became known as “flashes”. A number of the “flashes” have since been turned into settling lagoons for chemical waste, known as ‘limebeds’, but some still remain.
- 10.5 Subsequently, over time the mines deteriorated to such an extent that no new development was permitted in Northwich town centre and as a result, Vale Royal Borough Council was granted funding under the UK Government Land Stabilisation Programme, to undertake remediation of the Bottom Bed mines. The stabilisation programme included the infilling of four abandoned mines namely Barons Quay, Witton Hall, Penny’s Lane and Newman’s mines.

10.6 The largest of the infilled mines, and situated closest to the DOL, is Barons Quay which is located approximately 750m south-east of the DOL boundary.

10.7 There are a number of mines that remain without the benefit of stabilisation, which extend up towards Higher Marston and to the east of the DOL. It is considered that the proposed route of the HyNet Pipeline is outside the zone of influence with respect to both the stabilised and non-stabilised Bottom Bed mines at Northwich and as such no mitigation measures are likely to be required.

Top Bed Mines

10.8 In addition to the Northwich Mines Stabilisation Programme, Arup undertook research on the Top Bed salt deposits in the Northwich area. There is limited information in relation to the mining of the Top bed deposits and there is no record of any abandoned mine plans for the Top Bed mine, although there is some secondary information which refers to the evidence of workings in the Northwich area.

10.9 The Arup report refers to these secondary sources as 18th Century surface plans (dated 1721, 1768 and 1797), and refer to mines within the Top Bed. The 1768 plan references the Top Bed mines and brine pits owned by a Sir John Fleming Leicester. The Top Bed mines were considered to be largely unstable in the long term due to poor roof conditions in the immediately overlying “wet rockhead” and high extraction ratios. Therefore, it is considered likely that most of the Top Bed mines consisted of a shaft and a small chamber excavated into the halite.

10.10 The Arup report details that many of the Top Bed mines appeared to have collapsed and formed surface depressions (based upon information from historical mapping). Two larger mines are indicated based on the size of surface depressions formed on collapse, namely the Captains Hole (west of the River Weaver) and the Kents Top Mines in the Barons Quay area. These collapsed surface depressions measured 80m and 100m across respectively.

10.11 Arup have reported on the likely position of the Top Bed workings within their report; these are estimated, and their positions have been interpreted from inspections of surface features on historical topographical mapping and have not

been confirmed by intrusive investigation. Therefore, it is possible that their positions may differ considerably than to that shown on Arup Drawing, provided at Appendix 5.

10.12 The Arup report notes that the thickness of the Top Bed decreases to the west of the River Weaver, adjacent to the Winnington Fault, and northwards towards the Anderton area, which appears to be the result of natural dissolution over time. In the area around Northwich, the upper limit of the Top Bed occurs at a depth of approximately 35-45m.

10.13 The Arup report concludes that further work is required to confirm the extent and condition of the workings, the potential for collapse of workings and the requirement for remediation. The study area of the Arup report is confined to Northwich town centre and does not include the boundaries of the DOL and the “study area” appears to be some 600m south-east of the DOL.

10.14 The Arup report indicates that the Captains Hole mine is present to the west of the River Weaver at Furey Woods, approximately 500m south-east of the DOL.

10.15 Wharmby (1987) also reports on a number of Top Bed mines that are present to the west of the Weaver Navigation at Northwich. A number of these are reported to be located beneath and within close proximity of the Furey Limebeds, now known as Furey Woods, which is located adjacent to the eastern boundary of the DOL. These mines are listed below for ease of reference.

- Ashtons Byeflat Top Bed mine reported to be collapsed and buried under the Furey limebeds;
- Barker & Filkens Top Bed mine reported to be collapsed, flooded and buried beneath the Furey limebeds;
- Captains Hole Top Bed mine reported to be collapsed, flooded and buried beneath the Furey limebeds;
- Fureys Top Bed Mine, reported to be located near to the Furey Limebed but now collapsed and buried under the realigned course of the Weaver Navigation;
- Fureys Old, reported to be located between the west side of the Weaver Navigation and the Furey limebed, collapsed and buried;

- Hunts No.1/No.2 Top Bed mine reported to be collapsed and buried beneath the Weaver Navigation; and,
- Keys & Naylor's mine reported to be collapsed and buried beneath the Weaver Navigation.

10.16 The "Wharmby" report does not indicate the presence of any potential Top Bed mines beneath the proposed DOL boundary. The source information of the Top Bed mine workings is referenced within the "Wharmby" report as a *"Plan of Northwich and Witton Brook, 1797, No.71804, ICI Archives in Winnington, the 1:2500 OS mapping, 1876 edition and the Debes Wards Plan of 18th Century Rock Pits"*.

10.17 Due to the absence of abandoned mine plans of the Top Bed mines, it is possible that the workings detailed above may extend over a greater distance and the possibility of them being present beneath the DOL cannot be wholly discounted. "Wharmby" states that, in the case of the Top Bed mine workings, mining continued until the volume of water or brine entering the shaft became too great and the mine was allowed to flood, or the entry of water caused the shaft to become unsafe or collapse. Considering this information, the CBSCB assume that such unrecorded workings would lie within a 50m radius surrounding the respective shaft.

10.18 To the north-west of Northwich, there are no recorded mine shafts within the boundaries of the DOL with the nearest mine shaft recorded to be c.190-200m to the south-east. These are reported by "Wharmby" to be the Hunts No.1 and No.2 shafts. Based upon the assumptions made by the CBSCB, it is anticipated that no abandoned mine workings should underlie the DOL and the risks from abandoned mine workings in respect of the proposed pipeline is considered to be low.

Current

10.19 Underground rock salt mining is currently being undertaken at Meadowbank Mine, operated by Compass Minerals. The mine entrance is located at Meadowbank, situated in the south-western part of the DOL, with the underground workings generally extending towards the north-east beneath the Bostock Green area. The current planning consent boundary is shown on Drawing ST19815-010 for reference.

- 10.20 The CBSCB indicate that the mining operations at Meadowbank are subject to a number of planning conditions including the control of subsidence at the ground surface. Furthermore, the mine layouts have been designed by leading rock mechanics consultants, acting for both the operator and the planning authority, to ensure compliance with the planning conditions.
- 10.21 Winsford salt mine opened in 1844 and the extraction of the halite has been undertaken via a square room and pillar method of extraction whereby the pillars of rock salt that remain support the roof structure. Information provided on the Compass Minerals website indicates that currently, there were in excess of 137 interconnected rooms of void space and tunnels.
- 10.22 It is also understood that settlement monitoring is ongoing at surface above the mine workings and whilst it is our understanding that there is “limited” settlement at the ground surface, the prospect of future subsidence development cannot be entirely discounted.
- 10.23 Whilst it is considered that the subsidence risk to the proposed pipeline through this area from the underlying mine workings at Meadowbank is negligible/low, it is recommended that Compass Minerals, as the owner and operator of the mine, are approached at an early stage with regard to the proposed development. It would be prudent to discuss the possibility of reviewing their settlement monitoring data for the surface in the vicinity of the proposed pipeline, in order to further consider any potential ground stability risks.

Future

- 10.24 As noted above, rock salt mining is ongoing at Meadowbank Mine and it is possible that any future workings may underlie part of the proposed pipeline route. Therefore, as discussed above it is recommended that Compass Minerals are engaged at an early stage to discuss the proposed development.
- 10.25 In the view that the current mining operations are strictly controlled, regulated and monitored, it is considered that the prospect of any future mine workings offering significant adverse impact to the proposed development is likely to be low.

- 10.26 Nonetheless, there remains a possibility that future underground extraction licenses are granted beneath the proposed route of the pipeline. However, for reasons outlined above, it is considered that the potential risks would likely be low.

Mineshafts

- 10.27 The CSS report details that there is one mine shaft associated with rock salt mining within the DOL boundary (including buffer) or within 20m thereof. A further inspection of the location of the mine shafts reveals that it is not located within the boundary of the DOL but are situated within the buffer area defined within the CSS report.
- 10.28 The Meadowbank No.4 shaft located c.70m of the DOL boundary is a current active mine shaft for the Meadowbank Mine. Information publicly available on Compass Minerals website, indicates that the shaft was installed in 1963 and measures 4.88m in diameter and has a concrete lining. The total depth of the shaft is 189mbgl which houses an operational lift to provide access to the mine. It is understood that this shaft serves as the principal service shaft, by which the majority of equipment and materials are bought into the mine.
- 10.29 On the basis that this mine shaft is currently fully operational and managed/maintained it is anticipated that the likelihood of failure of the shaft may be considered to be low and that mitigation measures are in place to prevent failure of the lining and shaft. As a result, it is considered that no mitigation measures in relation to this shaft are required in respect of the DOL. Further details regarding this mine shaft is included at Appendix 3.

11 PROPOSED SITE WORKS

- 11.1 The project involves the construction, operation and maintenance of up to 125km of new pipeline to distribute hydrogen to industry for blending with the existing gas network. In addition to the construction of the pipeline, the project will involve the establishment of Hydrogen Above Ground Installations (HAGIs) and Block Valve Installations (BVIs).
- 11.2 The HAGIs are required to control the flow and pressure of hydrogen at key points along the proposed pipeline and will also include connection points to new hydrogen plant. They will include a range of permanent above ground components. It is understood that the exact location of the HAGIs is subject to further design, consultation and environmental impact assessment.
- 11.3 Where the distance between two HAGIs is greater than 16km, a Block Valve Installation (BVI) is typically required. These are smaller sites than the HAGIs and it is understood that the proposed locations of the BVIs is not yet determined.

Installation Techniques

- 11.4 It is understood that the pipeline will predominantly be constructed by open lay installation techniques which is most applicable to open fields etc. Trenches would generally be exposed using mechanical excavators or trenching machines which would normally straddle the trench. The depth and width would vary with pipeline diameter as per the design requirements but would allow a minimum reinstated cover of 1.2m over the top of the pipeline. Dewatering of trenches may be required if groundwater is encountered.
- 11.5 A range of trenchless installation techniques will be utilised at various crossing points (roads, rivers etc.) including horizontal directional drilling (HDD), auger boring, Grundoram (pipe ramming) and micro-tunnelling.
- 11.6 HDD involves guiding a pilot hole along a pre-determined profile beneath the obstacle and the depth of the drilled profile is set to minimise risk of the obstacle being crossed and to maximise protection of the pipeline. Once the pilot hole is complete the bore is enlarged in stages using reamers in soft ground or hope

openers in hard ground to a diameter approximately 1.5 times greater than the pipeline to be installed. The pipeline is then pulled through using the drilling rig.

- 11.7 Auger boring involves steel or concrete pipe being pushed into the ground along the crossing section and material removed by an auger drill inserted into the pipe. Auger boring also involves the excavation of two pits either side of the proposed crossing, one to accommodate the auger rig (thrust pit) and one to receive the auger head (reception pit).
- 11.8 Grundoram is a pipe ramming method which involves the use of a pneumatic piston driving a casing pipe from one side of the crossing to the other. Once the casing pipe has been installed the material is removed by inserting a plug and injecting compressed air to push the material out.
- 11.9 Micro-tunnelling involves concrete casing pipe being driven into the ground using a hydraulic ram or jack placed within a shaft.

Compounds

- 11.10 Temporary construction compounds would be established to support the construction of the pipeline and HAGIs. It is understood that their locations and area have not yet been established and is subject to further design. It is likely that the temporary compound areas will include fencing and access for plant, vehicles and personnel, hard surfacing and drainage, temporary connections to utilities, welfare facilities, vehicle and plant storage, pipe, equipment and material storage and lighting for winter months. On completion, the temporary compounds will be decommissioned, and the land reinstated to its former condition.

Intrusive Site Investigation

- 11.11 A limited intrusive ground investigation has been undertaken by Ian Farmer Associates. In 2023 at locations where trenchless crossings are planned. For all intrusive investigation methods along the DOL, it is important to ensure that deeper boreholes do not fully penetrate the Superficial Deposits and thereby avoid making contact with the potentially underlying brecciated materials in the areas of “wet rockhead”. On completion all boreholes should be appropriately backfilled and sealed to avoid any water ingress.

- 11.12 An appropriately designed ground investigation would assist in refining this risk assessment further.

Proposed Construction and Project Risks

- 11.13 It is understood that the, as part of the construction, pipe trench would generally be excavated using mechanical excavators or trenching machines, which would normally straddle the trench. The depth and width of the trenches would vary with pipeline diameter but would allow a minimum reinstated cover of 1.2m over the top of the pipeline. The largest proposed pipe diameter is 42". It is anticipated that the majority of excavations and trenchless methods would not fully penetrate the Superficial Deposits. This is particularly crucial in the areas of "wet rockhead" where there is the possibility of an underlying brecciated layer being present. The extent of salt dissolution, the form and scale of the dissolution void and collapse breccia beneath the DOL is unknown at this stage. If any of the proposed installation methods intercept the underlying brecciated layer/salt dissolution, the risk of triggering ground collapse could be increased.
- 11.14 An increased risk of the possibility of ground subsidence is most prevalent if the proposed works were to alter the hydrogeological conditions. If, for example, alteration took place allowing ingress of a fresh water into the ground, this could lead to the potential increase in dissolution and consequent ground subsidence. Ground works should therefore be managed appropriately and the hydrogeological conditions should be taken into consideration at the design stage.
- 11.15 Consideration should be given to the presence or possible presence of nearby brine wells or shafts, and the ingress of freshwater should be prevented in order to avoid collapse of the well/shaft column. However, it is envisaged that if a brine well or shaft is present within influencing distance of the DOL, then it could be appropriately infilled by plugging/grouting in order to restrict groundwater ingress.
- 11.16 To reduce the risk of subsidence, the hydrogeological regime of the scheme must be controlled. Surface water disposal via soakaways or infiltration methods should be avoided. In addition, it is recommended to avoid constructions that would create new preferential pathways for surface water to be introduced into the saturated

collapse breccia and underlying halite. It is anticipated that in the temporary compound areas, temporary drainage arrangements would be installed.

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12 SUMMARY OF RISK ASSESSMENT

- 12.1 A summary of the potential halite subsidence risks to the proposed DOL are detailed in Table 13.1:

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Item	DOL Affected	Mitigation
Natural Subsidence Risk	The potential for natural subsidence is mainly confined to areas where the deposits of the Northwich Halite Member subcrop beneath the Superficial Deposits. Two areas of the DOL are reported to be underlain by deposits of the Northwich Halite Member; these are where the DOL passes through Bostock Green/Meadowbank and Lymm, and as shown on Drawing ST19815-012 and ST19815-013. It is in these areas that “wet rockhead” is potentially present. In the absence of any uncontrolled brine pumping in vicinity of the DOL and the likely presence of a saturated brine layer preventing further solution it is considered that there is a reduced risk of further dissolution. Risks in areas outside the “wet rockhead” areas are considered to be low. However, subsidence from natural dissolution should not be totally discounted and residual surface settlement may still occur.	Residual surface settlement is expected in the areas of “wet rockhead” due to natural solution. It is recommended that the construction of the pipeline incorporates precautions in order to mitigate against any future minimal settlement. Other mitigation measures may involve the establishment of settlement monitoring pins at points where the DOL passes through the areas of “wet rockhead”. Soakaways as a form of drainage solution should be avoided. As part of any ground investigation, boreholes should be appropriately backfilled to avoid freshwater ingress.
Brine Pumping Risk	<i>Wild Brine Pumping</i> No ‘wild brine’ pumping is currently being carried out and the last such pumping ceased in 2006. Any residual movements would be expected to have ceased by now and the risks to the DOL are considered to be low. <i>Controlled Brine Pumping</i> Controlled brine pumping operations are designed to avoid any surface subsidence damage. The nearest controlled operations are located c.4km distance from the DOL. The potential risk from controlled brine pumping to the DOL is considered to be low. <i>Future Brine Pumping</i> There are currently no proposals for future brine pumping activities in vicinity of the proposed development.	<i>Wild Brine Pumping</i> None required. <i>Controlled Brine Pumping</i> None required. <i>Future Brine Pumping</i> None required.
Brine Wells/Boreholes	Information obtained from the CSS and CBSCB indicates that this 1 brine well located within, or within 20m distance of the DOL, south of Moulton. Brine wells reported to be present within 100m of the DOL have been included in the assessment and their approximate location is shown on Drawing Nos. ST19815-012 and ST19815-014. A detailed summary of these brine wells is included at Appendix 3 for reference. Whilst instances of well/shaft collapse are rare, an untreated brine well/shaft could represent a significant risk to infrastructure. Collapse of	Construction of the pipeline directly above known or suspected brine wells/shafts should be avoided and it is recommended that further investigative works are undertaken as necessary, as detailed below. <i>“Best Plot” Exercise</i> The desk based “best plot” position for each brine well/shaft should be ascertained by obtaining the appropriate source plan record. This would aid in verifying the most likely position of the feature in relation to the DOL.

Item	DOL Affected	Mitigation
	the well or shaft column could lead to significant collapse or voiding at the ground surface and an open well/shaft provides a point of entry for freshwater which potentially cause further dissolution of rocksalt. The current condition of the brine wells (and any shafts) cannot be regarded as stable. In the unlikely event of collapse, the area at risk is usually assessed by reference to the nature of the near surface deposits and the zones of potential ground instability associated with the brine wells/shafts. These zones are illustrated on Drawing Nos ST19815-014.	<i>Intrusive Investigation</i> Currently, no brine wells are recorded within the DOL, however, well reference 3-3-318 is recorded within 20m of the DOL. Depending on the results of the “best plot” exercise, where the zone of potential ground instability encroach within the DOL, an intrusive investigation should be undertaken to confirm the presence of the feature and its potential impact on the proposed pipe route. Should an intrusive investigation be required, it is anticipated that this could be undertaken by exposure by means of excavation. The investigation should confirm the position, dimensions and current condition of the well. <i>Stabilisation</i> Depending on the confirmed location of the feature in relation to the finalised pipeline route, further investigation and stabilisation may be required. Typically, this could comprise drilling and grouting or plugging of the well/shaft column and the design, construction, and installation of a reinforced cap at a suitable founding horizon (this would require confirmation by further investigation and would be more commonly undertaken to the larger diameter shafts, rather than wells). Where this is not possible, alternative methods such as the installation of geogrid reinforcement beneath the pipeline may be appropriate. It is recommended that all stabilisation methods are discussed and agreed with the CBSCB in advance.
Prescribed Notices of Damage	Seven PNODs have been filed to the CBSCB relating to land and property within the boundaries of the DOL. The majority of these relate to land in the south of the DOL in the area of Bostock Green. A single claim was filed where the DOL passes to the east of Lymm. All accepted claims are present in areas of “wet rockhead” and relate to poor drainage within agricultural fields. The subsidence in these areas was largely exacerbated by brine pumping which generally ceased by the 1980s. The absence of any accepted claims since 2002/04 suggests that there is currently minimal movement due to past brine pumping activities.	It is considered prudent that consideration should be given to site inspections where the DOL is reported to pass through areas of previously accepted PNODs to determine whether these areas have since deteriorated. Further mitigation measures are similar for “natural subsidence risk”, with the establishment of settlement monitoring pins and the incorporation of precautions into the construction of the pipeline in order to mitigate against future residual movements.
Recorded Subsidence Features	Three subsidence features are reported to intersect the DOL boundary as shown on Drawing Nos ST19815-014 and ST19815-015 and relate to geological mapping published in the 1960’s. Any recent features are likely to have been filed as a PNOD to the CBSCB suggesting an absence of new, recent subsidence features in the area.	It would be prudent to give consideration to the undertaking of site inspections where the DOL is reported to pass through areas of recorded subsidence features to determine whether these features are significant or have since deteriorated. Further mitigation measures are similar for “natural subsidence risk” and for “PNODS”, with the establishment of settlement monitoring pins and the incorporation of precautions into the construction of the pipeline in order to mitigate against future residual movements.

Item	DOL Affected	Mitigation
Rock Salt Mining	<i>Past Underground Workings</i> The proposed pipeline route is located outside the potential areas of influence of both the stabilised and non-stabilised Bottom Bed mines at Northwich. There is limited information currently available regarding the workings within the Top Bed. The CBSCB assume that any unrecorded workings would lie within a 50m radius around the respective mine shaft. In respect of the DOL, the nearest mine shaft is recorded to be c.190-200m, to the east at Northwich. Based upon the CBSCB assumption, the risks from abandoned mine workings are considered to be low. <i>Current Underground Workings</i> Rock salt mining is currently being undertaken at Meadowbank Mine which underlies the DOL in the southern extent of the proposed route. The mine workings extend from Meadowbank and towards the north-east where they underlie the DOL at Bostock Green. The mining operations are subject to a number of planning conditions which aim to prevent surface ground instability. It is understood that settlement monitoring is ongoing at the ground surface and whilst the risks to the proposed pipeline are considered likely to be low, the possibility of any future settlement cannot be discounted. <i>Future Underground Workings</i> Rock salt mining is ongoing at Meadowbank, and it is possible that any future workings may underlie the proposed pipeline route. In view that the current mining operations aim to minimise settlement, which are routinely monitored, it is considered likely that the potential for future mine workings to affect the proposed development is low, but cannot be discounted. The likelihood of any other future mining proposals being formulated which could affect the proposed pipeline in the foreseeable future can be sensibly discounted.	<i>Past Underground Workings</i> None required. <i>Current Underground Workings</i> It is recommended that Compass Minerals (operator of Meadowbank Mine) are contacted at an early stage regarding the possibility of reviewing the settlement monitoring data. Subject to the information provided, consideration should be given in the design of the pipeline to accommodate potential ground subsidence. <i>Future Underground Workings</i> None required.
Mine Shafts	Mine shafts recorded in the Anderton area, north-west of Northwich, are located at a sufficient distance outside the boundaries of the DOL and therefore do not represent a risk to the proposed pipeline. The Meadowbank No.4 shaft is located outside of the DOL boundary and	None required.

Item	DOL Affected	Mitigation
	is currently in operation serving as the principal service shaft to the mine. On the basis that this mine shaft is fully operational it is anticipated that the likelihood of the failure of the shaft is low and mitigation and management measures are already in place in order to prevent collapse.	

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13 CONCLUSIONS AND RECOMMENDATIONS

- 13.1 The HyNet North West Pipeline Project involves the construction and installation of below and above ground infrastructure to support the transportation of low carbon hydrogen. This halite risk assessment has been prepared in order to assess the risks to the proposed pipeline where it passes through the Cheshire Brine Subsidence Compensation District. The risk assessment has been prepared for the red line boundary (Draft Order Limits) which has been provided by WSP in shapefile format, dated July 2024.
- 13.2 The pipeline route, where it passes through the Compensation District, extends from Bostock Green in the south and trends roughly north-east where it terminates at Partington.
- 13.3 Ground movements associated with natural and industrial brine pumping processes (which exploit dissolution of the halite strata) do not conform to any simple or empirical model and are thus difficult to predict. A preliminary ground investigation has been undertaken at locations where trenchless placement of the pipe is proposed to take place. Investigation records at these areas have been taken into account as part of this assessment. In the absence of any clearly defined analytical techniques or models to predict behaviour of the ground in such circumstances, practical experience and historical records become key in assessing the likelihood and scale of risk. In this regard, Wardell Armstrong's involvement in the Cheshire Saltfield dates back to the 1970s, at which time a former senior employee at the CBSCB joined WA and thereafter maintained an advisory role to the Brine Board in relation to monitoring of ground movements, incidents of damage and advising on appropriate mitigation measures associated with development proposals in the Cheshire Saltfield.
- 13.4 Two areas of the proposed route are located within areas of potential "wet rockhead" associated with deposits of the Northwich Halite Member. These areas are shown on Drawing No. ST19815-012 and ST19815-013 and are located at Bostock Green and to the east of Lymm. In general, these areas represent those with the highest potential ground stability risk to the development, as it pertains to the dissolution of halite.

Natural Subsidence

- 13.5 It is considered that natural dissolution of the underlying halite deposits is mainly constrained to the areas of potential “wet rockhead” where rock salt is in the vicinity of mobile groundwater. The presence of saturated brine at rockhead, to some extent, prevents the further solution of halite. In the absence of any ongoing uncontrolled brine pumping in close proximity of the proposed pipeline route, it is considered that the removal of the protection afforded by the saturated brine layer is unlikely. This would thus lead to a reduced risk of further dissolution and consequent subsidence.
- 13.6 Whilst the likelihood of natural dissolution is generally regarded to be low, it cannot be entirely discounted in the areas of “wet rockhead” and residual surface settlement, although likely to be comparatively minor, should be expected in these areas of the DOL.
- 13.7 The risk of subsidence resulting from natural dissolution within the areas where the DOL passes through areas of “dry rockhead” is considered to be low.

Brine Pumping

- 13.8 ‘Wild brine’ pumping was discontinued in 2006 and any substantive residual movements would be expected to have ceased by now. Controlled brine pumping is currently in operation at Hill Top Farm and Holford, which are situated approximately 4km from the DOL. These controlled operations are designed in such a way as to avoid surface subsidence damage. The risks to the proposed pipeline of potential subsidence from past and current brine pumping are therefore considered to be low.

Brine Wells, Shafts & Boreholes

- 13.9 There are 2 brine wells located within, or within 20m distanced of the DOL boundary.
- 13.10 Whilst instances of well collapse are rare, the presence of a brine well (or shaft) within, or within influencing distance of the DOL can represent a significant stability risk to the proposed pipeline. The potential area at risk, in the unlikely event of collapse is usually assessed by the nature and thickness of overlying Superficial Deposits. The thickness of overlying Made Ground and Superficial Deposits has been

determined by review of nearby historical BGS borehole records and ranges in thickness up to 100m. The potential zone of instability for each brine well (including those located outside of the DOL boundary) is illustrated on Drawing No ST19815-014.

- 13.11 It is considered that the zones of influence indicated typically represent a worst-case scenario in instances where the collapsed area was to be left open and unattended for some time. It is considered more probable that the area at risk of collapse would be more constrained to a smaller zone of instability than that indicated.
- 13.12 Subject to the results of a ground investigation and review of the underlying ground conditions, it is likely that the zone of potential ground instability could be reassessed and possibly reduced.

Prescribed Notices of Damage & Subsidence Features

- 13.13 A number of Prescribed Notices of Damage have been filed and accepted within the proposed pipeline route. These are generally recorded in the Bostock Green area along with a single claim in the northern route corridor (east of Lymm). The majority of the claims are restricted to areas of “wet rockhead” which were mainly exacerbated by brine pumping activities. Any residual movement associated with past brine pumping activities would have expected to have ceased by now and the absence of any accepted claims since 2002/04 suggests that there is currently a low likelihood of significant ongoing movement.
- 13.14 The majority of reported subsidence features are generally located to the south of the Cheshire Saltfield, and south of the DOL. The 1960s geological mapping identifies three reported subsidence features within the proposed pipeline route which are generally located in the south in the Bostock Green area. In the absence of any ongoing brine pumping activities in the vicinity of the DOL the possibility of any new significant features is considered to be low.
- Rock Salt Mining***
- 13.15 It is considered that the stabilised and non-stabilised Bottom Bed mines at Northwich are located a sufficient distance away from the proposed pipeline route and do not present a potential risk.

- 13.16 The extent of workings within the Top Bed mines is unknown, however the CBSCB currently assume that any unrecorded mine workings would predominantly lie within a 50m radius surrounding a respective mine shaft. There are no recorded mine shafts located within a 50m radius of the DOL boundary and therefore, based on the CBSCBs assumption, it is considered that the risks to the proposed pipeline are likely to be low.
- 13.17 Currently, the only operational underground rock salt mining is located at the Compass Minerals Meadowbank Mine and it is understood that the mine workings extend beneath the southern route of the DOL in the area of Bostock Green. These mining operations are designed and managed to limit surface settlement and whilst the risks to the proposed pipeline are considered to be low, the potential for some settlement at the ground surface should not be discounted.
- 13.18 Rock salt mining at Meadowbank is ongoing and there is the potential for any future workings to underlie the proposed pipeline route.

Recommendations/Mitigation

- 13.19 It is recommended that where a potential risk presents itself to the proposed pipeline route, further investigation is undertaken.

Natural Solution

- 13.20 Residual surface settlement cannot be discounted in areas of “wet rockhead” and further investigation is recommended in order to assess the risks from natural dissolution and subsidence at the ground surface. This could comprise the establishment of settlement monitoring pins at points where the proposed pipeline is intended to pass through areas at an increased risk of residual settlement. Furthermore, it is recommended that the construction of the pipeline incorporates precautions, where possible, in order to mitigate against any differential settlement.

Brine Wells

- 13.21 Construction directly above reported positions of brine wells or shafts should be avoided. It is recommended that further investigation is undertaken as necessary

including desk-based research and intrusive investigations in order to definitively locate recorded brine wells or shafts within or within 20m of the DOL.

- 13.22 The desk based “best plot” exercise to investigate the position for brine wells within, or within influencing distance of the pipeline route should be determined by obtaining the appropriate source record. This will aid in verifying the most likely position of any brine wells or shafts in relation to the DOL.
- 13.23 Subject to the findings of the “best plot” exercise, further intrusive investigation may be necessary to confirm the position of the features in relation to the DOL. It is anticipated that this could be undertaken by the excavation of trenches into the Superficial Deposits.
- 13.24 Subject to their confirmed presence and position, the stabilisation of brine wells or shafts within, and within influencing distance of the DOL may be necessary. It is likely that brine wells could be grouted and plugged, whilst larger diameter shafts may require grouting and capping. These stabilisation methods would require confirmation by further ground investigation. Alternative options for treatment, particularly where the wells lie outside of the DOL boundary and access is restricted, may require the incorporation of precautions into the construction of the pipeline.
- 13.25 It is recommended that all stabilisation methods are discussed and agreed with the CBSCB in advance of the works.

Prescribed Notices of Damage & Recorded Subsidence Features

- 13.26 It is considered prudent to undertake site inspections where PNODs and recorded subsidence features reside within, or within close proximity to the proposed pipeline route. Additional mitigation measures would be similar to those required in respect to natural dissolution risks, including the establishment of settlement monitoring networks and the consideration of the incorporation of precautions within the construction of the pipeline to mitigate against any residual future movements.

Rock Salt Mining

- 13.27 Whilst the potential likelihood of significant risk to the proposed pipeline due to ongoing rock salt mining activities is considered to be low, it is recommended that

Compass Minerals (operator of Meadowbank Mine) are engaged at an early stage regarding the possibility of reviewing their settlement monitoring data. Subject to the results of the settlement monitoring data provided, consideration should be given in the design of the pipeline to accommodate potential ground subsidence. Any discussion with Compass Minerals may also usefully expand to the future working intentions for Meadowbank Mine, such that the long term potential ground stability risks to the pipeline could be considered.

Investigation and Construction Risk

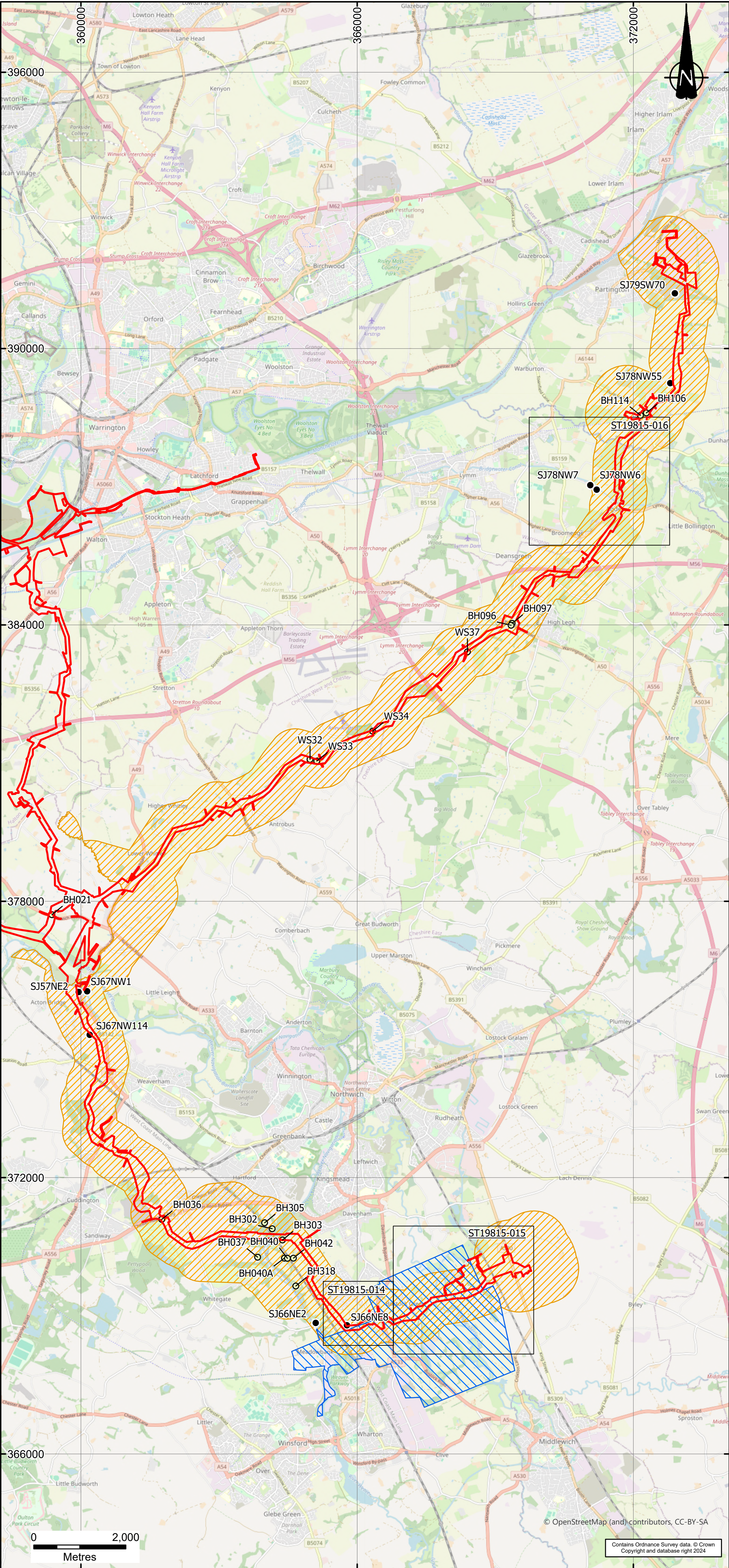
- 13.28 A limited intrusive ground investigation has been undertaken within the DOL, focused on proposed trenchless crossing locations, and the findings of this investigation has been assessed where appropriate. Insofar as future investigation and construction activity is proposed, it is important to ensure that deeper boreholes or constructions do not fully penetrate the Superficial Deposits and thereby avoid making contact with potential underlying brecciated deposits in areas of “wet rockhead”. If any future investigations or the proposed construction / installation methods intercept the underlying brecciated layer/salt solution, this could lead to the ingress of fresh water, promote circulation of unsaturated brine/water within the salt deposits and present the risk of triggering further subsidence and/or ground collapse. On completion, all boreholes should be appropriately backfilled and sealed to avoid any water ingress.
- 13.29 Where the works are being undertaken in close proximity to brine wells of shafts, the construction should similarly aim to avoid freshwater ingress.
- 13.30 All works should be managed appropriately to ensure that the localised hydrogeological conditions within the DOL are not altered such that salt dissolution is not encouraged. Surface water disposal should be controlled and disposal via soakaways or infiltration methods should be avoided. It is recommended to avoid construction of structures that would create new preferential pathways for surface water to be introduced into the saturated collapse breccia and underlying halite. It is anticipated that in the temporary compound areas, temporary drainage should be installed that does not incorporate infiltration / soakaway discharge.

13.31 This risk assessment is prepared on the basis of the information available at the time of writing and, upon receipt of any new information, it is recommended that this risk assessment should be reviewed and updated accordingly.



DRAFT FOR
COMMENT

DRAWINGS



KEY

- Draft Order Limits
- Layout Inset - see associated WA Drawing ref. for small scale detail
- Extent of Cheshire Brine Compensation District Nearby Route Corridor
- Planning Consent Area for Meadowbank Mine
- BGS Borehole
- Ground Investigation Borehole Locations

Notes:

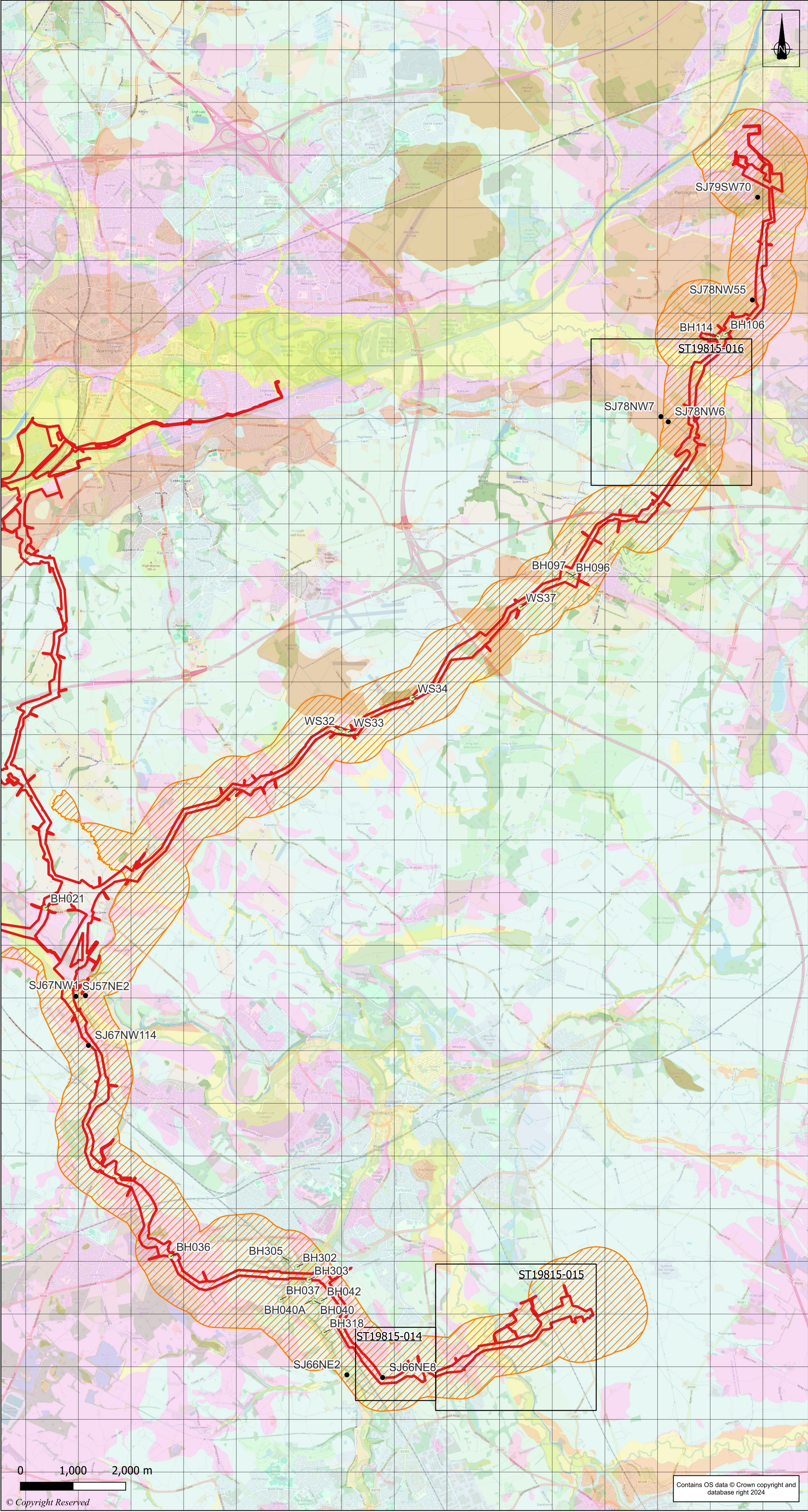
Boundaries are indicative.

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REVISION	DETAILS	DATE	DRAWN	CHKD	APPD
CLIENT	WSP ENVIRONMENT & INFRASTRUCTURE SOLUTIONS UK LTD				
PROJECT	HYNET HYDROGEN PIPELINE				
DRAWING TITLE	DRAFT ORDER LIMITS AND BRINE AREA				
DRG NO	ST19815-010		REV	A	SUIT. CODE --
DRG SIZE	A2	SCALE	1:60,000		
DRAWN BY	EG	CHECKED BY	RB		
		APPROVED BY	CS		



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KEY

Preliminary Order Limits

Layout Inset - see associated WA drawing ref. for small scale detail

Extent of Cheshire Brine Compensation District Nearby Route Corridor

BGS 1:50k Superficial Geology

TILL

GLACIOFLUVIAL DEPOSITS

RIVER TERRACE DEPOSITS

ALLUVIUM

RIVER TERRACE DEPOSITS (SAND AND GRAVEL)

ALLUVIAL FAN

TIDAL FLATS

PEAT

BGS Borehole

Ground Investigation Borehole Locations

Notes:

Boundaries are indicative
Contains data from British Geological Survey. © and Database Right UKRI. All rights reserved

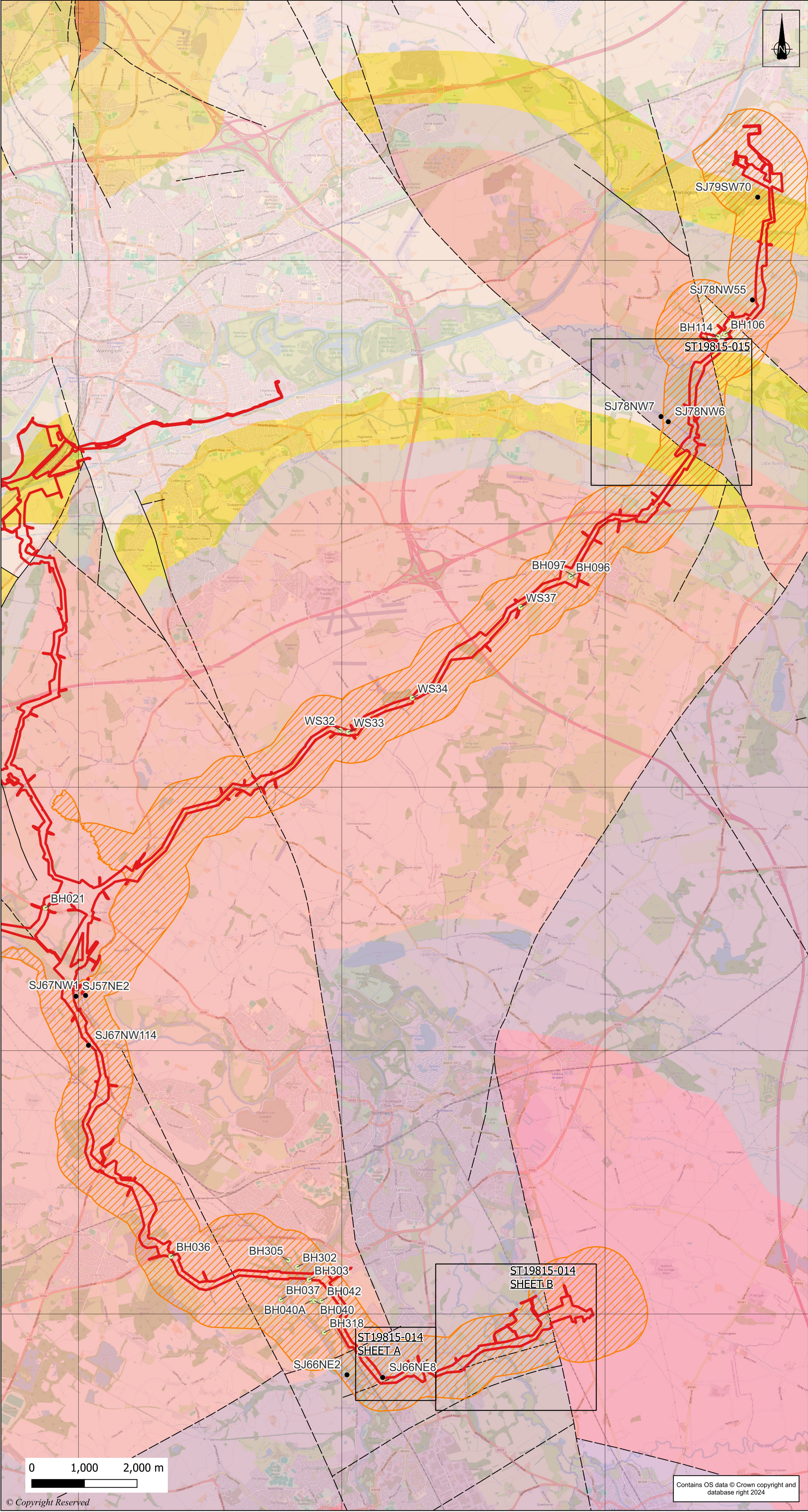
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REVISION	DETAILS	DATE	DRN	CHKD	APPD
CLIENT	WSP ENVIRONMENT & INFRASTRUCTURE SOLUTIONS UK LTD				
PROJECT	HYNET HYDROGEN PIPELINE				
DRAWING TITLE	DRAFT ORDER LIMITS AND SUPERFICIAL GEOLOGY				
DRG No.	ST19815-011		REV	A	
DRG SIZE	A2	SCALE	1:50,000	DATE	16/08/2024
DRAWN BY	EG	CHECKED BY	RB	APPROVED BY	CS

wardell armstrong

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kwsk02



KEY:

- Preliminary Order Limits
- Layout Inset - see associated WA drawing ref. for small scale detail
- Extent of Cheshire Brine Compensation District Nearby Route Corridor

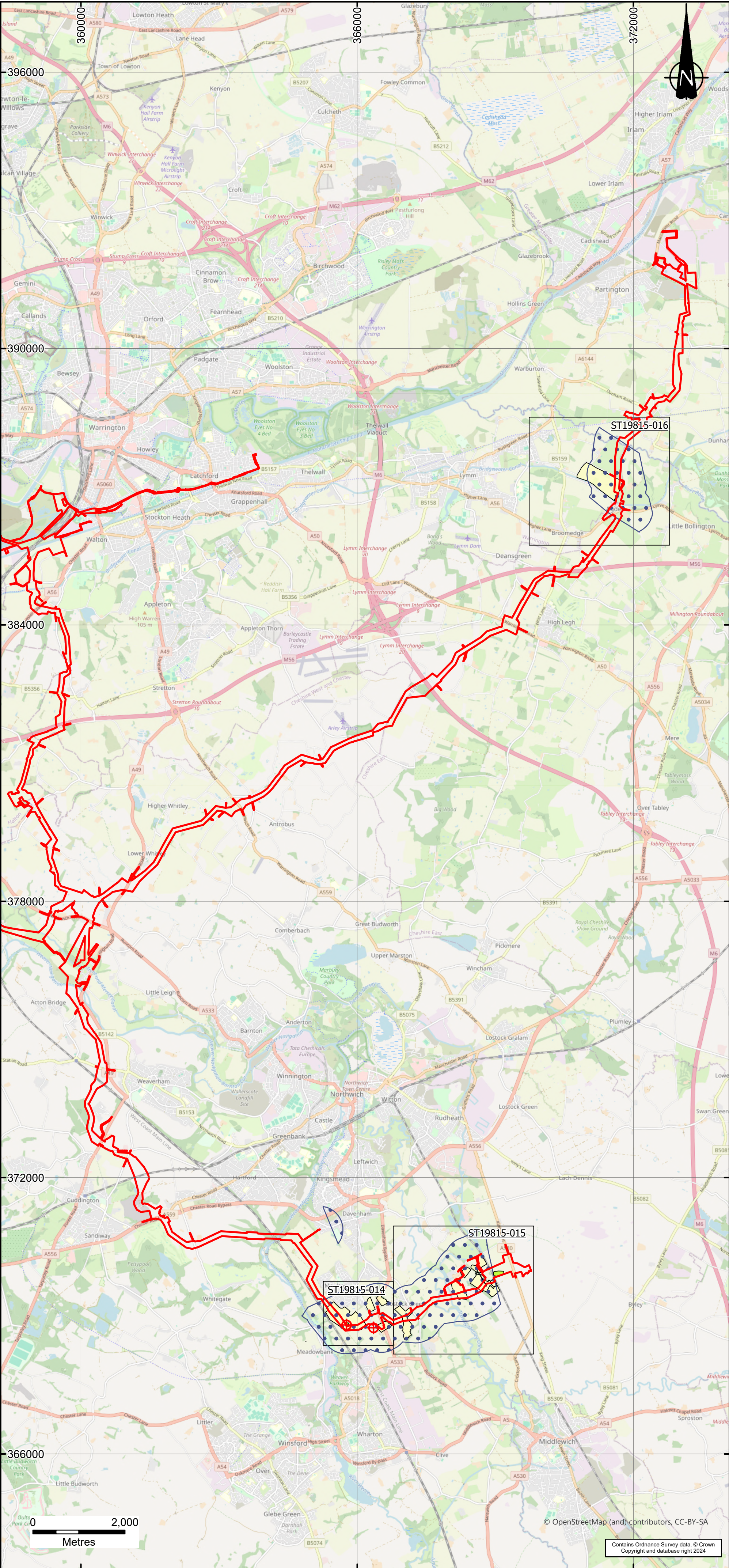
BGS 1:50k Geology

- NORTHWICH HALITE MEMBER
- SIDMOUTH MUDSTONE FORMATION
- WILKESLEY HALITE MEMBER
- TARPORLEY SILTSTONE MEMBER
- HELSEBY SANDSTONE FORMATION
- WILMSLOW SANDSTONE FORMATION
- BOLLIN MUDSTONE MEMBER
- Geological Fault
- BGS Borehole
- Ground Investigation Borehole Locations

Notes:
Boundaries are indicative.
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A	FIRST ISSUE	16/08/24	EG	RB	CS
REVISION	DETAILS	DATE	DRN	CHKD	APPD
CLIENT					
WSP ENVIRONMENT & INFRASTRUCTURE SOLUTIONS UK LTD					
PROJECT					
HYNET HYDROGEN PIPELINE					
DRAWING TITLE					
DRAFT ORDER LIMITS AND BEDROCK GEOLOGY					
DRG No.		ST19815-012		REV A	
DRG SIZE		SCALE		DATE	
A2		1:50,000		16/08/2024	
DRAWN BY		CHECKED BY		APPROVED BY	
EG		RB		CS	

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KEY

Draft Order Limits

Layout Inset - see associated WA Drawing ref. for small scale detail

Approximate Area of Wet Rockhead

Subsidence Features

Prescribed Notice of Damage

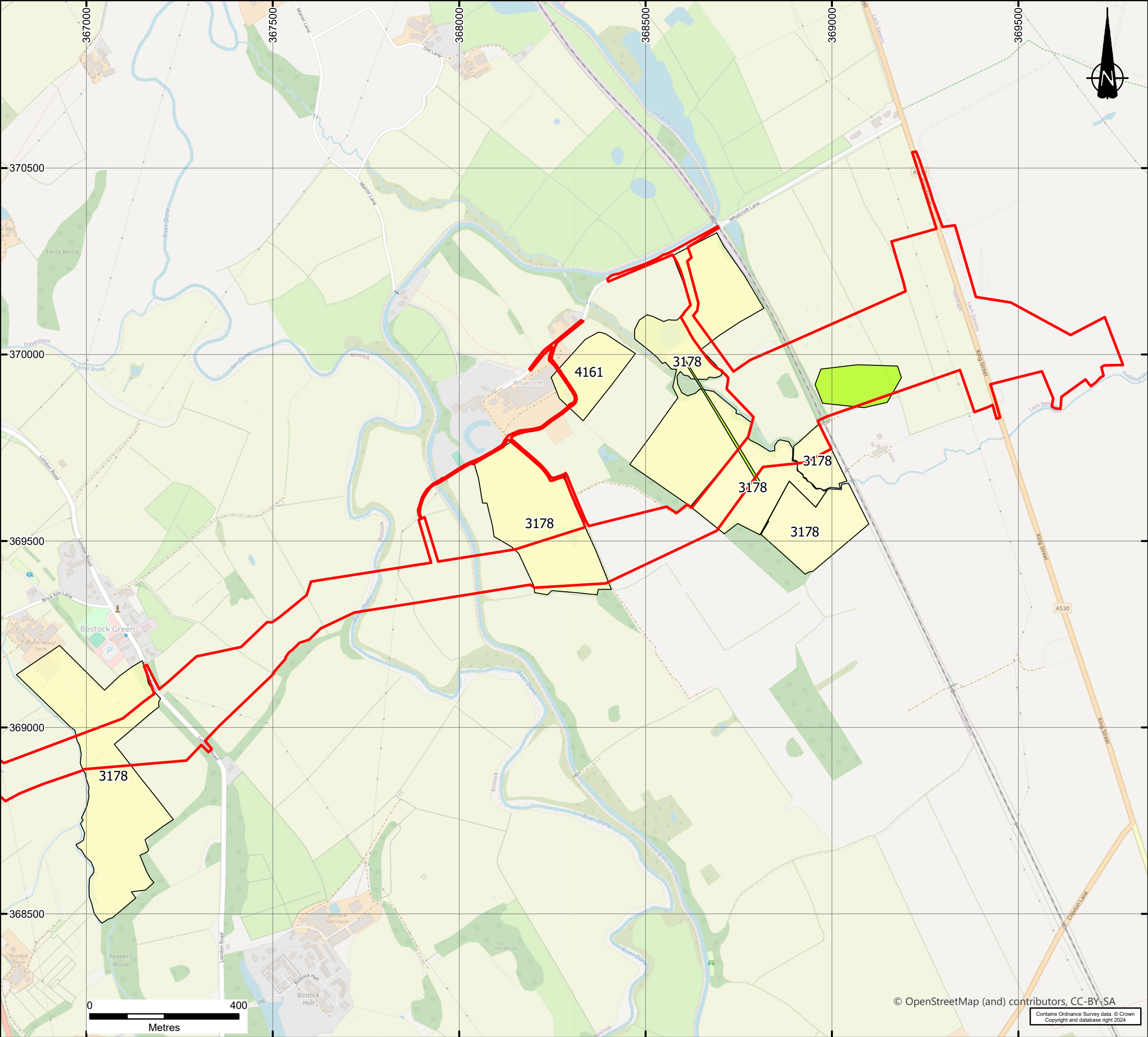
Brine Well

Notes:

Boundaries are indicative.

A	FIRST ISSUE	16/08/24	EG	RB	CS
REVISION	DETAILS	DATE	DRAWN	CHKD	APPD
CLIENT	WSP ENVIRONMENT & INFRASTRUCTURE SOLUTIONS UK LTD				
PROJECT	HYNET HYDRIGEN PIPELINE				
DRAWING TITLE	DRAFT ORDER LIMITS AND BRINE RELATED FEATURES				
DRG NO	ST19815-013		REV	A	SUIT. CODE --
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DRAWN BY	EG	CHECKED BY	RB		
		APPROVED BY	CS		

wardell armstrong



KEY

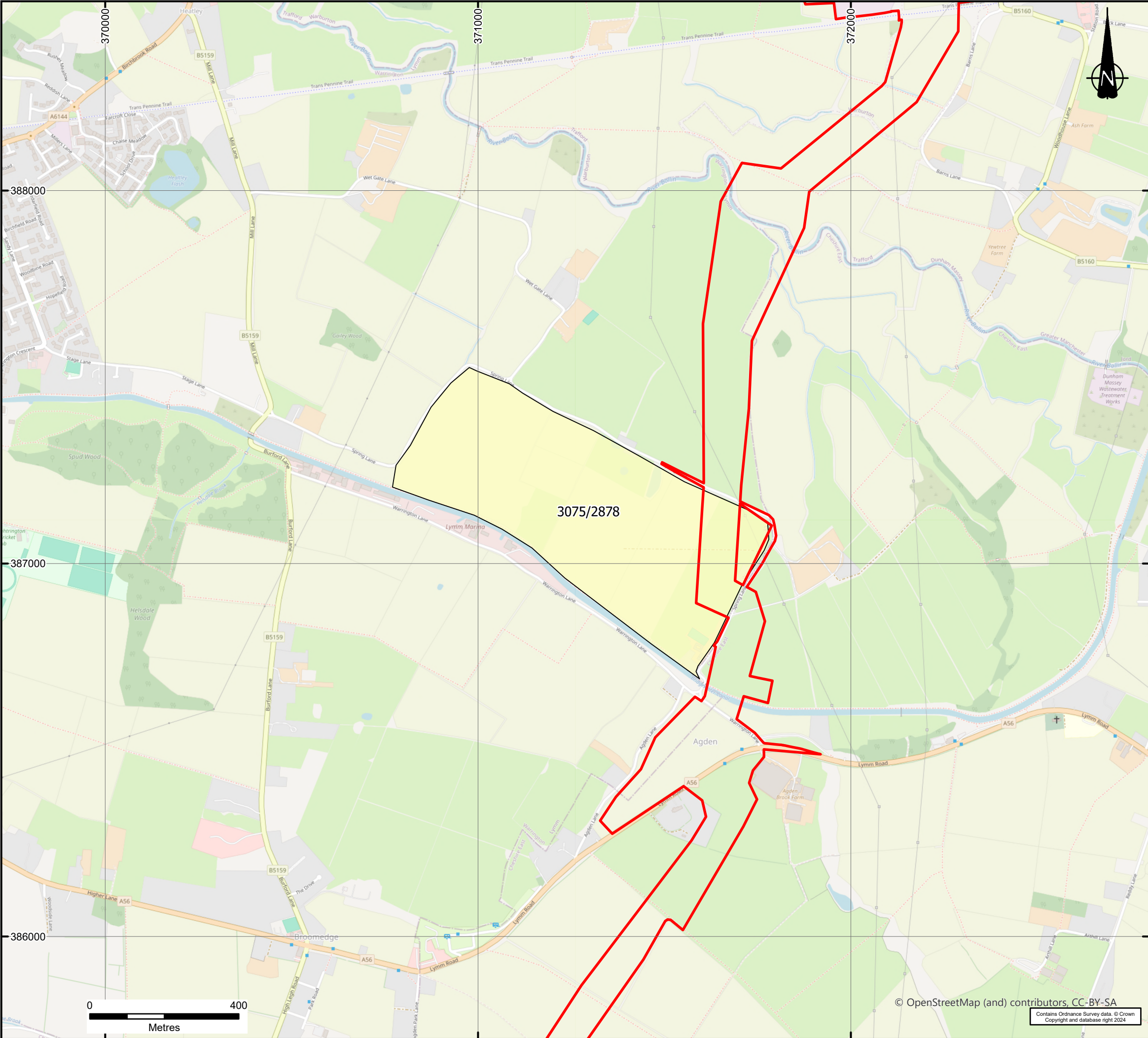
Draft Order Limits

Subsidence Features

Prescribed Notice of Damage

Notes:
Boundaries are indicative.

A	FIRST ISSUE	16/08/24	EG	RB	CS
REVISION	DETAILS	DATE	DRAWN	CHKD	APPD
CLIENT					
WSP ENVIRONMENT & INFRASTRUCTURE SOLUTIONS UK LTD					
PROJECT					
HYNET HYDROGEN PIPELINE					
DRAWING TITLE					
SUMMARY OF HALITE RELATED FEATURES - SOUTHERN AREA SHEET B					
DRG No.		ST19815-015		REV	A
DRG SIZE		A3		SUIT. CODE	---
SCALE		1:10,000		DATE	16/08/2024
DRAWN BY		EG		CHECKED BY	RB
APPROVED BY		CS			



KEY

Draft Order Limits

Prescribed Notice of Damage

Notes:

Boundaries are indicative.

A	FIRST ISSUE	16/08/24	EG	RB	CS
REVISION	DETAILS	DATE	DRAWN	CHKD	APPD

CLIENT

WSP ENVIRONMENT & INFRASTRUCTURE SOLUTIONS UK LTD

PROJECT

HYNET HYDROGEN PIPELINE

DRAWING TITLE

SUMMARY OF HALITE RELATED FEATURES - NORTHERN AREA

DRG No.	ST19815-016	REV	A	SUIT. CODE	---
DRG SIZE	A3	SCALE	1:10,000	DATE	16/08/2024
DRAWN BY	EG	CHECKED BY	RB	APPROVED BY	CS

wardell
armstrong

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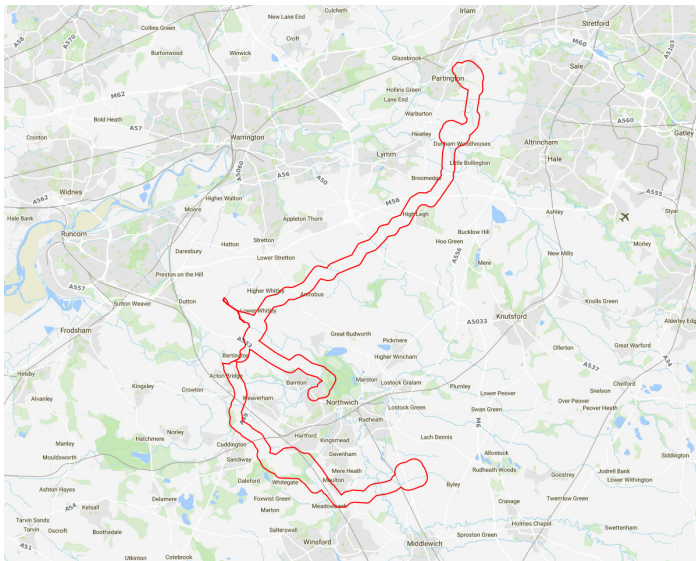
APPENDICES

Appendix 1

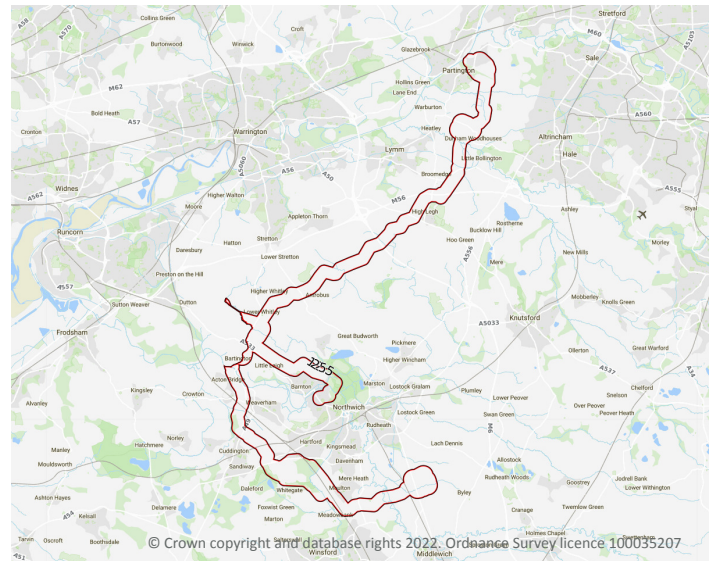
Cheshire Salt Search Report dated 18 July 2022, reference GS-8910632

Hynet Brine

Location plan



Site plan



Search results



Compensation District
Identified



Consultation Area
No



Notice of Damage
Identified



Commuted Claims
No



Future Claims Cover
Yes



Well/Shaft
Identified



Historical Salt Mining
Identified



Within DM32 Planning Policy
No

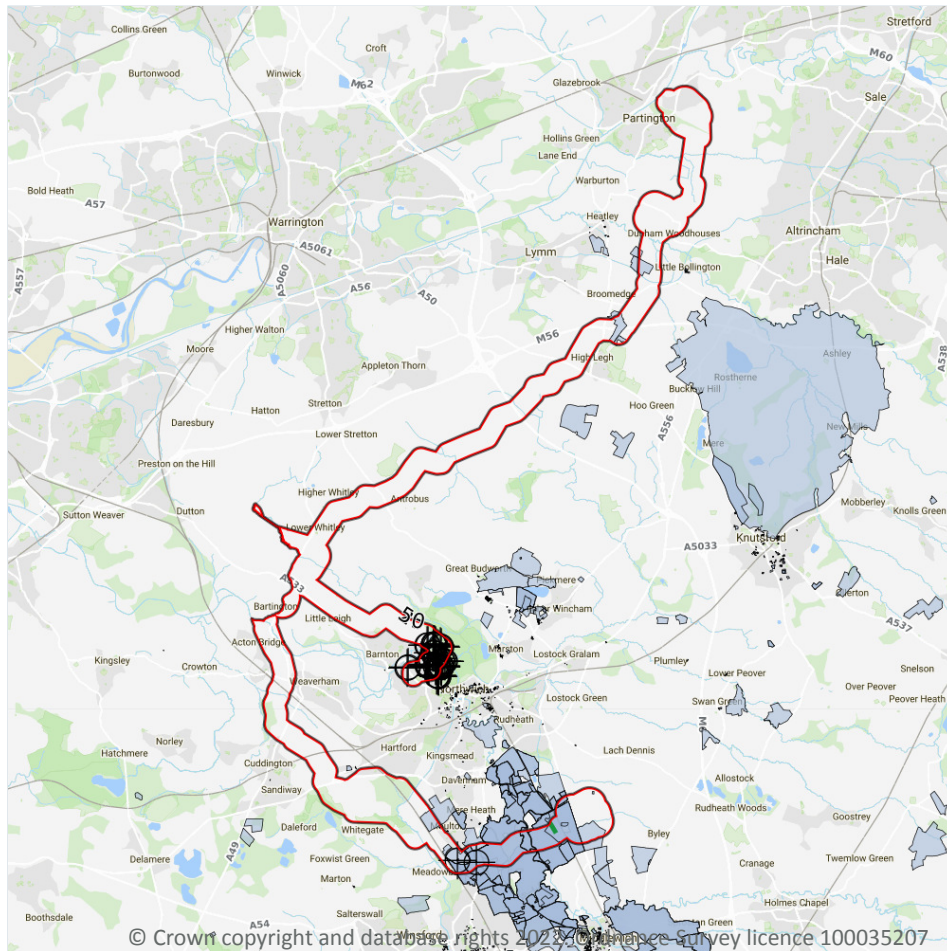


Active Salt Mining
Identified

Based on and limited to records held by the Cheshire Brine Subsidence Compensation Board (CBSCB) at the date of search and in relation to the address details identified by the customer in the procurement process.



Search results



— Site Outline

Search buffers in metres (m)

■ Prescribed notice of damage

▨ Area of weakness

— Lines of weakness

● Points of weakness

⊕ Shafts and wells

Cheshire Salt Search

This report is based on and limited to the records held by the Cheshire Brine Subsidence Compensation Board (CBSCB) in relation to this property and its environs, at the date of the search.

1. Is the property situated within the Compensation District?

The property is situated within the Cheshire Brine Subsidence Compensation District as prescribed by the First Schedule to the Cheshire Brine Pumping (Compensation for Subsidence) Act, 1952 (see note 2).

2. Is the property within a Consultation Area prescribed by the Cheshire Brine Subsidence Compensation Board under the provisions of section 38(1) of the 1952 Act?

The property is not within a Consultation Area prescribed by the Cheshire Brine Subsidence Compensation Board (the Board) under the provisions of Section 38(1) of the 1952 Act. It should be noted, however, that there are areas outside the consultation areas that could be at risk from the natural dissolution of the underlying saliferous strata.

3. Have any Prescribed Notice of Damage (PNOD) been filed in respect of the property since 08 January 1959 and, if so, was the claim accepted and discharged?

The following Prescribed Notices of Damage were identified at the site (see note 4):

PNOD Number	PNOD Date	Claim Accepted
3023	26/03/1959	Accepted
3075	03/09/1959	Accepted
3178	16/06/1960	Accepted
3178	06/06/1960	Accepted
3253	12/04/1961	Rejected
3434	24/06/1963	Rejected
3798	22/05/1973	Accepted
3848	13/05/1975	Rejected
3984	07/07/1980	Rejected
4035	26/04/1983	Rejected
4120	28/01/2000	Rejected
4161	22/03/2004	Accepted
4201	16/08/2006	Rejected
4229	24/07/2018	Rejected

4. Have any claims in respect of the property been commuted by a once and for all payment of compensation?

There has been no commutation of claims in connection with the property.

5. Would the compensation provisions of the 1952 and 1964 Acts apply should the property be affected at some future date by subsidence due to brine pumping?

If claims in respect of the property have not been commuted, then should the property suffer damage at some future date through subsidence due to brine pumping, the compensation provisions of the Cheshire Brine Pumping (Compensation for Subsidence) Acts 1952 and 1964 would be expected to apply to the property (see note 6).

6. Is there an historic brine well/shaft located within 20m of the property?

There is a record of a brine well/shaft within 20m of the property at the approximate position shown on the attached location plan, outline details of which are summarised as follows (see note 7):

Distance	Reference	Name	Shaft type
0	2-3-235	Higgins	Natural Brine Shaft
0	3-3-318	Moulton Hill	Natural Brine Shaft
0	2-3-020	Anon 11 Northwich	Natural Brine Shaft
0	2-3-021	Anon 12 Northwich	Natural Brine Shaft
0	2-3-116	Brunner Mond A	Natural Brine Shaft
0	2-3-117	Brunner Mond B	Natural Brine Shaft
0	2-3-123	Brunner Mond No. 2 Winnington	Natural Brine Shaft
0	2-1-265	Keys and Naylors	Mine Shaft
0	2-1-278	Cheshires	Mine Shaft
0	2-3-344	Marshalls Brine Pit	Natural Brine Shaft
0	2-3-399	Phoenix Works	Natural Brine Shaft
0	2-2-410	Poultry Yard Boring	Natural Brine Well
0	2-1-518	Hunts No. 1	Mine Shaft
0	2-1-519	Hunts No. 2	Mine Shaft
0	2-3-023	Anon 3 Northwich	Natural Brine Shaft
0	2-3-082	British Salt Company	Natural Brine Shaft
0	2-3-118	Brunner Mond Anderton No. 3	Natural Brine Shaft
0	2-3-269	Lord Stanley No. 1	Natural Brine Shaft

Distance	Reference	Name	Shaft type
0	2-3-270	Lord Stanley No. 2	Natural Brine Shaft
0	2-3-520	Blackburnes Brine Pit	Natural Brine Shaft
0	3-1-307	Meadowbank No. 4 Shaft	Mine Shaft
0	219	Brine Shaft	Brine Shaft
0	231	Blackburnes Brinepit brine shaft	Brine Shaft
0	232	Higgins	Shaft (Unknown)
0	233	Anon 3 Northwich	Shaft (Unknown)
0	234	Brunner Mond Anderton No.3	Shaft (Unknown)
0	236	Poultry Yard	Shaft (Unknown)
0	237	Brunner Mond 'A'	Shaft (Unknown)
0	238	Brunner Mond 'B'	Shaft (Unknown)
0	239	Lord Stanley No.1	Shaft (Unknown)
0	240	Lord Stanley No.2	Shaft (Unknown)
0	241	British Salt Company	Shaft (Unknown)
0	242	Pheonx Works	Shaft (Unknown)
0	243	Anon 11 Northwich	Shaft (Unknown)
0	244	Anon 12 Northwich	Shaft (Unknown)
0	245	Hunts No.2	Shaft (Unknown)
0	246	Keys & Naylor	Shaft (Unknown)
0	248	Marshalls Brine Pit	Brine Shaft
0	249	Cheshires	Shaft (Unknown)
0	268	Brunner Mond Winnington No.2	Shaft (Unknown)
0	524	Anon 11 Northwich	Shaft (Unknown)
9 m	2-3-122	Brunner Mond No. 1 Winnington	Natural Brine Shaft
16 m	267	Brunner Mond Winnington No.1	Shaft (Unknown)

7. Is there a recorded area, line or point of weakness, relating to historic brine pumping or natural dissolution, within 50m of the property?

There is a record of an area, line or point of weakness within 50m of the property as shown on the attached location plan (see note 8).

8. Is there any current or proposed uncontrolled brine pumping within 3km of the property?

There are no current or proposed uncontrolled brine pumping sites within 3km of the property (see note 9).

9. Is there any planning consent for brine extraction by controlled methods of pumping within 200m of the property?

The property is either within, or within 200m of, an area that has been granted planning consent for brine pumping by controlled methods (see note 10).

10. Is the site within 90m of an area that could be affected by historical (abandoned) rock salt underground mining?

Rock Salt mine workings are recorded to have taken place in the past, located on site (see note 11).

11. Is the site within the DM32 planning policy boundary which requires planning applications to have regard to potentially unstable rock salt mine workings?

The site is not within the DM32 planning policy area, which places conditions on development within the former mined areas (see note 12).

12. Is there any planning consent for rock salt extraction by underground mining within 120m of the property?

The property is located either within, or within 120m of, an area for which planning consent has been granted for rock salt extraction by underground mining methods (see note 13).

Additional remarks

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In relation to the determination of whether a damage notice has been filed in respect of the property, the boundaries of such notices have been identified by best endeavours in the absence of definitive file records and as such can only be regarded as approximate. For larger prescribed notice of damage boundaries, the subject of the notice could be remote from the subject property boundary.

Explanatory notes

1) Site Location

The area of land identified by the customer when digitising the enquiry boundary during the procurement process as shown on the attached plan. If the digitised boundary touches or overlaps with an adjoining property, then details relating to those adjoining properties will be included and may not be relevant to the enquiry property.

2) Compensation District

The geographic area prescribed by the Cheshire Brine Pumping (Compensation for Subsidence) Act, 1952 as subsequently amended, largely situated within Cheshire, but excluding Nantwich, and other areas, where redress is generally available for damage associated with the pumping of brine. This report only includes areas covered by the Cheshire Brine Compensation District. There are parts of Cheshire (and other parts of the country) where salt/brine can still pose a risk of subsidence. Further research may be necessary in these areas to determine the nature if this risk (if any).

3) Consultation Area

There is a statutory obligation to consult the Board with regard to development involving new foundations within these areas. Consultation with the Board is required at both the Planning Application and Building Control approval stages of development. As part of the development proposals, a suitable risk assessment should be prepared for submission and consideration by the Board.

4) Prescribed Notice of Damage Since 08 January 1959

A remedy for damage due to subsidence associated with the pumping of brine in Cheshire (in particular Northwich) dates back to 1891. However, a large proportion of the records relating to such damage are incomplete and a number of those properties have since been demolished. The Cheshire Brine Pumping (Compensation for Subsidence) Act 1952, introduced a more widespread means of redress for damage due to brine pumping within the identified Compensation District, see above. Regulations introduced on 08 January 1959 provided a specific format for the submission of a notice and progression of redress for damage and as such details of damage notices issued since 08 January 1959 contained in these searches have been limited to those received in accordance with the more formal procedures established on 08 January 1959. In relation to

the determination of whether a prescribed notice of damage has been filed in respect of the property, the boundaries of such notices have been identified by best endeavours in the absence of definitive file records and as such can only be regarded as approximate. For larger prescribed notices of damage boundaries, the subject of the notice could be removed from the subject property boundary.

5) Commutation

Where the damage to a property is likely to recur or exceed its market value, there is an option to discharge liability by a once and for all payment involving a commutation under cover of a deed of release. These deeds of release can extinguish any further means of redress and can contain a condition requiring future foundation designs to be approved by the Board to ensure future rights of redress. As a commutation has long term implications these will be declared in the searches back to 1891.

6) Future Liability

The provisions of the 1952 and 1964 Acts would be expected to be available for most properties, within the Compensation District, the exception being in relation to properties for which a commutation applies.

7) Brine Wells/Shafts

The location of the reported wells/shafts has been derived from source plan records of varying reliability, accordingly their locations have to be regarded as approximate.

8) Recorded Lines of Weakness

These features related to records of subsidence identified from historic plans. These features are referred to as 'subsidence hollows', 'lines of subsidence' etc and are regarded to represent areas of potential higher risk of subsidence.

9) Uncontrolled (wild) Brine Pumping

There are currently no wild brine pumping activities taking place within the Compensation District and there are unlikely to be such in the foreseeable future. Should the situation change then the search reports will thereafter be updated accordingly.

10) Planning Consent for Controlled Brine Pumping

Pumping of brine by controlled methods avoids the significant subsidence problems associated with uncontrolled pumping (wild brine pumping). Subsidence from controlled pumping is eliminated or of very low magnitudes. The current planning consent boundaries are likely to be significantly larger than the operational areas.

11) Abandoned Rock Salt mine workings

Rock Salt has been mined by underground mining techniques within the Cheshire Saltfield at various depths but typically within a depth of 90m. A number of these mines were abandoned without the mine having been stabilised and represent a significant subsidence risk. Some of the workings, in particular the bottom bed workings beneath Northwich town centre, have been the subject of a stabilisation scheme. In some instances, shaft records indicate the presence of workings the extent of which is unknown and in formulating this report it has been assumed that such unrecorded workings would lie within a 50m radius surrounding the respective shaft. As an initial sieving procedure, where the records of mine workings held by the Board indicate the presence or assumed presence of mine workings, a 90m reporting buffer has been applied to those boundaries for the purpose of these reports.

12) DM32 Planning Policy

This policy was introduced by Vale Royal Borough Council to ensure that no development takes place within the area covered by the policy until such time that the site is rendered fit for development and mitigated against the serious subsidence risk potentially associated with abandoned rock salt mines. Cheshire West and Chester Council is in the process of replacing this policy but the replacement policy is intended to include similar development constraints.

13) Planning Consent for Underground Rock Salt Mining

There is a single mine operation involving the extraction of rock salt by underground mining techniques currently taking place within the Cheshire Saltfield. This mining is subject to a number of conditions including the control of surface subsidence. The mine layouts have been designed by leading rock mechanics consultants acting for both the operator and planning authority to ensure compliance with the planning conditions.

Further details

Further details may be able to be obtained from the CBSCB in relation to the information provided herein, e.g. PNOD boundary or damage details, but such enquiries would be subject to a bespoke report and charge.

Terms and conditions

Groundsure's Terms and Conditions can be viewed online at this link: <https://www.groundsure.com/terms-and-conditions-jan-2020/>

Appendix 2
British Geology Survey Borehole Records

RECORD OF WELL

SJ 57/61

NN.....

55 57 NE/2
97/68

97/68

British Geological Survey

British Geological Survey

British Geological Survey

EXACT SITE
OF WELL

At ACTON BRIDGE
..... BROWN BOILING
Town or Village ACTON
County CHESHIRE

Six-inch National Grid sheet and reference SJ. 5995. 76A. SJ. 57 NE

For

State whether owner, tenant, builder, contractor, consultant, etc.:

Address (if different from above)

Level of ground surface above sea level (O.D.) 29 ft (..... m)

*DELETE

If well top is not at ground level state how far above* below: ft (..... m)

AS

British Geological Survey
NECESSARY

SHAFT ft (..... m); diameter ft (..... m);

HEADINGS (please attach details—dimensions and directions)

BORE .. 2300 ft (..... m); diameter: at top in (..... mm);

at bottom in (..... mm)

Full details of permanent lining tubes (position, length, inner and outer diameters, plain slotted etc.):

Water struck at depths of ft (..... m) below well top

Rest level of water ARTESIAN ft (..... m) above* well top. Suction at ft (..... m) below

Yield on hours* test pumping at 'days' galls per (..... l/s) with

depression to ft (..... m) below well top. Recovery to rest level in mins* hours

Capacity of pump g.p.h. (..... l/s)

Date of measurements

DESCRIPTION OF PERMANENT PUMPING EQUIPMENT:

Make and/or type Motive power

Capacity galls (..... m³) per hour. Suction at ft (..... m)below well top. Amount pumped galls (..... m³) per day. Estimatedconsumption galls (..... m³) per weekWell made by Date of sinking 1999

ADDITIONAL NOTES ANALYSIS (please attach copy if available)

LOG OF

STRATA

OVERLEAF

INSTITUTE OF GEOLOGICAL SCIENCES
HYDROGEOLOGY UNIT
EXHIBITION ROAD
LONDON SW7 2DE

IGS 2494 10 000 7/79

British Geological Survey

British Geological Survey

Received from MANKHAMSEDate 24.2.82

Observation well

Recorder

ER log

Site marked on

1" map ①6" map—Grid Sheet ①

(use symbol)

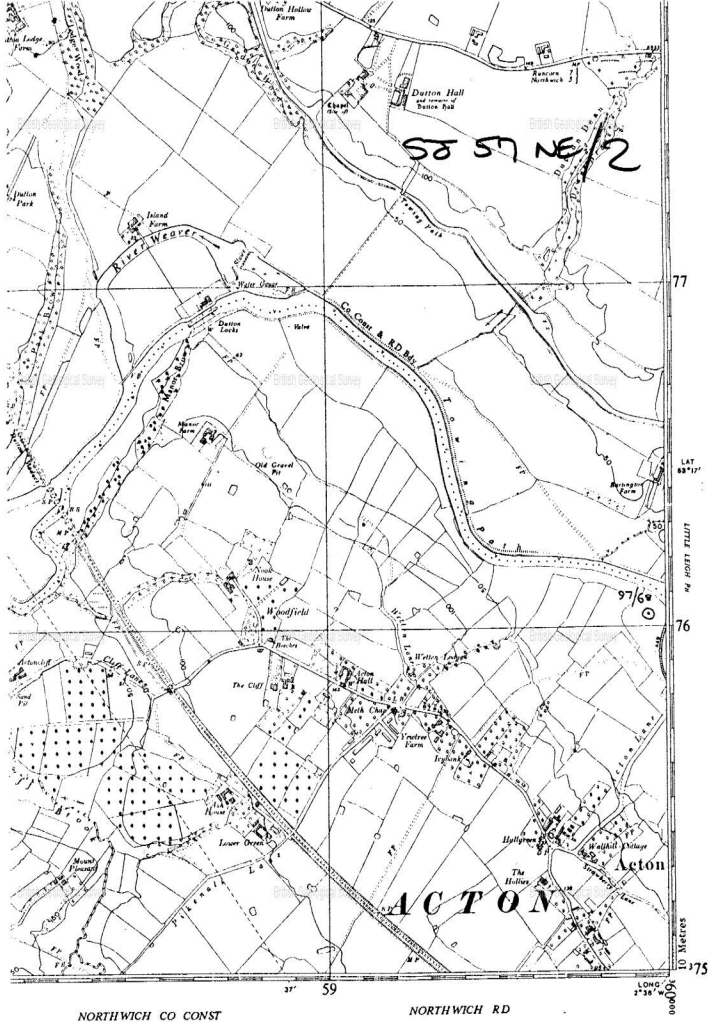
Copy to MAN ENSTAND

Date

British Geological Survey

50 57 NE/2 THICKNESS

[illegible]



RECORD OF WELL

SJ 57/61

NN.....

At ACTON BRIDGE

..... BRINE BORING

Town or Village ACTON

County CHESHIRE

97/68

97/68

**EXACT SITE
OF WELL**Six-inch National Grid sheet and reference SJ 5995 760A SJ 57.NE/2 ..

For

State whether owner, tenant, builder, contractor, consultant, etc.:

Address (if different from above)

Level of ground surface above sea level (O.D.) 29 ft (..... m)***DELETE**

If well top is not at ground level state how far above* ft (..... m)

SHAFT ft (..... m); diameter ft (..... m);

**AS
NECESSARY**

HEADINGS (please attach details—dimensions and directions)

BORE 2300 ft (..... m); diameter: at top in (..... mm);

at bottom in (..... mm)

Full details of permanent lining tubes (position, length, inner and outer diameters, plain slotted etc.):

Water struck at depths of ft (..... m) below well top

Rest level of water ARTESIAN ft (..... m) above* well top. Suction at ft (..... m)

Yield on hours* test pumping at galls per (..... l/s) with

depression to ft (..... m) below well top. Recovery to rest level in mins*

Capacity of pump g.p.h. (..... l/s)

Date of measurements

DESCRIPTION OF PERMANENT PUMPING EQUIPMENT:

Make and/or type Motive power

Capacity galls (..... m³) per hour. Suction at ft (..... m)below well top. Amount pumped galls (..... m³) per day. Estimatedconsumption galls (..... m³) per weekWell made by Date of sinking 1899ADDITIONAL NOTES ☐ ANALYSIS (please attach copy if available)**LOG OF****STRATA****OVERLEAF**Received from MANUKHARSEDate 24.2.82Observation well ☐Recorder ☐ER log ☐

Site marked on

1" map ☐6" map—Grid Sheet ☐

(use symbol)

Copy to NW. ENSLAND

Date

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LONDON SW7 2DE

For Institute use only

97/68

GEOLOGICAL
CLASSIFICATION

NATURE OF STRATA

If measurements start below ground surface, state how far.

THICKNESS

DEPTH

Feet

Inches

Metres

Feet

Inches

Metres

British Geological

British Geological Survey

British Geological

Ramo-
Yhaani
Kuper
Alluvial
Mud
Sandstone

SANDY CLAY

24

24

GRAVEL

12

6

36

6

KEUPER MARL

564

6

501

KEUPER MARL

499

2100

RED SANDSTONE

200

2300

British Geological Survey

British Geological Survey

British Geological Survey

I.P.S.

15/3/82

British Geological Survey

British Geological Survey

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British Geological Survey

British Geological Survey

British Geological Survey

British Geological Survey

ACTON BRIDGE Boring for Brine

SJ 57/61

Owner		Licence no. Appln no. 692/68		Nat. grid ref. 59957604 (59957604)			
Occupier		IGS ref. no. 57/INE/2		Status			
Ground level		m OD 29	ft. OD	Aquifer			
Level of well top		m OD	ft. OD	Code			
Rest water level		m bwt afternoon	ft. bwt	Summary of geological section			
(Date)		m OD	ft. OD	Thickness			
Construction: Method		Date 1899		Depth			
Depth bwt	Dia.	Lining (below well top)			Summary of geological section	Thickness	Depth
		From	To	Dia.			
2300'					Sandy clay	24	
					Gravel	12'6"	
					Keuper Marl	564'6"	601'
					Red silt	1499	2100'
						200'	2300'
Abstraction rates		Type of pump					
gph PWL		Chem./bact. anal.		YES/NO			
gpd		Well driller					

If insufficient space has been allowed, continue in 'Notes' overleaf.

PTO.

1/6/79/207

SJ57/61
97

RECORD OF WELL (SHAFT OR BORE)

1" N.S. 97
1" O.S.
Grid Ref. 33NE
Six-inch quarter sheet. 33NE

At ACTON BRIDGE BORING FOR BRINE

Town or Village

County CHESHIRE

Six-inch quarter sheet

Exact site West bank of River Weaver alongside Acton in parish of Acton

(A rough sketch-map or a tracing from a map is very desirable)

Level of ground surface above sea-level (O.D.) +29 ft. If well starts below ground surface, state how far

Shaft ft., diameter ft. Bore 2300 ft. Diameter of bore: at top ins.; at bottom ins.

Details of permanent lining tubes (internal diameters preferred)

Water struck at depths of (feet)

Rise-level of water below top of well feet. Section at feet. Yield on hours' test

gallons per (with pump of capacity g.p.h.); depressing water level to feet

below top. Time of recovery hrs. Amount normally pumped daily g.p.h. for hours

Quality (attach copy of analysis if available)

Sunk by James Timmins and for Mr. Allen

Date of well 1899

Information from John James Hall

(For Survey use only).
GEOLOGICAL
CLASSIFICATION.

NATURE OF STRATA
(and any additional remarks).

THICKNESS DEPTH
Feet. Inches Feet. Inches.

Drift	Sandy clay	24 0	24 0
36 1/2	Gravel	12 6	36 6

Kempston Sand	Red and grey sand and occasional hard bands of sandstone	564 6	601 0
106 3/4			

	Marl	1499 -	2100 -
--	------	--------	--------

Interstratified?	Red sandstone	200 -	2300 -
or			
Kempston?			
Interstratified?			

Yields 600,000 gallons per day at 1700 ft.

Yields 750,000 gallons per day at 2100 ft.

breaks brine (10% NaCl).

Running to waste, outfall being placed several feet under River Weaver.

Bores to 601 ft. by James Timmins and 601 to 2300 ft. by James Thom.

Temperature of water taken by Timmins 1899 was 66° Fahr. at depth 601 ft.

GEOLOGICAL SURVEY AND MUSEUM.
SOUTH KENSINGTON.
LONDON, S.W.7.

For Survey use only

Date received	G.S.M. Office File No.	Site marked on 1" map (see symbol)
---------------	------------------------	------------------------------------

(11111) W 10001 Q 500 10,000 500
A.S.B.W.L. 50,000

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)

1-inch Map Registered No.

5566NE/2

109

British Geological Survey

6-inch Map
Registered
No.

41 NW/1

Name and Number of Shaft or Bore

Newbridge Shaft.

Messrs. Vending House Warrington

For Messrs.

Town or Village

County

Six-inch quarter sheet

Exact site

Attach a tracing from
a map, or a sketch-
map, if possible.

Purpose for which made

(Shedlock p 20 says 56-92 ft)

Level at which shaft
bore commenced relative to O.D.

0.2. 60 ft.

State if shaft
bore is up, down, horizontal or

inclined; in latter cases give angle of inclination and direction

Made by

Information from

Date of Sinking

Specimens

Additional Notes in Space Overleaf

(For Survey use only)

GEOLOGICAL
CLASSIFICATION

NATURE OF STRATA

THICKNESS

DEPTH

Glacial bass and mud.

210 -

210

Sand

3 -

213

KM

76 6

292

6

Rock left (not proved)

16 6

309

-



Continued Overleaf

GEOLOGICAL SURVEY AND MUSEUM,

Date
receivedCorrespond-
ence File No.1" N.S. Map
No.1" O.S. Map
No.Site marked (use symbol)
on 1" Map on 6" Map

South Kensington,

LONDON, S. W. 7.

British Geological Survey

British Geological Survey

RECORD OF WELL (SINKING OF BORE)

At Meadow Bank Rock Salt Pit (1842) S.N.S. 109
Grid Ref. 41NW 2.
 Town or Village Winsford County Cheshire Six-inch quarter sheet 41NW
 Exact site Salt pit map 41NW. Meadow Bank
 in parish of N. of Winsford. (A rough sketch-map or a tracing from a map is very desirable)

Level of ground surface above sea-level (O.D.) 88.23 ft. If well starts below ground surface, state how far _____ ft.
 Shaft _____ ft. diameter _____ ft. Bore _____ ft. Diameter of bore: at top _____ ins.; at bottom _____ ins.
 Details of permanent lining tubes (internal diameters preferred) _____

Water struck at depths of (feet) _____

Rest-level of water below top of well _____ feet. Suction at _____ feet. Yield on _____ hours' test
 above _____ gallons per _____ (with pump of capacity _____ g.p.h.); depressing water level to _____ feet
 below top. Time of recovery _____ hrs. Amount normally pumped daily _____ g.p.h. for _____ hours.
 Quality (attach copy of analysis if available) _____

Sunk by _____ for Mr _____ Date of well 1843
 Information from See J. Dickinson. 'Salt and Govt. Report 1881 p. 58.
also Shored, Salt memoir, 1921 p. 31.

(For Survey use only).
 GEOLOGICAL
 CLASSIFICATION.

NATURE OF STRATA
 (and any additional remarks).

THICKNESS

DEPTH

Feet. inches.

Feet. inches.

Soil & drift composed of sand and clay
 (varying in other parts of the area
 up to 60 ft.)

6

-

6

Variagated marl with beds of hard blue
 and brown marl and marlstone, with
 scales of limestone, locally called
 'shaley' or 'shelly' ('skerry')

21

-

27

Brown and a little blue marl and marl-
 stone, with gypsum

164

-

191

Brown marl, granular, called 'horse-
 beans'

3

-

194

Hard marlstone, called 'the Flag', over
 the rock-head

2

-

196

(A.) Rock-salt, inferior

15

6

211

Blue and brown marlstone, hard, with
 gypsum

3

-

214

(B.) Rock-salt

33

-

247

Blue marlstone, hard

3

-

250

(C.) Rock-salt, top bed

69

6

320

(Middle marl. Brown and blue marl and
 marlstone, with veins and lumps of
 rock-salt

36

-

356

(D.) Rock-salt, bottom bed

121

-

477

Proved below by Mr. H.E. Falk in 1843

Blue marlstone, with small irregular
 cubes and lumps of rock-salt, and
 scales of limestone

2

-

479

Brown and blue marlstone, with small
 irregular cubes and lumps of rock-
 salt, and scales of limestone

12

-

491

Rock-salt

6

-

491

Blue marlstone, with limestone and a
 little rock-salt

1

6

493

(Contd....)

GEOLOGICAL SURVEY AND MUSEUM,
 SOUTH KENINGTON,
 LONDON, S.W.7.

Date
 received

G.S.M. Office
 File No.

Site marked
 on 1" map
 (see symbol)

(11188) W.S.2001.0.388 10,000 9/59
 A.6 B.W.156 Op.446

1/m 3/m

1.83

8.23

58.23

59.13

59.74

64.47

65.38

75.44

76.05

97.54

108.51

146.39

146.00

149.66

149.81

150.27

RECORD OF SHAFT OR BORE FOR MINERALS

1-inch Map Registered No.

Name and Number of Shaft or Bore

Newbridge No. 4 (Shaft) Moulton Hall

5566 NE/8

For Messrs.

Town or Village

County

Six-inch quarter sheet

Exact site "250 yds SSE of Moulton Farm"

6-inch Map
Registered
No.Attach a tracing from
a map, or a sketch-
map, if possible.

Purpose for which made Salt (none found)

Level at which shaft
bore commenced relative to O.D.

127.32 (38.81)

State if shaft
bore is up, down, horizontal or

inclined; in latter cases give angle of inclination and direction

Made by

Information from

Date of Sinking 1881

Specimens

Additional Notes in Space Overleaf

(For Survey use only)
GEOLOGICAL
CLASSIFICATION

NATURE OF STRATA

THICKNESS

DEPTH

303 {
Wet sand and gravel
Clay + loam
Dry red clay
Running sand
Dry sand loam + clay
Dry compound material (bel)
Sand + grav.
Bel + grav. [? collapsed material] *

20	20	6.10
4	24	7.32
30	54	10.46
7	61	18.59
21	82	24.99
68	150	45.72
6	156	47.55
147	44.50	92.35

On Oct. 17/1881 struck hard
substance. Rods dropped 18" and
before they could be raised hole
was filled w. gravel to a height
of 15 yds from bottom.

175.68 (53.55) below O.D.
Salt rock (hard) beneath
to be 1 ft
thick, was then 60 m below
O.D., turned on
nearly RM borehole.
(i.e. some 10 m below
the base of this bore.)

Drift bore as proved in bore in this area,
and in the Weaver valley to the west, is much
closer to the 47.55 m depth (base of sand + gravel bed).

than the total depth of 303 ft (92.35 m).
Sherlock quotes this bore as evidence
of a deep pre-glacial channel,
but it is much more likely
that the sequence from 47.55 m
to 92.35 m is all collapsed
sandstone.

Continued Overleaf

1" N.S. 109
1" O.S.
Grid Ref. **4**

RECORD OF WELL, SHAFT OR BORE

At **Newbridge No. 4. Shaft Moulton Hill.**

Town or Village **Moulton** County **Ceshire** Six-inch quarter sheet **41NW**

Exact site **Bore made (referred to as No. 4 Shaft) near 150 yds. S. E. of Hill side Farm, Moulton Hill, WINSFORD** (A rough sketch-map or a tracing from a map is very desirable)

Level of ground surface above sea-level (O.D.) **123.32** ft. If well starts below ground surface, state how far _____ ft.

Shaft _____ ft., diameter _____ ft. Bore **30.3** ft. Diameter of bore: at top _____ ins.; at bottom _____ ins.

Details of permanent lining tubes (internal diameters preferred).

Water struck at depths of (feet)

Rest-level of water below top of well _____ feet. Section at _____ feet. Yield on _____ hours' test above _____ feet

_____ gallons per _____ (with pump of capacity _____ g.p.h.); depressing water level to _____ feet

below top. Time of recovery _____ hrs. Amount normally pumped daily _____ g.p.h. for _____ hours.

Quality (attach copy of analysis if available).

Sunk by _____ for Mr. _____ Date **April 1881**

Information from **Sinking for salt. No salt found**

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA (and any additional remarks).	THICKNESS		DEPTH	
		Feet.	Inches.	Feet.	Inches.
	Wet sand and gravel	20	0	20	0
	Clay and loam	4	0	24	0
	303 ft. Dry red clay	30	0	54	0
	Glacial Running sand	7	0	61	0
	Dry sand, loam and clay	21	0	82	0
	Dry unimproved (under clay)	68	0	150	0
	Sand and gravel	6	0	156	0
	Bonded clay and gravel.	147	0	303	0
On October 17, 1881. Struck hard substance. Rats dropped 18" and before they time to be raised top hole was filled with gravel to a height of 18 yd from the bottom.					

T/m	D/m
	6.10
	7.32
	16.46
	18.69
	24.99
	45.72
	47.55
	92.35

Date received	G.S.M. Office File No.	Site marked on 1" map (see symbol)
------------------	---------------------------	--

Marbury, Northwilt. Cheshire

1" map. 97.

6" map. Cheshire 34 NW. W.

NGR 6564 7536

Marbury Estate. Trial boring for the
Cheshire Salt & Brine Co.

Metric.

	Thickness	Depth.
Sandy clay with a strong bed of clay $3\frac{1}{2}$ ft. 3 ft from surface.	$11\frac{1}{2}$	3.51
Fine red sand	5	16.52
V. fine red loam	1	17.52
Red Keuper marls with a few inches of grey marls	$8\frac{1}{2}$	26.37
Gypsum vein in indurated marls	$1\frac{1}{2}$	27.16
Red marl	$15\frac{1}{2}$	42.88
Gypsum vein as before	2	44.88
Red & grey marl	21	65.89
Gypsum vein in dark indurated marl	$2\frac{1}{2}$	68.18
Rock head & surface of Rock salt.	$5\frac{1}{6}$	73.65

Surface of boring 80 ft above. O.D.

Brine stands at 120 ft from surface.

Site is 800 yards west of Dairy House Farm, Marbury.

According to R.L. Sherlock surface level 79.95 ft. O.D.

Depth of Top Salt Bed 44 ft. below O.D.

Depth of sinking 174 ft. (R.L.S.).

WATER RESOURCES BOARD

WELL RECORD

SHEET 1

W.R.B. REF. No. SS67/17

R.A. LICENCE No.

British Geological Survey

British Geological Survey

British Geological Survey

1. WELL IDENTITY

NATIONAL GRID REFERENCE SS 6564 7537Well at Mottery EstateI.G.S. REF. No. LA09S NE 5 34 N 47200 ft. W. of Dainthorne Pn.RIVER AUTHORITY Mottery 12500295Town Mottery, NorthwichHYDROMETRIC AREA 68County Cheshire

SUB-CATCHMENT

Owner of well

Well made by

Date of sinking

Information from ISSDate received 12.3.68

2. WELL DESCRIPTION

Level of ground surface m. If well top is not at above* m.

above sea level (O.D.) 79.95 ft. ground level how far below ft.Shaft m. deep; Diameter at top m.; at bottom m.
ft. ft. ft.Bore m. deep; Diameter at top m.; at bottom m.
ft. ft. ft.

Details of headings

DETAILS OF PERMANENT LINING TUBES

Length m.; Diam. m.; Plain m.; Slotted m.; Top m. above* surface
ft. ft. ft. ft. ft. below surfaceLength m.; Diam. m.; Plain m.; Slotted m.; Top m. above* surface
ft. ft. ft. ft. ft. below surfaceLength m.; Diam. m.; Plain m.; Slotted m.; Top m. above* surface
ft. ft. ft. ft. ft. below surface

Details of well screen

DETAILS OF REST WATER LEVELS DURING CONSTRUCTION

Water struck at depths of below well top

Rest level of water m. above* O.D.* m. deep. Date
ft. below well top when bore ft.Rest level of water m. above* O.D.* m. deep. Date
ft. below well top when bore ft.Rest level of water m. above* O.D.* m. deep. Date
bore ft. below well top when bore ft.

Method of drilling

Brief details of well development e.g. acid treatment etc.

* delete as applicable

(45452-1) 1

British Geological Survey

British Geological Survey

British Geological Survey

WATER RESOURCES BOARD

WELL RECORD

SHEET 2

W.R.B. REF No.

5567/17

R.A. LICENCE No.

4. HYDROGEOLOGY

Topography AT WELL SITE

Local depression ☐ , Flat surface ☐ , Hill top ☐ , Hillside ☐ , Valley bottom ☐ , Terrace ☐

MAJOR AQUIFER Lithology

Depth to top of aquifer m. Thickness penetrated m.
..... ft. ft.Top of aquifer m. $\frac{AOD^*}{BOD}$ Total thickness of aquifer m.
..... ft. ft.Coefficient of storage Transmissibility $\frac{m^2/day^*}{galls/day/ft.}$

MINOR AQUIFER (a) Lithology

Depth to top of aquifer m. Thickness penetrated m.
..... ft. ft.Top of aquifer m. $\frac{AOD^*}{BOD}$ Total thickness of aquifer m.
..... ft. ft.Coefficient of storage Transmissibility $\frac{m^2/day^*}{galls/day/ft.}$

MINOR AQUIFER (b) Lithology

Depth to top of aquifer m. Thickness penetrated m.
..... ft. ft.Top of aquifer m. $\frac{AOD^*}{BOD}$ Total thickness of aquifer m.
..... ft. ft.

ADDITIONAL NOTES:

That bore for the nearby Salt & Brine Co
Bore 120' bs.
Top salt bed 94' BOD.

* delete as applicable

(46452-2)1

MARBURY

Marbury Estate Boring

Marbury, Northwilt. horizon

1" map. 97.

6" map. horizon 34 NW.W.

Marbury Estate. First boring for the
Clersey Salt & Brine Co.

Sandy clay with a strong bed of clay $3\frac{1}{2}$ ft. 3 ft from surface.	$11\frac{1}{2}$	
Fine red sand	5	$16\frac{1}{2}$
V. fine red loam	1	$17\frac{1}{2}$
Red Keuper marls with few inches of grey marls	$8\frac{1}{2}$	104
Gypsum vein in indurated marls	$1\frac{1}{2}$	$105\frac{1}{2}$
Red marl	$15\frac{1}{2}$	121
Gypsum vein as before	2	123
Red & grey marl	21	144
Gypsum vein in dark indurated marl	$26\frac{3}{8}$	$170\frac{3}{8}$
Rock head & surface of Rock salt.	$5\frac{3}{8}$	176

Surface of boring 80 ft above O.D.

Brine stands at 120 ft from surface.

Site is 800 yards west of Quirry House farm, near f.

According to R.L. Sherlock surface level 79.95 ft. O.D.

Depth of Sp Salt Bed 94 ft. below O.D.

Depth of sinking 174 ft. (R.L.S.).

Name and Number of Sheet or Page given by Geological Survey

Anderton Shafts

Brine & salt workings

17 NE/6

47 " CHESHIRE

6" Quarter Sheet 34NW

GEOLOGICAL
CLASSIFICATION

DESCRIPTION

THICKNESS

DEPTH

Anderton

near Northwich.

~~34NW~~

~~15.16~~

34NW.15. NGR 6506 7548

6

Anderton Shaft No. 1.

British Company, Anderton.

Surface 97.25 O.D.
(38.94 m.)

127 $\frac{3}{4}$ ft. below O.D. to Top Salt Bed (?)

Total depth of sinking 225 ft. (R. L. Sherlock).
(68.58 m.)

34NW.16. NGR 6504 7544

7

Anderton Shaft No. 2.

Indicated on Salt Union & P. F. Kendall's plans.
Not shown by R. L. Sherlock.
No details.

Name and Number of Shaft or Bore given to Geological Survey
Messrs Higgins's. Auderton

GEOLOGICAL CLASSIFICATION	DESCRIPTION	THICKNESS	DEPTH
	NGR 6503	7521	2410
	Bore or shaft?		
	Site given by R. L. Sherlock on field slip.		
	No details.		
	Kendall's mess. gives the following particulars:-		
	Messrs Higgins's (Salt Union) :-		
	(12.48m).		
	Surface +57.34 ft. (17.5m).		
	Drift + marl to -137.0 ft. 0. D.		
	Rock Head at -137 ft. 0. D.		

~~THICKNESS~~

33-111-2

DATE	DESCRIPTION	AMOUNT	REMARKS
11-1-19	1" Map. 97 (Warrington & Remcom).		

* Site not given [see next sheet
overleaf.]

Quoted in Calvert. A. F. Silt in 'Cheshire'
1915. p. 721. Graphic section.

Drift

Sand and clay	-	14	0	-	14	0
Sand, waterworn pebbles and blue clay	-	5	0	-	19	0
Indurated red clay	-	20	0	-	39	0
Indurated blue clay	-	15	0	-	54	0
Red and blue clayey marl	-	20	0	-	74	0
Red marl	-	8	0	-	82	0
Blue marl	-	8	0	-	90	0
Red marl with gypsum	-	10	0	-	100	0
Blue clay and red marl with boards of gypsum up to $\frac{1}{2}$ " thick and very numerous	-	50	0	-	150	0
At 150 ft. weak brine broke in and ran in the borehole above the shaft water 3 ft.	-	-	-	-	150	0
Red and blue marl with a slaty formation, and in the latter fibrous gypsum interbedded	-	38	0	-	188	0
Red marl	-	3	0	-	191	0
Slaty marl with fibrous gypsum	-	18	0	-	209	0
Red marl with fibrous gypsum	-	21	0	-	230	0
Slaty marl with gypsum	-	9	0	-	239	0
marl with gypsum	-	6	0	-	245	0
Slaty marl with gypsum	-	12	0	-	257	0
marl with gypsum	-	12	0	-	269	0
Slaty marl with gypsum	-	6	0	-	275	0
Red and blue marl with gypsum	-	6	0	-	281	0
Two cavities were met with here one above the other about 6" diameter. Brine rose in the well to overflowing and the test strength became 17 or more.	-	-	-	-	281	0
Marl with gypsum	-	9	0	-	290	0
Slaty marl. Very much gypsum	-	3	0	-	293	0
Marl with gypsum	-	12	0	-	305	0
Slaty marl with gypsum	-	9	0	-	314	0
Slaty blue indurated clay and gypsum	-	6	0	-	320	0
Marl and gypsum	-	12	0	-	332	0
Slaty formation with gypsum	-	6	0	-	338	0
Very salty blue indurated clay	-	6	0	-	344	0
Very firm marl	-	9	0	-	353	0
Slaty marl, very little gypsum	-	6	0	-	359	0
Slaty slaty marl	-	9	0	-	368	0
Marl with gypsum	-	24	0	-	392	0
Marl with copious gypsum	-	12	0	-	404	0
Slaty formation	-	6	0	-	410	0
Slaty slaty marl and gypsum	-	9	0	-	419	0
Here met a hard rock which took 24 hours to break through	-	-	-	-	-	-
Trace of marl, much gypsum & halblaster line	-	12	0	-	431	0

Kemper
Hess

SJ 67 NW

GEOLOGICAL
CLASSIFICATION

DESCRIPTION

THICKNESS

DEPTH

Slaty, with trace of marl, plenty
of gypsum
Slaty, copious gypsum
much gypsum

-	6	0	-	437	0
-	11	0	-	448	0
-	2	0	-	450	0

(137.6m)

According to Messrs Tinsmin
the site of this bore is alongside
the Leigh on the north eastern
side of Acton Bridge and
in Little Leigh Parish

"Leigh Arms" Acton Bridge

{ 1" map. 97 (Runcorn)

{ 6" map. Cheshire 33 NE.

{ surface about 50ft. O. D.

Name and Number of Shaft or Bore given by Geological Survey:

County **CHESHIRE**

Bore or 'Artesian Well' at **LITTLE LEIGH**

6th Quarter Sheet **33NE**

on the River Weaver

33NE 2.

GEOLOGICAL
CLASSIFICATION

DESCRIPTION

THICKNESS

Drift	1" map. 97 (Warrington & Runcorn).				
	* Site not given [see next sheet]				
Kempston marl	Quoted in Calvert. A. F. Salt in Cheshire				
	1915. p. 721. Graphic section.				
Drift	Sand and clay	14	0	14	0
	Sand, waterworn pebbles and blue clay	5	0	19	0
?	Indurated red clay	20	0	39	0
	Indurated blue clay	15	0	54	0
Kempston marl	Red and blue clayey marl	20	0	74	0
	Red marl	8	0	82	0
Kempston marl	Blue marl	8	0	90	0
	Red marl with gypsum	10	0	100	0
Kempston marl	Blue clay and red marl with bands of gypsum up to 1/2" thick and red numerous	50	0	150	0
	At 150 ft. weak brine broke in and above the shaft water 1 ft.			150	0
Kempston marl	Red and blue marl with a slaty formation, and in the latter fibrous gypsum interbedded	34	0	184	0
	Red marl	3	0	191	0
Kempston marl	Slaty marl with fibrous gypsum	18	0	209	0
	Red marl with fibrous gypsum	21	0	230	0
Kempston marl	Slaty marl with gypsum	9	0	239	0
	Marl with gypsum	6	0	245	0
Kempston marl	Slaty marl with gypsum	12	0	257	0
	Marl with gypsum	12	0	269	0
Kempston marl	Slaty marl with gypsum	6	0	275	0
	Red and blue marl with gypsum	6	0	281	0
Kempston marl	Two cavities were met with here one above the other about 6" diameter. Brine was in the well to overflowing and the last strength became 1/2 move			287	0
	Marl with gypsum	9	0	290	0
Kempston marl	Slaty marl: very much gypsum	3	0	293	0
	Marl with gypsum	12	0	305	0
Kempston marl	Slaty marl with gypsum	9	0	314	0
	Slaty blue indurated clay and gypsum	6	0	320	0
Kempston marl	Marl and gypsum	12	0	332	0
	Slaty formation with gypsum	6	0	338	0
Kempston marl	Very silty blue indurated clay	6	0	344	0
	Very firm marl	9	0	353	0
Kempston marl	Slaty marl, very little gypsum	6	0	359	0
	Slaty silty marl	9	0	368	0
Kempston marl	Marl with gypsum	24	0	392	0
	Marl with copious gypsum	12	0	404	0
Kempston marl	Slaty formation	6	0	410	0
	Slaty silty marl and gypsum	9	0	419	0
Kempston marl	Here met a hard cover which took 24 hours to break through				
	Trace of marl, much gypsum fall back line	12	0	431	0

Name and Number of Shaft or Bore given by Geological Survey:

33 NE/2

County

6" Quarter Sheet

SJ 67/25

GEOLOGICAL CLASSIFICATION	DESCRIPTION	THICKNESS			DEPTH		
	Slaty, with traces of mud. platy of gypsum	-	6	0	-	437	0
	Slaty, capricious gypsum	-	11	0	-	448	0
	Mud gypsum	-	2	0	-	450	0

According to Messrs Tinsmin
the site of this bore is alongside
the Leigh on the north eastern
side of Acton Bridge and
in Little Leigh Parish

"Leigh Arms" Acton Bridge

{ 1" map. 97 (Runcorn)
{ 6" map. Cheshire 33 NE.
{ Surface about 50 ft. O. D.

5367/13A-C
County CHESHIRE
6" Quarter Sheet 34NW

Name and Number of Shaft or Bore given by Geological Survey:

Anderton Shaft

Brine & Salt workings

Anderton

near Northwich.

34NW

15.16 & 17.

A 34NW.15.

Anderton Shaft No. 1.

British Company, Anderton.

Surface 97.25 O.D.

127 $\frac{3}{4}$ ft. below O.D. to Top Salt Bed (?)

Total depth of sinking 225 ft. (R.L. Sharlock).

B 34NW.16.

Anderton Shaft No. 2.

Indicated on Salt Union & P.F. Kendall's plans.

Not shown by R. L. Sharlock.

No details.

C 34NW.17.

Anderton Shaft No. 3.

Not shown by R. L. Sharlock.

Indicated on Salt Union & P.F. Kendall's plans.

Details as given in P.F. Kendall's notes:—

{ Surface + 96.1 ft. O.D.

{ Drift clay tunnel to - 231.9 ft. O.D.

Section of Boring at Agden, Lynn
 No. 2 Bore AGDEN near SJ 78 NW 6 17NE
 One-inch (N.S.) map 98. Bollington Cheshire
 O.D. 72 about 66 ft. 17NE 8.

	THICKNESS.		DEPTH.		
	Feet.	Inches	Feet.	Inches	
Sand & Gravel	12	-	12	-	3.65
Soft Sandy clay	11	-	23	-	7.01
Clay & Stones	41	-	64	-	19.50
Loamy Sand	5.0	-	714	-	34.76
Sand & Gravel	47	-	161	-	49.07
Fine Sand	23	-	184	-	56.08
Gravel	12	-	196	-	59.74
Grey Marl & Gypsum	8	-	204	-	62.17
Variegated Marls with Gypsum	86	-	290	-	83.39
			317	-	96.62
Hard Grey Bind	4	-	321	-	97.84
Strong Variegated Marls with Salt	33	-	354	-	107.89
Soft "	18	-	372	-	113.38
Variegated marls with bands of Gypsum	120	-	492	-	149.96
Red Sandstone	9	-	501	-	152.70
Variegated Marls	36	-	537	-	163.47
Hard Grey Marl with Salt	6	-	543	-	165.50
Saltrock with bands of hard marl	4.9	-	592	-	180.46

Water Level after Borehole struck Sandstone at
 492 ft. = 20 ft. about [Chelan surface]
 Tubes to 520 ft. about.

But see attached slip for completed
 bore to 692 ft. 7 in. Supplied by J. Thoms in 1934.

SI 78 NW 16

County Cheshire6-in. Map 17NE 18

GSM

BORE or SHAFT at Agden BridgeSurface level _____ O.D. 85 One-inch Map 98Communicated Dec. 1926 by Major E. Timmins, RumanDate of sinking 1916 Borer Major J. Thom, F.R.S.M.
Major Timmins, Ruman

Specimens

Description.	THICKNESS.		DEPTH.	
	Feet.	Inches.	Feet.	Inches.
Surface ground	2		2	0.60
Sand & gravel	62		64	19.50
Loamy sand	62		126	38.40
Sand & gravel	70		196	59.74
Variolated mud	4		200	60.96
Grey mud & gypsum.	27	6	227	68.34
Variolated mud & gypsum	82	6	310	94.48
Strong red mud	7		317	96.62
Hard grey mud	3	6	320	97.68
Variolated mud	10		330	100.73
Soft mud	8	6	339	103.32
Variolated mud, showing salt	33		372	113.38
to gypsum.	20		392	119.48
Grey mud	9	6	401	122.37
Variolated mud & gypsum	62	6	455	138.68
Red mud	13		468	142.64
Variolated mud	24	6	492	150.11
Red sandstone	8	6	501	152.70
Variolated mud	36		537	163.62
Grey mud showing salt	6		543	165.50
Rock salt	48	9	591	180.36
Rock salt not penetrated	100		691	210.61

Name and Number of Shaft or Bore given by Geological Survey

6th Quarter Sh

1st Aug 98.

near Bridgewater Canal

Details from Messrs E. F. Linn & Sons Ltd. 1942

Surface 85 ft. o. D.
(25.90 m)

Grift	-	196	0	-	196	0
Gypsum marls	-	126	0	-	321	0
Marls	-	51	0	-	373	0
Marl and gypsum	-	120	0	-	493	0
Red sandstone	-	9	0	-	562	0
Variogated marls	-	36	0	-	538	0
Grey marl and silt	-	6	0	-	544	0
Silt rock with hard marl bands	-	49	0	-	593	0

Water level after striking sandstone rose to 25 ft. from surface.

August 9, 1916. Borehole deepened another 100 ft.
no other details.

T/m	D/m
	59.74
	98.14
	113.69
	150.26
	153.00
	163.98
	165.81
	180.74

This is Agden Boring No. 178 NW 6

JOURNAL OF NO. 1. HOLE FOR MESSRS. AGDEN SALT WORKS LD.
AGDEN.

Ft. ins.	Strata	Ft. ins.	olm
2 0	Surface soil.	2 0	0.60
2 0	Soft fine sand.	4 0	1.21
8 0	Coarse sand and gravel.	12 0	3.65
11 0	Soft sandy clay.	23 0	7.01
41 0	Sandy clay and stones.	64 0	19.50
50 0	Loamy sand.	114 0	34.74
42 0	Coarse sand and gravel.	156 0	47.54
26 0	Fine sand.	182 0	55.47
14 0	Gravel.	196 0	59.74
4 0	variegated marl.	200 0	60.96
4 0	Grey marl and gypsum.	204 0	62.17
8 0	Red marl.	212 0	64.61
59 0	variegated marl with bands of gypsum.	271 0	82.60
39 0	Strong red marl and gypsum.	310 0	94.48
10 6	Hard grey bind.	320 6	97.68
10 0	variegated marl.	330 6	100.73
3 0	Strong variegated marl.	333 6	101.65
5 6	Soft red marl.	339 0	103.32
15 0	Strong variegated marl showing salt.	354 0	107.89
6 0	Soft " " "	360 0	109.72
32 0	Strong variegated marl with thin gypsum bands.	392 0	119.48
10 0	Soft grey marl.	402 0	122.52
2 6	Strong variegated marl.	404 6	123.29
22 0	Strong red marl.	426 0	129.99
28 6	Strong variegated marl with gypsum bands.	455 0	138.48
9 6	Red do do	464 6	141.57
28 0	do do do	492 6	150.11
8 6	Red sandstone.	501 0	152.70
36 0	Variegated marl.	537 0	163.67
6 0	Hard grey marl showing salt.	543 0	165.50
149 7	Salt rock with bands of hard marl. " " and marl.	692 7	209.09

TOTAL DEPTH:- 692'-7".

Salt
See Memoir p 50.
SW -

5578/28

*Thin in Agden Basin of Salt Marais, p. 50.**on p. 50*JOURNAL OF NO. 1. HOLE FOR MESSRS. AGDEN SALT WORKS LD.
AGDEN.

Ft. ins.		Strata	ft. ins.	
2	0	Surface soil.	2	0
2	0	Soft fine sand.	4	0
8	0	Coarse sand and gravel.	12	0
11	0	Soft sandy clay.	23	0
41	0	Sandy clay and stones.	64	0
50	0	Loamy sand.	114	0
42	0	Coarse sand and gravel.	156	0
26	0	Fine sand.	182	0
14	0	Gravel.	196	0
4	0	Variegated marl.	200	0
4	0	Grey marl and gypsum.	204	0
8	0	Red marl.	212	0
59	0	Variegated marl with bands of gypsum.	271	0
39	0	Strong red marl and gypsum.	310	0
10	6	Hard grey bind.	320	6
10	0	Variegated marl.	330	6
3	0	Strong variegated marl.	333	6
5	6	Soft red marl.	339	0
15	0	Strong variegated marl showing salt.	354	0 - 269
6	0	Soft " " " "	360	0
32	0	Strong variegated marl with thin gypsum bands.	392	0
10	0	Soft grey marl.	402	0
2	6	Strong variegated marl.	404	6
22	0	Strong red marl.	426	6
28	6	Strong variegated marl with gypsum bands.	455	0
9	6	Red do do	464	6
28	0	do do	492	6
8	6	Red sandstone.	501	0
36	0	Variegated marl.	537	0
6	0	Hard grey marl showing salt.	543	0
149	7	Salt rock with bands of hard marl.		
		" " and marl.	692	7 X Not

TOTAL DEPTH: - 692 - 7".*See Memoir p 50
811.*

SJ 7120 8695

SJ 78/28

Section of Boring at Agden Lyman

No. 1 Bore AGDEN

near

Bollington

Cheshire

One inch (N.S.) map p. 98.

County Cheshire

Date of Sinking 1914

6-inch map.

17NE

17NE

8.

66 ft.

	THICKNESS.		DEPTH.	
	Feet.	Inches.	Feet.	Inches.
Sand & Gravel	12	-	12	-
Soft Sandy Clay	11	-	23	-
Clay & Stones	41	-	64	-
Loamy Sand	50	-	114	-
Sand & Gravel	47	-	161	-
Fine Sand	23	-	184	-
Gravel	12	-	196	-
Grey Marl & Gypsum	8	-	204	-
Variegated Marls with Gypsum	86	-	290	-
			317	-
Hard Grey Bind	4	-	321	-
Strong Variegated Marls with Salt	33	-	354	-
Soft	18	-	372	-
Variegated Marls with bands of Gypsum	120	-	492	-
Red Sandstone	9	-	501	-
Variegated Marls	36	-	537	-
Hard Grey Marl with Salt	6	-	543	-
Saltrock with bands of hard Marl	49	-	592	-

Water Level after Borehole struck Sandstone at 492 ft. = 20 ft. about [Water surface]

Tubes to 520 ft. about.

But see attached slip for completed bore to 692 ft. 7 in. Supplied by J. Thomas in 1934.

Name and Number of Shaft or Bore given by Geological Survey:

County CHESHIRE

6" Quarter Sheet

GEOLOGICAL
CLASSIFICATION

DESCRIPTION

THICKNESS

DEPTH

1" map 98.

Borehole at AGDEN.

near Bridgewater Canal

Details from Messrs E. Timmins & Sons Ltd. 1942

Surface 85 ft. O.D.

Drift	-	196 0	-	196 0
Gypsaceous marls	-	126 0	-	322 0
Marls	-	51 0	-	373 0
Marl and gypsum	-	120 0	-	493 0
Red sandstone	-	9 0	-	502 0
Variiegated marls	-	36 0	-	538 0
Gray marl and salt	-	6 0	-	544 0
Salt rocks with hard marl bands	-	49 0	-	593 0

Water level after striking sandstone rose to
25 ft. from surface.

August 9. 1916. Borehole deepened another 100 ft.
No other details.

RECORD OF SHAFT OR BORE FOR MINERALS

SJ78NW

Name and Number of Shaft or Bore given by Geological Survey:

Nº 3 Salt Bore, Agden Salt Works

Name and Number given by owner (if different from above):

AGDEN Cheshire

Town or Village

Date of sinking

Exact site

See site map

Purpose for which made

Salt & brine

Level at which bore commenced relative to O.D. about 65 ft If not down bore, state if horizontal or up

Made by Messrs J. Thom & Co. for Messrs. Agden Salt Works.

Information from Messrs J. Thom & Co Date received 1943

Specimens

Dip of strata

A sketch-map tracing from a large scale map is desirable.

17NE

9.

County Cheshire

6" Quarter Sheet 17NE

1" N.S. Geol. Map 98

1" O.S. Geol. Map -

Whether Confidential

Yes.

GEOLOGICAL CLASSIFICATION	DESCRIPTION	THICKNESS		DEPTH	

JOURNAL OF NO.3 HOLE FOR MESSRS. AGDEN SALT WORKS LD. AGDEN.

CHES
17NE

Ft.	ins.	Strata	Ft.	ins.
2	0	Surface soil.	2	0
13	0	Sand.	15	0
3	0	Clay.	18	0
5	0	Sand and gravel.	23	0
13	0	Clay and sand.	36	0
38	0	Sand.	74	0
7	0	Sand and gravel.	81	0
8	0	Sand.	89	0
15	0	Sandy clay.	104	0
24	0	Loamy sand.	128	0
3	0	Fine sand.	131	0
22	0	Loamy sand and gravel with large boulders at 153 ft.	153	0
10	0	Stiff stoney clay.	163	0
12	0	Loamy sand and gravel.	175	0
4	0	Clay and large stones.	179	0
5	0	Red marl and gypsum.	184	0
16	0	Red marl.	200	0
15	0	Red marl and gypsum.	215	0
92	0	Variegated marl and gypsum.	307	0
27	0	Hard marl.	334	0
16	0	Softer variegated marl.	350	0
90	0	Marl and gypsum.	440	0
3	0	Hard marl.	443	0
33	0	Variegated marl and gypsum.	476	0
24	6	Hard marl.	500	6
13	6	Variegated marl with hard bands, traces of salt at 514 ft.	514	0
18	0	Hard and soft bands with gypsum.	532	0
7	0	Grey marl (signs of salt)	539	0
9	0	Red marl with hard bands.	548	0
29	0	Red sandy marl with traces of salt.	577	0
11	0	Soft red marl - very salty.	586	0
4	0	Salt rock.	592	0
26	0	Salt rock with small marl beds.	617	0
8	0	Salt rock.	625	0
50	0	Red marl with salt bands.	675	0
86	6	Salt rock.	761	6
9	6	Salt rock with bands of marl..	771	0
4	0	Marl and salt veins.	775	0

TOTAL DEPTH:- 775 ft.

SJ 78/27

SJ 7106 8705

(*1102) Wt. 30370.0370 10.000 9/30 A.S.E.W.Ltd. Gp. 685

RECORD OF SHAFT OR BORE FOR MINERALS

17NE. 9.
 County Cheshire
 6" Quarter Sheet 17NE
 1" N.S. Geol. Map 98
 1" O.S. Geol. Map -
 Whether Confidential
Yes.

Name and Number of Shaft or Bore given by Geological Survey:

Nº3 Salt Bore, Agden Salt Works

Name and Number given by owner (if different from above):

AGDEN Cheshire

Town or Village

Date of sinking

Exact site

See site map

A sketch-map tracing from a large-scale map is desirable
17NE 9.

Purpose for which made

Salt & Brine

Level at which bore commenced relative to O.D. about 65ft If not down bore, state if horizontal or up

Made by Messrs J. Thom & Co. for Messrs

Agden Salt Works.

Information from Messrs J. Thom & Co

Date received 1943

Specimens

Dip of strata

GEOLOGICAL CLASSIFICATION

DESCRIPTION

THICKNESS

DEPTH

JOURNAL OF NO.3 HOLE FOR MESSRS. AGDEN SALT WORKS LD.
AGDEN.

ft. ins.		Strata	ft. ins.	
2	0	surface soil.	2	0
13	0	Sand.	15	0
3	0	Clay.	18	0
5	0	sand and gravel.	23	0
13	0	Clay and sand.	36	0
38	0	Sand.	74	0
7	0	sand and gravel.	81	0
8	0	Sand.	89	0
15	0	sandy clay.	104	0
24	0	loamy sand.	128	0
3	0	fine sand.	131	0
22	0	loamy sand and gravel with large boulders at 153 ft.	153	0
10	0	Stiff stoney clay.	163	0
12	0	loamy sand and gravel.	175	0
4	0	Clay and large stones.	179	0
5	0	red marl and gypsum.	184	0
16	0	red marl.	200	0
15	0	red marl and gypsum.	215	0
92	0	variegated marl and gypsum.	307	0
27	0	hard marl.	334	0
16	0	softer variegated marl.	350	0
90	0	marl and gypsum.	440	0
3	0	hard marl.	443	0
33	0	variegated marl and gypsum.	476	0
24	6	hard marl.	500	6
13	6	variegated marl with hard bands, traces of salt at 514 ft.	514	0
18	0	hard and soft bands with gypsum.	532	0
7	0	grey marl (signs of salt)	539	0
9	0	red marl with hard bands.	548	0
29	0	red sandy marl with traces of salt.	577	0
11	0	Soft red marl - very salty.	588	0
4	0	Salt rock.	592	0
25	0	Salt rock with small marl beds.	617	0
8	0	Salt rock.	625	0
50	0	red marl with salt bands.	675	0
86	6	Salt rock.	761	6.
9	6	Salt rock with bands of marl..	771	0
4	0	marl and salt veins.	775	0

TOTAL DEPTH:- 775 ft.

Central h.s.
North West NRA

ACCIDENT
NUMBER 98
22237

FORM WR-38

National Rivers Authority
North West Region
BOREHOLE RECORD

NRA No. 55

(Please type)

A. SITE DETAILS		Consent No 827	5578NW	55
Borehole drilled for	J. PRIESTNER PARTNERSHIP			
Location	POTTER HOUSE FARM CORSEY LANE			
NGR (8 fig.)	556878	7280	8925	Please attach site plan
Ground Level (If known) ..				
Drilling Company	BLAIR DRILLING			
Date of drilling	Commenced: 30/5/95 Completed: 6/6/95			

B. CONSTRUCTION DETAILS

Borehole datum (If not ground level).....	FLANGE (WELL CAP)	above	m below GL
(point from which all measurements of depth are taken eg flange, edge of chamber, etc)			
Borehole drilled diameter	250 mm from 0	to 5.3	m/depth
	175 mm from 5.3	to 6.5	m/depth
	mm from	to	m/depth
Casing material <u>STEEL</u> diameter	200 mm from 0	to 5.3	m/depth
and type (eg plain steel, plastic slotted)			
<u>PLASTIC</u> diameter	125 mm from 0	to 6.5	m/depth
	mm from	to	m/depth
	mm from	to	m/depth

Grouting details 5.3

Water struck at 6 METRES

m (depth below datum - mbd)

m (depth below datum - mbd)

Rest water Level on completion 2.38 mbd

C. TEST PUMPING SUMMARY (Please supply full details on Forms WR-39)

Test Pumping Datum	above	m below borehole datum (mbd)
(If different from borehole datum)		
Pump Suction Depth 5.0 METRES	mbd	
Water Level (Start of Test) 2.38	mbd	
Water Level (End of Test) 2.37	mbd	
Pumping rate 4.4 cu per hr.	m ³ /d	18
for 4.8 hrs	days/hours	
Recovery to 2.37	mbd	in mins : hrs : days
(from end of pumping)		
Date(s) of measurements 29 th 30 th June 1 st July		

RECEIVED C.A.S.C.

DAVE LAMAS

SHOPS ROAD

SJ78NW/55

FORM WR-38 (cont.)

WRB N° ~~SJ78/57~~NRA
No.

(Please type)

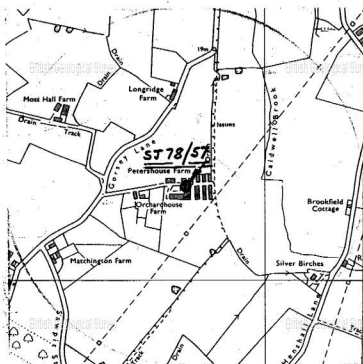
D. STRATA LOG

Geological Classification	Description of strata	Thickness	Depth
(BGS only)		m	m
Shirdley Hill Sand	TOP SOIL	0.2	0.2
	CLAY (CONTAINING SAND)	0.3	0.5
	SAND (WET) B.G. of CLAY	4.6	5.1
? Walsby Sst Fm (map suggests Tarporley Sistst Fm. A. Howard 1/12/97	WEAKLY FRACTURED SANDSTONE STEEL LINER AT 5.3m	26.96	32.06
	LAYER OF WATERSTONE	0.08	32.14
	MEDIUM SANDSTONE	6.2	38.34
	(VERY) HARD SANDSTONE	12.1	50.44
	LAYER OF WATERSTONE	0.16	50.60
	HARD SANDSTONE	14.4	65m
[continue on separate page if necessary]			
Other Comments (eg gas encountered, saline water intercepted, etc)			

FOR OFFICIAL USE ONLY

FILE CONSENT NO.

Site Plan



SJ78/57 ~~PETER~~HOUSE Fm ABH.

29.6.95 To 1.7.95.

Pumping test carried out: (48 hrs)
at an average pumping rate of
1,203 gph. Total quantity abstracted
57,763 galls. Drawdown 1.65 metres
Full recovery in 4 hours
See report GC32/95 - DCP

Central h.s.
North West NRA

98

FORM WR-38

National Rivers Authority
North West Region
BOREHOLE RECORD

SJ78/57

NRA
No.

(Please type)

A. SITE DETAILS		Consent No	827	SJ78NW 55
Borehole drilled for	J. PRIESTNER PARTNERSHIP			
Location	PETER HOUSE FARM CORSEY LAKE			
NGR (8 fig.)	556878	7280	8925	Please attach site plan
Ground Level (if known) ..				
Drilling Company	BLAIR DRILLING			
Date of drilling	Commenced: 30/5/95 Completed: 6/6/95			

B. CONSTRUCTION DETAILS

Borehole datum (if not ground level).....	FLANGE (WELCAP)		above
(point from which all measurements of depth are taken eg flange, edge of chamber, etc)			m below GL
Borehole drilled diameter	250 mm from 0	to 5.3	m/depth
	175 mm from 5.3	to 65	m/depth
	mm from	to	m/depth
Casing material <u>STEEL</u> diameter 200 mm from 0	to 5.3	m/depth	
and type (eg plain steel, plastic slotted)			
<u>PLASTIC</u> diameter 125 mm from 0	to 65	m/depth	
	mm from	to	m/depth
	mm from	to	m/depth
Grouting details <u>5.3</u>			
Water struck at <u>6 METRES</u>	m (depth below datum - mbd)		
	m (depth below datum - mbd)		
Rest water Level on completion	2.38	mbd	

C. TEST PUMPING SUMMARY (Please supply full details on Forms WR-39)

Test Pumping Datum	above
(if different from borehole datum)	m below borehole datum (mbd)
Pump Suction Depth <u>50 mm</u>	mbd
Water Level (Start of Test)	2.38 mbd
Water Level (End of Test)	2.37 mbd
Pumping rate <u>4.4 cu per hr.</u>	m ³ /d : Vs
for <u>48 hrs.</u>	days/hours
Recovery to <u>2.37</u>	mbd in mins : hrs : days
(from end of pumping)	
Date(s) of measurements	29 th 30 th June 1995

WRB N° SJ78/57

FORM WR-38 (cont.)

NRA
No.

(Please type)

D. STRATA LOG

Geological Classification	Description of strata	Thickness	Depth
(BGS only)		m	m
SHIRDLEY HILL SAND	TOP SOIL CLAY (CONTAINING SAND) SAND (wet) 8.13 of clay	0.2 0.3 4.6	0.2 0.5 5.1
? HILSBY SST FM	WEAKLY FRACTURED SANDSTONE STEEL LINER AT 5.3m	26.96	32.06
(MAP SUGGESTS TARPORLEY SILTSTONE FM)	LAYER OF WATERSTONE MEDIUM SANDSTONE	0.08 6.2	32.14 38.38
A HOWARD 11/2/97	(VERY) HARD SANDSTONE LAYER OF WATERSTONE HARD SANDSTONE	12.1 0.16 14.4	50.44 50.60 65m
[continue on separate page if necessary]			
Other Comments (eg gas encountered, saline water intercepted, etc)			

FOR OFFICIAL USE ONLY

FILE CONSISTING OF

CONSTANT RATE PUMPING TEST

CONSENT NO. 827

Pumping test at

PETER MOUST FARM

NGR

SJ 7280 - 8925 (5778/57)

Observations from

BLA B DRILLING

NGR

Description of datum point
from which measurements
were made (eg ground level,
flange, dip tube/other):

FLANGE

Height above ground
level (metres):

Date	Time	Elapsed time		Depth of water level below datum (metres)	Drawdown (metres)	Meter readings (m ³) or Discharge rate (m ³ /hr)	Comments (eg pump started, pumping rate changed, pump stopped)
		Minutes	Hours				
		DAY (- 3)				* denotes meter reading/flow measurement required	
		DAY (- 2)					
		DAY (- 1)					
29/6/15	9-30	0		2.38		* 00000.00	
		1		2.42			
		2		2.47			
		3		2.51			
		4		2.54			
		5		2.57			
		6		2.60			
		7		2.64			
		8		2.68			
		9		2.71			
		10		2.74			
		15		2.81		* 00001.42	
		20		2.87			
		25		2.92			
		30		2.97		* 00002.87	
		35		3.03			
		40		3.08			
		45		3.13			
		50		3.19			
		55		3.25			
		60		3.32		* 00005.64	= 1240 gph.
		70		3.41			
		80		3.48			
		90		3.54		*	
		100		3.61		*	
		120	2	3.67		*	
		150		3.72		*	
		180	3	3.76		* 00016.73	
		210		3.81			
		240	4	3.85		* 00022.26	1224 gph
	14:30	300	5	3.88		*	

FORM WR-39/4

**National Rivers Authority
North West Region
PUMPING TEST DATA**

5578/57

CONTINUATION SHEET[illegible]

FORM WR-39/2

**National Rivers Authority
North West Region
PUMPING TEST DATA**

5578/57

CONSTANT RATE PUMPING TEST - RECOVERY							
CONSENT NO.		827		Description of datum point from which measurements were made (eg ground level, flange, dip tube/other): FLANGE Height above ground level (metres):			
Pumping test at		PETER HOUSE FARM					
NGR							
Observations from		BLAIR DRILLING					
NGR							
Date	Time	Elapsed time		Depth of water level below datum (metres)	Drawdown (metres)	FINAL METER READING.	Comments
		Minutes	Hours				
1/7/95	9-30	0		4.03		200162.56	
		1		3.95			
		2		3.89			
		3		3.84			
		4		3.78			
		5		3.71			
		6		3.65			
		7		3.59			
		8		3.52			
		9		3.46			
		10		3.41			
		15		3.33			
		20		3.26			
		25		3.19			
		30		3.13			
		35		3.06			
		40		2.99			
		45		2.91			
		50		2.86			
		55		2.78			
	10-30	60	1	2.71			
		70		2.62			
		80		2.54			
		90		2.47			
		100		2.45			
	11-30	120	2	2.42			
		150		2.40			
	12-30	180	3	2.39			
		210		2.39			
	1-30	240	4	2.37		END OF TEST	
	2-30	300	5	2.36		4-00	2.37

DATA ACQUISITION SHEET

CSC/D/313

SJ78/S7

NRA region: NW

File Number: HYDRO COMMENTS ON PROPOSED ABSTRACTIONS FROM UNDERGROUND SOURCES
RING FIVE NO2 JAN-DEC 1995

Pump Well Identification:

NRA id No: 25/69/17/28

BGS (WL) No: SJ78/S7

NGR: SS 9280 8925

Elevation:

Measuring Point:

Site Name: ~~MARSH~~ PETERHOUSE FARM

Locality: WARBURTON, LYMM

Well details:

depth of pumping well:

diameter:

casing details:

☐ observation boreholes

number of obs bhs:

obs bh details:

Aquifer Details:

confined / unconfined ?

If confined, confining layer:

Aquifer Geology	from	to	Aquifer Geology	from	to
CLAY SAND MMG - KENNER NATUREGNE SSTN		0.5 5.1 65			

Pumping Test Details:

date of test:

length of test:

RWL:

PWL:

pumping rate:

See spreadsheet line 635
1200 gph

Additional Well Information:

- ☐ Well Loss Data: B..... C..... Efficiency.....
- ☐ Well Acidified
- ☐ Flow Logs
- ☐ Other Geophysical Logs
- ☐ Fissure Information: major inflows from.....to.....
from.....to.....
from.....to.....

Aquifer Parameters:

Analysis Type: *Jacob*

Transmissivity: *240 m²/d*

Storage Coefficient: *-*

Analysis Type:

Transmissivity:

Storage Coefficient:

Analysis Type:

Transmissivity:

Storage Coefficient:

Other Data:

Confidence:

excellent

☐☐☐☐☒

very poor

Notes:

*log normal plot of both ddn + recovery "stepped"
suggestive of draining + re-filling of fractured horizons?*

*Doubtful test analysis of any great value - used
final portion of recovery for AS (is same as final portion of
ddn).*

BOREHOLE LOG

81.496
(Mandate Core)

Site Partington

Job No. S.I. 1146

Client N. W. G. B.

Date Sep. 1967

Borehole No. 1

Diameter

Ground Level Existing

Scale 1/4 in = 1 ft.

Description	Depth	Legend	Sample	'N' Value	Core recovery %	Water Levels
Existing Ground	0'-0"					
Fill - fly ash (p.f.a.)	7'-6" (2.29m)				Nil	Entry
Compact red sand with lumps of weathered sandstone	15'-0" (4.57m)				Nil	
Coarse grained sandstone with seams of mudstone	19'-3" (5.81m)				63	
	22'-1" (6.73m)				100	
	27'-1" (8.25m)				88	

BOREHOLE LOG S5793W/70

Site Partington
 Client N. W. G. B.
 Borehole No. 1
 Ground Level Existing

Job No. S.I. 1146
 Date Sep. 1967
 Diameter _____
 Scale 1/4 in = 1 ft.

(contd.)

Description	Depth	Legend	Sample	N' Value	Core recovery %	Water Levels
Coarse grained sandstone with seams of mudstone	32'-0"				61	
	(9.75m)					
	34'-10"					
	(10.62m)					
	39'-10"					
	(12.14m)				80	
	45'-0"					
	(13.72m)					
	50'-0"				72	
	(15.24m)					
Very soft sandstone	55'-0"				57	
	(16.76m)					
Coarse grained sandstone					7	
					1/2 in	

BOREHOLE LOG

SUTSW/70

Site PartingtonJob No. S.I. 1146Client N.W.G.B.Date Sep. 1967Borehole No. 1

Diameter

Ground Level ExistingScale 1/4 in = 1 ft

(contd.)

Description	Depth	Legend	Sample	'N' Value	Core recovery	Water Levels
Coarse grained sandstone with seams of mudstone					Drilling without core recovery	
	80'-0" (24.38m)				100	
	85'-0" (25.91m)				Drilling without core recovery	

BOREHOLE LOG

SJT9SW/10

Site PartingtonJob No. SI 1148Client N.W.G.B.Date Sept. 1967Borehole No. 1 (contd.)

Diameter

Ground Level ExistingScale 1/4 in = 1 ft.

Description	Depth	Legend	Sample	'N' Value	Core recovery	Water Levels
Coarse grained sandstone with seams of mudstone					2	
	110'-0"					
	(33.53m)					
	112'-0"					
	(34.14m)					
Very soft sandstone					75	
	115'-0"					
	(35.05m)					
					0	
	120'-0"					
	(36.58m)					
	125'-0"					
	(38.10m)					

Drilling without core recovery

Drilling without core recovery

BOREHOLE LOG

SJ79SW/70

Site Partington

Job No. S.I. 1148

Client N.W.G.B.

Date Sept 1967

Borehole No. 1 (contd.)

Diameter

Ground Level Existing

Scale $\frac{1}{4}$ in = 1 ft

Description	Depth	Legend	Sample	'N' Value	Core Recovery %	Water Levels
Very soft sandstone					Drilling without core recovery	
	140'-0"					
	42.67m					
	142'-0"					
	44.3-28m					
Coarse grained sandstone					75	
	145'-0"					
	44.20m					
	147'-6"				Nil	
	44.96m					
					73	
	152'-6"					
	46.48m					
					Drilling without core recovery	

BOREHOLE LOG

S179SW/70

Site Partington Job No. S1. 1146
 Client N. W. G. B. Date Sept 1967
 Borehole No. 1 (contd.) Diameter _____
 Ground Level Existing Scale 1/4 in = 1 ft

Description	Depth	Legend	Sample	'N' Value	Core Recovery %	Water Levels
coarse grained sandstone					Drilling without core recovery	
	175'-0" 53.34m				53	
	180'-0" 54.86m					
	181'-6" 55.32m				Drilling without core recovery	
	186'-6" 56.85m				Drilling without core recovery	
	191'-0" 58.22m					

BOREHOLE LOG

S1793W/70

Site: Partington

Job No. S.I. 1146

Client: N. W. G. B.

Date: Sept 1967

Borehole No. 1 (contd.)

Diameter

Ground Level

Scale: 1/4 in = 1 ft.

Description	Depth	Legend	Sample	'N' Value	Core Recovery %	Water Levels
Coarse grained sandstone	200'-0"					
	60.96m				95	
	205'-0"					
	62.48m					
Coarse grained sandstone (fissured as suggested by vibration on drill string)	210'-0"				Drilling without core recovery	
	64.01m					
					Drilling without core recovery	Loss of water into rock from depth 210'.
	224'-0"					

68.28m

BOREHOLE LOG

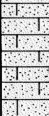
S179SW/70

Site PartingtonJob No. S.I. 1146Client N. W. G. B.Date Sept. 1967Borehole No. 1 (cont'd.)

Diameter

Ground Level

Scale 1/4 in = 1 ft.

Description	Depth	Legend	Sample	'N' Value	Core recovery %	Water Levels
Coarse grained sandstone (fissured as suggested by vibrations on the steel.)	230'-0"				Drilling without core recovery	
Coarse grained sandstone	70'-10m 235'-0"				95	
Coarse grained sandstone (fissured as suggested by vibrations on the steel.)	71'-6.3m 257'-0"				Drilling without core recovery	

78'-33m

BOREHOLE LOG

S279SW/70

Site Partington

Job No. S.I. 1146

Client N. W. G. B.

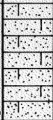
Date Sept. 1967

Borehole No. 1 (contd.)

Diameter

Ground Level

Scale $\frac{1}{4}$ in = 1 ft.

Description	Depth	Legend	Sample	'N' Value	Core recovery %	Water Levels
Coarse grained sandstone (fissured as suggested by vibrations on the steel.)	265'-0"				Drilling without core recovery	No water return from the hole.
Coarse grained sandstone	80'-17m 270'-0"				95	
	82'-30m					

GEOLOGICAL SURVEY OF GREAT BRITAIN

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)

6-inch Map Registered No.

Name of Shaft or Bore given by Geological Survey:

N.W.C.S. Partington No.1

Name and Number given by owner:

For whom made North Western Gas Board

Town or Village Partington County Cheshire

Exact site 1180 yds SSE Partington Church (Attach a tracing from a map, or a sketch-map, if possible.)

Nat. Grid Reference

G.S.J. 729 912

1° N.S. Map No.

1° O.S. Map No.

Confidential or not

No

Purpose for which made Site investigation

Ground Level at bore shaft relative to O.D. 70ft above O.D. (27.34m) If not ground level give O.D. of beginning of shaft bore

Made by Matthews & Mumby Ltd (Foundations) Ltd.

Date of sinking Sept. 1967

Information from N.W. Gas Board

Date received

Examined by G. Warrington

SPECIMEN NUMBERS AND ADDITIONAL NOTES

* Note. Site subsequently worked at 729 913.

(For Survey use only) GEOLOGICAL CLASSIFICATION	DESCRIPTION OF STRATA	THICKNESS		DEPTH		THICKNESS	DEPTH
		ft	in.	ft	in.	METRES	METRES
Made ground 7' 6" Weathered K. Sat. 7' 6"	NO CORE RECOVERY	15	0	15	0		4.57
	63" core recovery Medium red-brown medium grained sst. with thin dark red brown silty micaceous mudstone bands sst. show some ripple- drift bedding	15	0	19	3		5.67
	100" core recovery Medium red-brown medium-coarse grained sst, current bedded	19	3	22	1		6.73
Keuper Sandstone	88" core recovery Lighter red-brown medium-coarse sst. coarsens downwards, micaceous. Has some small red-brown mudstone flakes Bottom 9" firm argillaceous red brown sat. Core loss may have been due to loss of mudstone band above 9" fine sst.	22	1	27	1		8.25
	61" core recovery Core broken. Medium red-brown medium grd. sst. with some thin red-brown laminae and scattered mudst. flakes	27	1	32	1		9.18

Name of Shaft or Bore given by Geological Survey:

N.W.G.B. Partington

6-inch Map
Registered
No.

SJ 79 SW/70

GEOLOGICAL CLASSIFICATION	DESCRIPTION OF STRATA	THICKNESS		DEPTH	
		Fr	In.	Fr	In.
'Keuper' Sandstone	70% core recovery Core rather broken Ssts. as above with more mudst. laminae and bands	32	0	32 34	1 10
	80% core recovery Ssts. as above becoming darker downwards. More mudstone laminae in upper 2 feet. Shows some signs of disturbance in crumpling of mudst. bands. Little sign of mudst. in lower part where sst. is clean dark red brown. Some mudst. laminae in bottom 10 1/2 inches where colour is again lighter and includes some yellowish bands. Palynology sample taken at 3 1/2"	34	10	39	10
	72% core recovery Light red-brown to yellow-brown medium gr. sst. with thin argillaceous streaks	39	10	45	0
	57% core recovery Light red brown medium-coarse grained sst. with occasional thin dark red brown mudstone laminae	45	0	50	0
	7% core recovery Medium-dark medium-coarse red brown sst. rather soft and friable 'Gritty' feel	50	0	55	0
	NO CORE RECOVERED	55	0	80	0
	100% core recovery Light red brown coarse, almost gritty sst. No mudstone laminae	80	0	85	0
	NO CORE RECOVERED	85	0	110	0
	75% core recovery Medium grained red-brown and mottled yellow-green sst. with mudstone laminae. Some mudstones green malachite? impregnation colour	110	0	115	0
	NO CORE RECOVERY	115	0	140	0
Upper Mottled Sandstone	75% core recovery Soft, very friable, micaceous, coarse grained, light red brown and mottled white sst. becoming finer and	140	0	145	0

THICKNESS metres	DEPTH metres
	9.18 10.62
	12.14
	13.72
	15.24
	16.76
	24.38
	25.91
	33.53
	35.05
	42.67
	44.20

6-inch Map
Registered
No.

SJ 79 SW/70

GEOLOGICAL CLASSIFICATION	DESCRIPTION OF STRATA	THICKNESS		DEPTH	
		Ft	In.	Ft	In.
	b.f. more compact and darker coloured basally. Some pale green mudst. pellets in white parts and red brown ones in red parts. Core above 144' very worn and broken.	145	0		
	NO CORE RECOVERY	145	0	147	6
	73% core recovery Medium red-brown medium gnd. sst. with dark red brown mudst. laminae in basal 12". Some of the laminae broken and disturbed	147	6	152	6
	NO CORE RECOVERY	152	6	175	0
Upper Mottled Sandstone	53% core recovery Medium red brown, medium gnd. compact sst. White in basal 4"	175	0	180	0
	NO CORE RECOVERY	180	0	200	0
	Sats. as above but slightly coarser and with light coloured gritty stringers basally and rare dark colour mudst. laminae	200	0	205	0
	NO CORE RECOVERY	205	0	230	0
	95% core recovery Medium-dark rd. bn. medium gnd. sst. with coarse gritty stringers at 231/6 - 232/0	230	0	235	0
	NO CORE RECOVERY	235	0	265	0
	95% core recovery Medium red bn. medium gnd. sst. with some fine dark red bn. mudst. laminae in top 15" and White mottling in basal 12"	265	0	270	0
	Bottom of hole			270	0
				G. Warrington 20.2.68	

NWGS PARTINGTON 1.

ST 79/108

Owner			Licence No.			Nat. Grid Ref. 7290 9120		
Occupier			IGS Ref. No. ST 79 SW 70			Status		
Ground Level			m OD		ft. OD		Aquifer	
Level of Well Top			m OD		ft. OD			
Rest Water Level			m bwt		ft. bwt		Summary of Geological Section	
(Date)			m OD		ft. OD		Thickness	
Construction							Depth	
Depth bwt	Dia.	Linings (below well top)				15' light red-bran med/coarse silt-some med bands to Med coarse silt to		110' 270'
		From	To	Dia.	Type			
Abstraction Rates			Type of Pump					
gph			Chem./Bact. Anal.			YES NO		
gpd			Well Driller					

If insufficient space has been allowed, continue in 'Notes' overleaf.

Plant used: Comacchio 205	Project: HyNet North West - Hydrogen Pipeline			Location ID: BH017
Dates: 03/10/2022 - 04/10/2022	Client: Cadent			
Location: 357858.01E 377504.03N	Ground level: 26.49mOD	Logged by: CG/TW	Vertical scale: 1:50	Sheet 1 of 2 Project ID: 2230746

 IAN FARMER ASSOCIATES	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH017									
	Dates: 03/10/2022 - 04/10/2022		Client: Cadent			Sheet 2 of 2									
Rotary Boring Log	Location: 357858.01E 377504.03N		Ground level: 26.49mOD	Logged by: CG/TW	Vertical scale: 1:50	Project ID: 2230746									
Coring, Samples & In Situ Testing			Strata Details			Groundwater									
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation						
				16.29	10.20	Weak, thickly laminated (0 to 10 degrees) reddish brown, locally light bluish grey, locally cemented MUDSTONE. (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP End of Borehole at 10.20m									
								11							
								12							
								13							
								14							
								15							
								16							
								17							
								18							
								19							
								20							
Flush Details			Borehole Diameter		Boring Progress			Remarks:							
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
				10.20	121	03/10	16:30	8.80		4.60					
						04/10	08:00	8.80	8.80	3.80					
						04/10	16:30	10.20	8.80	7.60					
									SPT Hammer: JN01 Energy Ratio: 65%						
				Casing Diameter		Water Strikes			Monitoring Installations						
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
				10.20	139										
Checked by:		MHW	IFA RC												
Log status:		FINAL	v01.01												

 IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH021	
	Dates: 28/09/2022 - 05/10/2022		Client: Cadent				
Cable Percussion and Rotary Boring Log		Location: 359368.97E 377709.04N		Ground level: 42.11mOD	Logged by: JM/AE	Vertical scale: 1:50	Sheet 1 of 2 Project ID: 2230746

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
0.10 - 0.70	B1	SPT(S) N=11 (2,2/2,2,3,4)	41.91	0.20	Dark brown, slightly clayey, silty, fine to coarse SAND with frequent rootlets. TOPSOIL			
0.50	ES2			(0.50)	Dark grey, slightly gravelly, clayey, fine to coarse SAND. Gravel is subangular to subrounded, fine and medium including quartzite, occasional sandstone and siltstone.			
0.70 - 1.20	ES3			0.70	GLACIOFLUVIAL DEPOSITS			
1.00	B4			(0.70)	Brown and light brown, slightly gravelly, very clayey, very silty, fine and medium SAND with occasional pockets of firm, brown, slightly sandy, slightly gravelly silt. Gravel is subangular to subrounded, fine and medium including quartzite, occasional sandstone and siltstone.			
1.20	ES5			1.40	GLACIOFLUVIAL DEPOSITS			
1.20 - 1.65	D6			(0.60)	Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine and medium including quartzite, sandstone and occasional siltstone.			
1.40 - 2.00	B7			2.00	GLACIAL TILL			
2.20	D8 B9			(1.20)	Extremely weak, thinly and thickly laminated, reddish brown MUDSTONE recovered as clayey, angular to subrounded, fine to coarse very silty, very sandy gravel. (Grade IVa) [BOLLIN MUDSTONE MEMBER]			
2.20 - 2.58				3.00	MERCIA MUDSTONE GROUP			
2.20 - 2.70				(0.80)	Very weak, thickly laminated, light grey SILTSTONE recovered as silty, angular to subangular, fine and medium gravel. (Grade III) [BOLLIN MUDSTONE MEMBER]			
3.00	D10	SPT(S) 50 (5,14/50 for 180mm)	38.91	3.20	MERCIA MUDSTONE GROUP			
3.00 - 3.33	B11			(0.80)				
3.20 - 3.70	0 0 0	AZCL	38.11	4.00	Assessed zone of core loss, possible very weak siltstone. MERCIA MUDSTONE GROUP			
4.00 - 5.00				(1.20)				
5.00 - 5.70				5.20	Weak, thinly laminated (10 to 15 degrees) light greenish grey SILTSTONE. Discontinuities are set 1: 10 to 20 degrees, very closely spaced, planar, smooth, clean, with yellowish brown staining (1mm). Set 2: 85 to 90 degrees, very closely spaced, planar, smooth, clean, with yellowish brown staining (1mm). (GRADE II) [BOLLIN MUDSTONE MEMBER]			
5.70 - 7.20	71 34 34	NIDD	36.91	5.20	Between 5.20m and 5.44m: weak, greenish grey siltstone, non intact, drilling disturbed, recovered as; clayey, subangular and angular coarse gravel. Between 5.70m and 5.90m: assessed zone of core loss. Between 5.90m and 6.20m: weak light greenish grey siltstone, non intact, drilling disturbed, recovered as; clayey subangular and angular, coarse gravel.			
5.00 - 5.70	19			(1.23)				
5.70 - 7.20	87 13 13	NA	35.68	6.43	Stiff, reddish brown locally mottled light greenish grey, silty, slightly calcareous CLAY, with up to 70 percent, angular and subangular lithorelicts (up to 30mm) of very weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER]			
5.70 - 7.20	9			(0.92)				
7.20 - 8.20	86 55 55	7	34.76	7.35	Extremely weak, thinly laminated (20 to 25 degrees) reddish brown, slightly micaceous, slightly calcareous MUDSTONE. Discontinuities are 25 to 30 degrees, extremely closely and very closely spaced, planar, smooth, clean, with dark brown staining (1mm) (GRADE I) [BOLLIN MUDSTONE MEMBER]			
7.20 - 8.20	55			(0.71)				
8.20 - 8.60	0	AZCL	34.05	8.06	Assessed zone of core loss, possible extremely to very weak mudstone. MERCIA MUDSTONE GROUP			
8.20 - 8.60	0			(2.40)				
8.60 - 10.10	0 0 0	8.60m - SPT(S) 50 (9,10/50 for 205mm)						
8.60 - 10.10	0 0 0							

Chiselling				Borehole Diameter		Boring Progress					Remarks:			
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)				
3.70	4.20	60		10.10	121	28/09	12:30	4.40	4.20	3.70	Service inspection pit hand excavated from GL to 1.20m. Between 4.00m and 5.00m casing wasn't flushing correctly and concrete from above was trapped causing SPT Hammer: AR2371/JN01 Energy Ratio: 62/65%			
						04/10	08:00	0.00	4.00	Dry				
						04/10	16:30	8.60	5.00	6.80				
						05/10	08:00	8.60	5.00	1.00				
				Casing Diameter		Water Strikes					Monitoring Installations			
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
				4.20	150	0.80		0	0.80	Wet				
				10.10	139									

Checked by:	MHW	IFA CP v01.01
Log status:	FINAL	

 IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH021									
	Dates: 28/09/2022 - 05/10/2022		Client: Cadent												
Rotary Boring Log	Location: 359368.97E 377709.04N		Ground level: 42.11mOD	Logged by: JM/AE	Vertical scale: 1:50	Sheet 2 of 2 Project ID: 2230746									
	Coring, Samples & In Situ Testing		Strata Details			Groundwater									
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation						
			10.10m - SPT(S) 50 (10,12/50 for 210mm)	31.65	10.46	Assessed zone of core loss, possible extremely to very weak mudstone. MERCIA MUDSTONE GROUP									
						End of Borehole at 10.46m									
								11							
								12							
								13							
								14							
								15							
								16							
								17							
								18							
								19							
								20							
Flush Details			Borehole Diameter		Boring Progress			Remarks:							
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
4.00	5.00	Air	20			05/10	20:52	10.10	5.00	3.80	no recovery.				
5.00	5.70	Air	100								Between 8.20m and 8.60m run was terminated as it was not drilling correctly and when pulled back the core was likely blown away.				
5.70	7.20	Air	100								SPT Hammer: AR2371/JN01 Energy Ratio: 62/65%				
7.20	8.20	Air	100												
8.20	8.60	Air	10												
			Casing Diameter		Water Strikes			Monitoring Installations							
			Depth (m)		Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:			MHW	IFA RC											
Log status:			FINAL	v01.01											

Plant used: Comacchio 205	Project: HyNet North West - Hydrogen Pipeline			Location ID: BH036
Dates: 14/10/2022 - 21/10/2022	Client: Cadent			
Location: 361754.98E 371093.95N	Ground level: 42.70mOD	Logged by: ST/CE	Vertical scale: 1:50	Sheet 1 of 3 Project ID: 2230746

Plant used: Comacchio 205	Project: HyNet North West - Hydrogen Pipeline			Location ID: BH036
Dates: 14/10/2022 - 21/10/2022	Client: Cadent			
Location: 361754.98E 371093.95N	Ground level: 42.70mOD	Logged by: ST/CE	Vertical scale: 1:50	Sheet 2 of 3 Project ID: 2230746

 IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: HyNet North West - Hydrogen Pipeline			Location ID: BH036								
	Dates: 14/10/2022 - 21/10/2022	Client: Cadent											
Dynamic Sampling and Rotary Boring Log	Location: 361754.98E 371093.95N		Ground level: 42.70mOD	Logged by: ST/CE	Vertical scale: 1:50	Sheet 3 of 3 Project ID: 2230746							
	Samples & In Situ Testing		Strata Details			Groundwater							
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation					
					Orangish brown, fine and medium SAND. GLACIOFLUVIAL DEPOSITS								
22.00 22.00 - 22.45	D32	SPT(S) N=4 (1,2/1,1,1,1)		(5.00)	Between 22.00m and 22.45m: spt recovered as orangish brown, silty, fine and medium sand.								
24.00 24.00 - 24.45 24.50 - 24.55	D33 D34	SPT(S) 50 (5,6/50 for 296mm)	18.70	24.00 (1.39)	Stiff, brown, slightly sandy, silty CLAY. GLACIOFLUVIAL DEPOSITS								
25.00 25.00 - 25.39	D35	SPT(S) 50 (10,11/50 for 236mm)	17.31	25.39	End of Borehole at 25.39m								
Dynamic Sample Recovery			Remarks:										
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks									
24.00	25.00		100										
				SPT Hammer: JS01 Energy Ratio: 58%									
				Water Strikes			Monitoring Installations						
				Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		MHW	IFA DS v01.01										
Log status:		FINAL											

 IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: HyNet North West - Hydrogen Pipeline			Location ID: BH037				
	Dates: 13/12/2022 - 19/12/2022	Client: Cadent							
Dynamic Sampling and Rotary Boring Log	Location: 363837.97E 370272.01N		Ground level: 23.63mOD	Logged by: JM/NC	Vertical scale: 1:50	Sheet 1 of 4 Project ID: 2230746			
Samples & In Situ Testing			Strata Details			Groundwater			
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.00 - 0.40	B1	SPT(S) N=11 (2,3/3,3,2,3)	23.23	(0.40)	Dark brownish grey, slightly gravelly, silty, fine and medium SAND with rootlets. Gravel is subangular to rounded, fine and medium including quartzite.				
0.40 - 0.70	B2			0.40	TOPSOIL				
0.70 - 1.20	B4			(0.80)	Brown, slightly mottled light brown, slightly gravelly, silty, fine and medium SAND. Gravel is subangular to rounded, fine and medium including quartzite.				
					ALLUVIUM				
1.20			22.43	1.20	Below 0.70m: rare gravel.				
1.20 - 1.65	D6	(0.85)		Medium dense, brown, silty, fine SAND.					
1.20 - 2.00	B5			ALLUVIUM					
1.85	D7								
2.20		SPT(S) N=8 (2,2/2,2,2,2)	21.58	2.05	Loose, light brown, slightly silty, fine and medium SAND with rare gravel. Gravel is subrounded to rounded, fine and medium including mudstone and sandstone.			2	
2.20 - 2.65	D9								
2.20 - 3.20	B8								
2.70	D10								
3.20		SPT(S) N=10 (3,2/3,2,2,3)		(2.15)				3	
3.20 - 3.65	D11								
3.30	D12								
3.40 - 4.20	B13								
3.70	D14								
4.20		SPT(S) N=25 (2,3/3,6,8,8)	19.43	4.20	Light brown, gravelly, slightly silty, fine and medium SAND with rare cobbles. Gravel is rounded, fine to coarse including mudstone and siltstone. Cobbles are rounded including siltstone.			4	
4.20 - 4.65	D15								
4.40	D16								
4.75 - 7.85	D17			(0.90)	Soft, brown locally mottled light greenish grey, clayey, slightly sandy, slightly gravelly SILT. Gravel is subangular, fine and medium including mudstone and siltstone.				
5.20		SPT(S) 50 (7,9/50 for 275mm)	18.43	5.20	ALLUVIUM			5	
5.20 - 5.65	D18								
5.60 - 5.70	D19			(1.00)	Very dense, brown, fine to coarse SAND.				
					ALLUVIUM				
6.20		SPT(S) N=27 (3,5/7,7,6,7)	17.43	6.20	Between 5.80m and 6.00m: rare subrounded fine and medium gravel of quartzite.			6	
6.20 - 6.65	D20								
				(2.00)	Between 6.00m and 6.20m: slightly clayey.				
6.90 - 7.00	D21								
7.20 - 8.20	80 0 0	NA	15.43	8.20	Very stiff thinly bedded (0 to 15 degrees) reddish brown locally mottled light blueish grey SILT with up to 5% subrounded lithorelicts (up to 5mm) of extremely weak mudstone. Frequent off-white gypsum crystals (up to 10mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			8	
8.20 - 9.50	96 0 0								
				(2.80)					
TCR/SCR/ROD			FI	Samples & Tests					
Dynamic Sample Recovery			Remarks:						
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks					
1.20	2.20		93	Service inspection pit hand excavated from GL to 1.20m.					
2.20	3.20		100						
3.20	4.20		100						
4.20	5.20		84						
SPT Hammer: JT01 Energy Ratio: 66%									
Water Strikes				Monitoring Installations					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
8.20	8.20	8.20	20	6.70		0.00	15.00	Plain	50
20.00	16.00	20.00	20	4.20		15.00	25.00	Slotted	50
Checked by:		MHW	IFA DS						
Log status:		FINAL	v01.01						

	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH037	
	Dates: 13/12/2022 - 19/12/2022		Client: Cadent			Sheet 2 of 4	
Rotary Boring Log	Location: 363837.97E 370272.01N		Ground level: 23.63mOD	Logged by: JM/NC	Vertical scale: 1:50	Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
9.50 - 11.00	100 0 0					Very stiff thinly bedded (0 to 15 degrees) reddish brown locally mottled light blueish grey SILT with up to 5% subrounded lithorelicts (up to 5mm) of extremely weak mudstone. Frequent off-white gypsum crystals (up to 10mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP	× ×		
11.00 - 12.50	73 0 0	AZCL	12.00m - D25	12.63	11.00	Extremely weak, reddish brown locally mottled light blueish grey MUDSTONE. Discontinuities are 0 to 90 degrees, extremely to very closely spaced, planar, smooth, tight with soft brown silt infill (up to 0.25mm) and localised black manganese staining (<1mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
		18			(1.60)				
12.50 - 14.00	7 0 0			11.03	12.60	<i>Between 12.50m and 12.60m: recovered from drilling barrel into a tub.</i> Assessed zone of core loss. Possible extremely weak siltstone. Soft drilling and lost flush at 13.50 m. (Driller description). <i>At 13.50m: soft drilling and lost flush.</i>			
14.00 - 15.00	0 0 0								
15.00 - 16.00	80 55 55	AZCL	14.00m - SPT(C) N=42 (7,6/8,7,14,13)	8.43	15.20	Extremely weak, light blueish grey SILTSTONE. Highly fractured. Discontinuities are 0 to 90 degrees, extremely closely to very closely spaced, undulating, smooth, clean with localised black manganese staining (<1mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP	× ×		
		20	15.45						
16.00 - 17.00	100 100 100		15.00m - SPT(C) N=48 (12,10/12,12,12,12)	8.18	15.20	Very weak, thinly bedded (0 to 10 degrees) reddish brown locally mottled light blueish grey MUDSTONE. Discontinuities are 0 to 10 degrees, closely spaced, planar, smooth, clean. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 15.45m and 16.00m: non intact, drilling disturbed, recovered as silty subangular to subrounded fine to coarse gravel.</i> <i>At 17.00m: extremely weak diametrically.</i>			
17.00 - 18.50	80 80 67	5	16.00m - SPT(S) 50 (25 for 95mm/50 for 78mm) 16.00m - D26 16.18m - C27 17.00m - C28		(2.05)		17.50		
18.50 - 19.50	90 10 0	12	17.50m - C29	6.13	17.50	Interbedded very weak, thickly laminated (0 to 5 degrees) light blueish grey SILTSTONE and reddish brown MUDSTONE. Discontinuities are 0 to 5 degrees, very closely to closely spaced, planar smooth, clean with localised black manganese staining (<1mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
		AZCL		5.43	18.20				
		15		(1.30)	19.50	Very weak reddish brown locally mottled light blueish grey MUDSTONE. Discontinuities are 0 to 90 degrees, very closely spaced, planar and undulating, smooth, clean, with localised black manganese staining (<1mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
		NIDD		4.13	19.50	Very weak, very thinly bedded (0 to 5 degrees) reddish brown locally mottled light blueish grey MUDSTONE with frequent off-white gypsum veins (up to 5mm). (GRADE I) [BOLLIN MUDSTONE MEMBER]			

Continued next sheet

Flush Details				Borehole Diameter		Boring Progress				Remarks:	
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
8.20	9.50	Air mist	100			13/12	16:30	6.20		Dry	
9.50	11.00	Air mist	100			14/12	08:00	6.20		Dry	
11.00	12.50	Air mist	100			14/12	16:30	16.00	16.00	15.40	
12.50	14.00	Air mist	0			15/12	08:00	16.00	16.00	15.10	
14.00	15.00	Air mist	0								
15.00	16.00	Air mist	0								
16.00	40.00	Air mist	100								

Casing Diameter				Water Strikes				Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	MHW	IFA RC
Log status:	FINAL	v01.01

 IAN FARMER ASSOCIATES	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH037	
	Dates: 13/12/2022 - 19/12/2022		Client: Cadent				
Rotary Boring Log	Location: 363837.97E 370272.01N		Ground level: 23.63mOD	Logged by: JM/NC	Vertical scale: 1:50	Sheet 3 of 4 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
19.50 - 21.00	100 100 100	0	20.10m - C30			Very weak, very thinly bedded (0 to 5 degrees) reddish brown locally mottled light blueish grey MUDSTONE with frequent off-white gypsum veins (up to 5mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 19.50m and 20.05m: non intact, drilling disturbed, recovered as subrounded fine to coarse gravel.</i>			
21.00 - 22.50	100 100 100		21.15m - C31						
22.50 - 24.00	100 100 100	NIDD	23.00m - C32			Between 22.50m and 22.90m: non intact, drilling disturbed recovered as clayey subangular to subrounded fine to coarse gravel.			
		0							
24.00 - 25.50	0 0 0	AZCL		-0.37	24.00	Assessed zone of core loss. Possible mudstone. MERCIA MUDSTONE GROUP			
25.50 - 27.00	67 67 67								
27.00 - 27.75	0 0 0	AZCL			-3.37	27.00			
27.75 - 28.50	100 100 100								
28.50 - 29.25	100 100 100	0	28.80m - D35			Extremely weak to very weak, dark brown locally mottled light blueish grey MUDSTONE. Non intact drilling disturbed, recovered as clayey subangular to subrounded fine to coarse gravel. (Grade III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
29.25 - 30.00	0 0 0								
						Extremely weak, thinly to thickly laminated (0 to 10 degree), light reddish brown mottled brownish grey SILTSTONE. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Assessed zone of core loss. Possible mudstone.			
Continued next sheet									

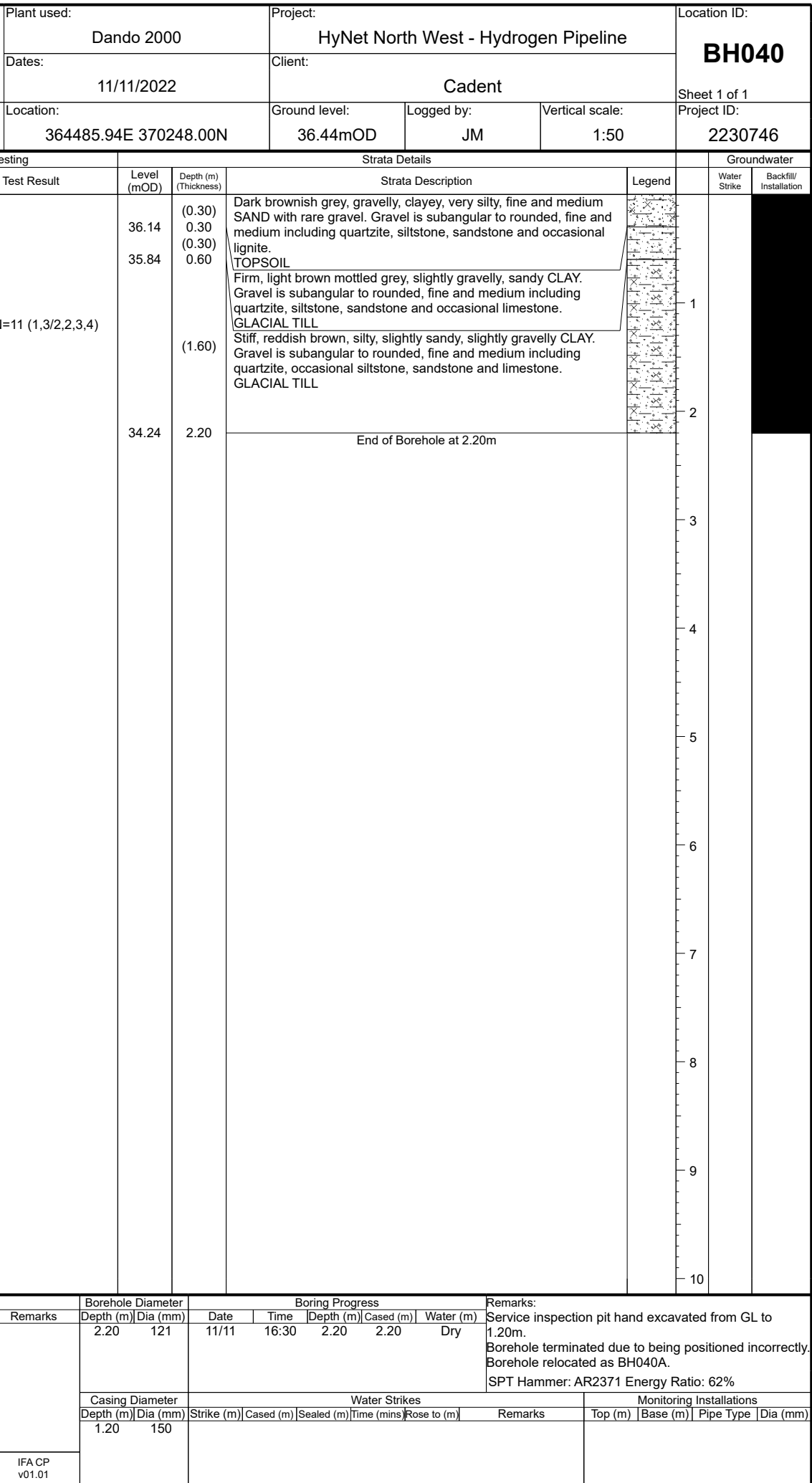
Flush Details				Borehole Diameter		Boring Progress						Remarks:			
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
						15/12	16:30	28.50	21.00	12.40	SPT Hammer: JT01 Energy Ratio: 66%				
						16/12	08:00	28.50	21.00	10.10					
						16/12	16:30	40.00	31.50	19.70					
						19/12	08:00	40.00	31.50	33.60					
				Casing Diameter		Water Strikes						Monitoring Installations			
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	MHW	IFA RC
Log status:	FINAL	v01.01

 IAN FARMER ASSOCIATES	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH037	
	Dates: 13/12/2022 - 19/12/2022		Client: Cadent				
Rotary Boring Log	Location: 363837.97E 370272.01N		Ground level: 23.63mOD	Logged by: JM/NC	Vertical scale: 1:50	Sheet 4 of 4 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
30.00 - 30.75	0 0 0	AZCL	30.00m - SPT(S) 50 (8,13/50 for 230mm)			Assessed zone of core loss. Possible mudstone. MERCIA MUDSTONE GROUP			
30.75 - 31.50	100 0 0	20	31.00m - D36	-7.12	30.75 (0.75)	Very weak, thickly laminated to very thinly bedded (0 to 5 degrees), dark reddish brown MUDSTONE. Discontinuities are 0 to 90 degrees, very closely spaced, planar, smooth, clean. Drilling disturbed predominantly recovered as gravel. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		31	
31.50 - 32.50	0 0 0	AZCL		-7.87	31.50 (1.00)	Assessed zone of core loss. Possible mudstone. MERCIA MUDSTONE GROUP		32	
32.50 - 33.25	93 0 0	16	32.50m - SPT(S) 50 (6,6/50 for 275mm)	-8.87	32.50 (0.75)	Very weak, thinly to thickly laminated (0 to 5 degrees), light blueish grey mottled brown SILTSTONE. Discontinuities are 0 to 90 degrees, very closely spaced, undulating, smooth, clean. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP	xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx xxxxxx	33	
33.25 - 34.00	100 0 0	15	33.50m - D37	-9.62	33.25 (0.75)	Very weak, reddish brown MUDSTONE. Discontinuities are 0 to 90 degrees, very closely spaced, planar, smooth, tight with soft brown silt infill (up to 0.25mm). (GRADE II) MERCIA MUDSTONE GROUP		34	
34.00 - 35.50	73 7 0	12	34.50m - C38 35.00m - D39	-10.37	34.00 (1.50)	Very weak, thinly to thickly laminated (0 to 10 degrees) dark brown mottled light blueish grey MUDSTONE. Discontinuities are set 1: 50 to 60 degrees, very closely spaced, planar and undulating, smooth, clean. Set 2: 75 to 80 degrees, very closely spaced, planar, smooth, clean. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		35	
35.50 - 37.00	100 27 0	15	36.30m - D40 36.35m - C41	-11.87	35.50 (3.10)	Very weak, thinly to thickly laminated (0 to 5 degrees) brown mottled blueish grey MUDSTONE. Discontinuities are set 1: 0 to 10 degrees, very closely to closely spaced, planar, smooth, clean. Set 2: 60 to 70 degrees, very closely spaced, planar, smooth, clean. (GRADE II) MERCIA MUDSTONE GROUP		36	
37.00 - 38.50	67 13 0	15	38.00m - C42			At 38.00m: locally weak.		37	
38.50 - 40.00	7 0 0	AZCL		-14.97	38.60 (1.40)	Assessed zone of core loss. Possible mudstone. MERCIA MUDSTONE GROUP		38	
				-16.37	40.00	End of Borehole at 40.00m		39	
								40	

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)		Water (m)				
										SPT Hammer: JT01 Energy Ratio: 66%					
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		MHW		IFA RC											
Log status:		FINAL		v01.01											





IAN FARMER ASSOCIATES

Plant used:

Dando 2000/Comacchio 205

Project:

HyNet North West - Hydrogen Pipeline

Location ID:

BH040A

Dates:

14/11/2022 - 29/11/2022

Client:

Cadent

Sheet 1 of 6

Cable Percussion and Rotary Boring Log

Location:

364420.02E 370251.97N

Ground level:

34.79mOD

Logged by:

JM/AE

Vertical scale:

1:50

Project ID:

2230746

Samples & In Situ Testing			Strata Details					Groundwater	
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.00 - 0.40	B1			(0.40)	Dark brownish grey, slightly gravelly, silty, fine and medium SAND with frequent rootlets. Gravel is subangular to rounded, fine and medium including sandstone, siltstone, limestone and quartzite.				
0.40 - 0.70	B2		34.39	0.40	TOPSOIL				
0.50	ES3			(0.30)					
0.70 - 1.20	B4		34.09	0.70	Firm, light brown mottled grey, slightly gravelly, sandy CLAY. Gravel is subangular to rounded, fine and medium including sandstone, siltstone, limestone and quartzite.				
					GLACIAL TILL				
1.20		SPT(S) N=12 (1,2/2,3,3,4)							
1.20 - 1.65	D6								
1.20 - 1.70	B5				Firm, reddish brown slightly mottled grey, slightly silty, slightly sandy CLAY with occasional gravel. Gravel is subangular to rounded, fine and medium including sandstone, siltstone and quartzite.				
					GLACIAL TILL				
2.20		SPT(S) N=37 (6,6/7,10,10,10)			Below 2.20m: stiff, slightly gravelly, sandy.				
2.20 - 2.65	D8								
2.20 - 2.70	B7								
3.20		SPT(S) N=40 (5,5/7,10,10,13)		(4.70)					
3.20 - 3.65	D10								
3.20 - 3.70	B9								
4.00		SPT(S) 50 (6,7/50 for 285mm)							
4.00 - 4.44	D12								
4.00 - 4.50	B11								
5.30		SPT(S) 50 (4,8/50 for 225mm)	29.39	5.40					
5.30 - 5.68	D13		29.19	5.60	Reddish brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine and medium including siltstone, mudstone and occasional quartzite and sandstone.				
5.60 - 6.00	B14				GLACIAL TILL				
6.50		SPT(S) 50 (4,11/50 for 235mm)			Very stiff, reddish brown, slightly sandy CLAY, with up to 10 percent subangular to subrounded lithorelicts (up to 60mm) of extremely weak mudstone and siltstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER]				
6.50 - 6.89	D16				MERCIA MUDSTONE GROUP				
6.50 - 7.00	B15				Below 6.00m: occasional grey siltstone lithorelicts.				
8.20		SPT(S) 50 (4,12/50 for 225mm)		(5.60)					
8.20 - 8.58	D18				Below 8.20m: gypsum crystals present.				
8.20 - 8.70	B17								
9.50		SPT(S) N=17 (5,3/3,4,5,5)							
9.50 - 10.00	B19								
9.50 - 9.95	D20								
Continued next sheet									

Chiselling				Borehole Diameter		Boring Progress					Remarks:				
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
3.00	3.20	30		50.50	121	14/11	16:30	1.20		Dry	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: AR2371 Energy Ratio: 62%				
5.20	5.30	30				15/11	08:00	1.20		1.00					
15.50	16.00	60				15/11	16:30	11.20	10.50	Wet					
						16/11	08:00	11.20	10.50	10.50					
				Casing Diameter		Water Strikes					Monitoring Installations				
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
				16.00	150	45.00	22.00		20	45.00	Fast				
				50.50	139										

Checked by:

MHW

IFA CP v01.01

Log status:

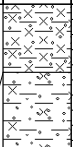
FINAL

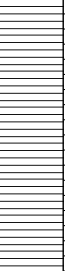
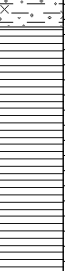
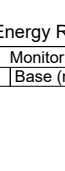
		Plant used: Dando 2000/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH040A	
		Dates: 14/11/2022 - 29/11/2022		Client: Cadent			Sheet 2 of 6	
Cable Percussion and Rotary Boring Log		Location: 364420.02E 370251.97N		Ground level: 34.79mOD	Logged by: JM/AE	Vertical scale: 1:50	Project ID: 2230746	

Samples & In Situ Testing			Strata Details				Groundwater			
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation		
11.20	D22 B21	SPT(S) N=11 (2,2/2,3,3,3)	23.59	11.20	Very stiff, reddish brown, slightly sandy CLAY, with up to 10 percent subangular to subrounded lithorelicts (up to 60mm) of extremely weak mudstone and siltstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		11			
11.20 - 11.65 11.20 - 11.70										
12.20 - 12.65 12.20 - 12.70	UT B23	10 blows. No recovery	22.29	12.50	Firm, reddish brown CLAY, with up to 10 percent subangular and subrounded lithorelicts (up to 20mm) of extremely weak mudstone and siltstone. Occasional lenses of extremely weak, grey siltstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				12	
13.50 13.50 - 14.20 13.50 - 14.20	B24 D25	SPT(S) N=0 (0,0/0,0,0,0)	22.29	12.50	Soft, reddish brown mottled grey CLAY, with up to 20 percent subangular and subrounded lithorelicts (up to 20mm) of extremely weak mudstone and siltstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				13	
13.50 - 14.20				(3.00)		<i>Below 13.50m: very soft.</i>		14		
15.00 - 15.45	UT26	25 blows. 60% recovery	19.29	15.50	Stiff, grey CLAY, with up to 15 percent subangular and subrounded lithorelicts (up to 20mm) of extremely weak mudstone and siltstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER]		15			
15.50	D27			(0.50)						
16.00 - 17.50	86 23 23	AZCL	16.00m - SPT(S) N=50 (5,8/8,12,15,15) 16.00m - D28 16.40m - D30 16.90m - D31	18.79	16.00	MERCIA MUDSTONE GROUP		16		
		NA		18.21	16.58	Stiff, grey, clayey SILT, with up to 30 percent subangular and angular lithorelicts (up to 20mm) of very weak siltstone. Rare, off white, gypsum crystals (up to 10mm). (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				
		0		17.64	17.15	Stiff, thin laminated (0 to 10 degrees) reddish brown locally mottled light bluish grey, silty CLAY, with rare, (0 to 10 degrees) off white, gypsum veins (up to 12mm). (GRADE IVb) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				
17.50 - 19.00	100 43 43	NIDD	17.70m - C32 18.75m - D33	16.89	17.90	Very weak, light bluish grey SILTSTONE, with frequent, (0 to 90 degrees) off white, crystalline, gypsum veins (up to 2mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		17		
		0								
		NA		15.79	19.00	Between 17.50m and 17.75m: non intact, drilling disturbed, recovered as; angular and subangular, fine to coarse gravel of siltstone. Stiff, reddish brown locally mottled bluish grey, silty CLAY, with up to 35 percent angular lithorelicts (up to 30mm) of extremely weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				
19.00 - 20.50	84 0 0	AZCL	19.38m - D34	14.79	20.00	Very stiff, thin laminated (0 to 5 degrees) light bluish grey locally mottled reddish brown, clayey SILT, with up to 10 percent subangular lithorelicts (up to 20mm) of extremely weak to weak siltstone. Rare, (0 to 5 degrees) off white, crystalline, gypsum veins (up to 3mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		18		
		FI								
Continued next sheet										

Chiselling				Borehole Diameter		Boring Progress					Remarks:		
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)			
						16/11	16:30	16.00	16.00	11.20	SPT Hammer: AR2371 Energy Ratio: 62%		
						17/11	08:00	16.00	16.00	9.10			
						17/11	16:30	19.00	19.00	15.60			
						24/11	08:00	19.00	19.00	NR			
				Casing Diameter		Water Strikes					Monitoring Installations		
				Depth (m) Dia (mm)		Strike (m)		Cased (m) Sealed (m)		Time (mins) Rose to (m)		Remarks	
Checked by:		MHW		IFA CP v01.01									
Log status:		FINAL											

 IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH040A				
	Dates: 14/11/2022 - 29/11/2022		Client: Cadent			Sheet 3 of 6				
Rotary Boring Log	Location: 364420.02E 370251.97N		Ground level: 34.79mOD	Logged by: JM/AE	Vertical scale: 1:50	Project ID: 2230746				
Coring, Samples & In Situ Testing			Strata Details				Groundwater			
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
20.50 - 22.00	94 0 0	NA	21.25m - D35			Very stiff, locally thinly laminated (0 to 10 degrees) reddish brown locally mottled light bluish grey, silty CLAY. with up to 20 percent angular and subangular lithorelicts (up to 25mm) of extremely weak mudstone. Rare, (0 to 10 degrees) off white, crystalline, gypsum veins (up to 5mm). (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		21		
		AZCL						22		
22.00 - 23.50	100 0 0	NA	22.35m - D36			Between 22.28m and 22.55m: very stiff, grey, clayey silt.		23		
						Between 22.67m and 22.76m: very stiff, grey, clayey silt.		24		
23.50 - 25.00	94 0 0		24.75m - D37					25		
		AZCL						26		
25.00 - 26.50	100 0 0	NA	26.25m - D38			Between 25.70m and 25.85m: very stiff, grey, clayey silt.		27		
				8.04	26.75	Very weak, thinly laminated (5 to 10 degrees) reddish brown and light bluish grey MUDSTONE, with rare, (45 to 80 degree) off white, crystalline, gypsum veins (up to 2mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		28		
26.50 - 28.00	100 83 83	1	27.30m - C39		(1.00)	Between 27.52m and 27.65m: 60 degree joint, planar, rough, clean.		29		
				7.04	27.75	Very weak, thinly laminated (0 to 5 degrees) reddish brown and light bluish grey MUDSTONE. Discontinuities are 30 to 45 degrees, very closely spaced, planar, smooth, clean. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		30		
28.00 - 29.50	100 30 30	5	28.40m - D40		(1.00)	Between 28.06m and 28.02m: non intact, drilling disturbed. Between 28.02m and 28.35m: 85 degree joint, planar, smooth, clean. Between 28.54m and 28.62m: 1x rounded cobble (80mm) of medium strong, reddish brown, fine grained sandstone.				
		NA	29.45m - D41		(1.70)	Very stiff, light bluish grey locally mottled reddish brown, clayey SILT, with up to 60 percent angular lithorelicts (up to 20mm) of very weak siltstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				
		AZCL								
Continued next sheet										
Flush Details				Borehole Diameter		Boring Progress			Remarks:	
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)
						24/11	16:30	22.00	19.00	NR
						25/11	08:00	22.00	22.00	19.10
						25/11	16:30	34.00	22.00	30.10
						28/11	08:00	34.00	22.00	12.90
						SPT Hammer: AR2371 Energy Ratio: 62%				
				Casing Diameter		Water Strikes			Monitoring Installations	
				Depth (m) Dia (mm)		Strike (m) Cased (m) Sealed (m) Time (mins) Rose to (m)			Remarks	
Checked by: MHW				IFA RC						
Log status: FINAL				v01.01						

 IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH040A											
	Dates: 14/11/2022 - 29/11/2022		Client: Cadent			Sheet 4 of 6											
Rotary Boring Log	Location: 364420.02E 370251.97N		Ground level: 34.79mOD	Logged by: JM/AE	Vertical scale: 1:50	Project ID: 2230746											
	Coring, Samples & In Situ Testing		Strata Details				Groundwater										
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation								
29.50 - 31.00	96 0 0	NA	31.20m - D42	4.34	30.45	Very stiff, light bluish grey locally mottled reddish brown, clayey SILT, with up to 60 percent angular lithorelicts (up to 20mm) of very weak siltstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, thinly laminated (0 to 5 degrees) reddish brown locally mottled light bluish grey, silty CLAY, with up to 40 percent subangular and subrounded lithorelicts (up to 40mm) of extremely to very weak mudstone and siltstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 31.70m and 31.94m: very stiff, greenish grey, clayey silt, with up to 30 percent subangular lithorelicts (up to 30mm) of very weak siltstone.</i>											
31.00 - 32.50	96 0 0																
32.50 - 34.00	96 0 0	NA	33.65m - D43														
34.00 - 35.50	100 0 0	NA	35.50m - D44		(8.55)												
35.50 - 37.00	95 0 0	NA				<i>Between 35.85m and 36.05m: very stiff, bluish grey, clayey silt, with up to 20 percent subangular lithorelicts (up to 15mm) of very weak siltstone.</i>											
37.00 - 38.50	93 0 0	NA	37.70m - D45														
38.50 - 40.00	100 66 66	NA	39.30m - C46	-4.21	39.00	Very weak, thinly laminated (0 to 5 degrees) reddish brown MUDSTONE, with frequent (0 to 90 degrees) off white, crystalline, gypsum veins (up to 2mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 39.53m and 40.20m: non intact drilling disturbed, recovered as; angular, fine to coarse, clayey gravel os weak mudstone.</i>											
						Continued next sheet											
Flush Details			Borehole Diameter		Boring Progress			Remarks:									
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)							
						28/11	16:30	46.00	22.00	21.10							
						29/11	08:00	46.00	22.00	19.10							
						29/11	16:30	50.50	22.00	32.50							
						SPT Hammer: AR2371 Energy Ratio: 62%											
				Casing Diameter		Water Strikes			Monitoring Installations								
				Depth (m) Dia (mm)		Strike (m)		Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)	
Checked by:		MHW		IFA RC													
Log status:		FINAL		v01.01													

 IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH040A		
	Dates: 14/11/2022 - 29/11/2022		Client: Cadent			Sheet 5 of 6		
Rotary Boring Log	Location: 364420.02E 370251.97N		Ground level: 34.79mOD	Logged by: JM/AE	Vertical scale: 1:50	Project ID: 2230746		
	Coring, Samples & In Situ Testing		Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	
40.00 - 41.50	67 53 53	NA	40.40m - D47	-5.41	40.20	Very weak, thinly laminated (0 to 5 degrees) reddish brown MUDSTONE, with frequent (0 to 90 degrees) off white, crystalline, gypsum veins (up to 2mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, reddish brown, silty CLAY, with up to 25 percent subangular lithorelicts (up to 10mm) of extremely weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 40.70m and 40.90m: weak, reddish brown mottled greenish grey mudstone.</i> <i>Between 41.00m and 41.10m: non intact, drilling disturbed, recovered as; angular, fine to coarse, clayey gravel of weak mudstone.</i>		
		0						
		NIDD						
41.50 - 43.00	83 75 75	AZCL	42.30m - C48	-6.96	41.75	Very weak, thinly laminated (0 to 5 degrees) light bluish grey locally mottled reddish brown SILTSTONE, with occasional (0 to 5 degrees) off white, crystalline, gypsum veins (up to 3mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 43.00m and 43.60m: non intact, drilling disturbed, recovered as; subangular and angular, fine to coarse, clayey gravel of siltstone.</i>		
		4						
		NIDD						
43.00 - 44.50	73 60 60	AZCL	44.80m - C49	-8.81	43.60	Very weak, reddish brown MUDSTONE. Highly fractured zone. Discontinuities are: 0 to 90 degrees, very closely spaced, planar, smooth, tight, with soft, brown, clay infill (up to 0.25mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 44.12m and 44.25m: 85 degree joint, undulating, smooth, clean.</i> <i>Between 44.70m and 44.90m: very weak, reddish brown mudstone.</i>		
		15						
		NIDD						
44.50 - 46.00	90 20 20	AZCL	45.30m - D50	-11.41	46.20	Very weak, thinly laminated (0 to 15 degrees) light greenish grey SILTSTONE, with frequent (0 to 60 degree) off white, crystalline, gypsum veins (up to 3mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, reddish brown, silty CLAY, with up to 50 percent angular lithorelicts (up to 25mm) of extremely and very weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Weak, reddish brown MUDSTONE. Highly fractured zone. Discontinuities are: 0 to 90 degrees, very closely spaced, planar, smooth locally undulating, tight with soft brown clay infill (up to 0.25mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		
		0						
		NIDD						
46.00 - 47.50	100 66 66	NA	47.00m - D52	-12.21	47.00	Very weak, reddish brown MUDSTONE, with frequent (0 to 30 degrees) off white, crystalline, gypsum veins (up to 3mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 25mm) of very weak mudstone. (GRADE III)		
		13						
		NIDD						
47.50 - 49.00	100 7 7	AZCL	48.40m - D53	-14.31	49.10	Very weak, reddish brown MUDSTONE, with frequent (0 to 30 degrees) off white, crystalline, gypsum veins (up to 3mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 25mm) of very weak mudstone. (GRADE III)		
		2						
		NIDD						
49.00 - 50.50	93 37 37	AZCL	49.15m - C54	-14.91	49.70	Very weak, reddish brown MUDSTONE, with frequent (0 to 30 degrees) off white, crystalline, gypsum veins (up to 3mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 25mm) of very weak mudstone. (GRADE III)		
		2						
		NIDD						
Continued next sheet								
Flush Details				Borehole Diameter		Boring Progress		Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	
								SPT Hammer: AR2371 Energy Ratio: 62%
				Casing Diameter		Water Strikes		Monitoring Installations
				Depth (m) Dia (mm)		Strike (m) Cased (m) Sealed (m) Time (mins) Rose to (m)		
								Top (m) Base (m) Pipe Type Dia (mm)
Checked by:		MHW	IFA RC					
Log status:		FINAL	v01.01					

 IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH040A									
	Dates: 14/11/2022 - 29/11/2022		Client: Cadent			Sheet 6 of 6									
	Rotary Boring Log		Location: 364420.02E 370251.97N		Ground level: 34.79mOD	Logged by: JM/AE	Vertical scale: 1:50	Project ID: 2230746							
Coring, Samples & In Situ Testing				Strata Details				Groundwater							
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation						
		NA	50.20m - D55			Very stiff, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 25mm) of very weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP End of Borehole at 50.50m									
		AZCL													
								51							
								52							
								53							
								54							
								55							
								56							
								57							
								58							
								59							
								60							
Flush Details			Borehole Diameter		Boring Progress			Remarks:							
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
									SPT Hammer: AR2371 Energy Ratio: 62%						
				Casing Diameter		Water Strikes			Monitoring Installations						
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		MHW	IFA RC												
Log status:		FINAL	v01.01												

Plant used:

Comacchio 205

Dates:

01/11/2022 - 15/11/2022

Project:

HyNet North West - Hydrogen Pipeline

Client:

Cadent

Location ID:

BH042

Dynamic Sampling and Rotary Boring Log

Location:

364615.94E 370251.99N

Ground level:

37.59mOD

Logged by:

FH/CE

Vertical scale:

1:50

Sheet 1 of 6

Project ID:

2230746

Samples & In Situ Testing				Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.00 - 0.40	B1	SPT(S) N=18 (2,3/4,4,5,5)	37.19	(0.40)	Soft, dark brown, slightly gravelly, very sandy SILT. Gravel is subrounded to rounded, fine and medium including sandstone, slate and quartz. TOPSOIL Light brown, silty, fine and medium SAND. ALLUVIUM				
0.40 - 0.50	D2								
0.50 - 1.00	B3								
0.70	D4								
1.20	D5	SPT(S) N=12 (1,2/3,3,3,3)	36.39	1.20	Medium dense, greyish brown, fine and medium SAND, with rare pockets (up to 30mm) of firm, dark grey, silty clay with a slight organic odour. ALLUVIUM				
1.20 - 1.65	B17								
1.20 - 2.20									
2.20	D6	SPT(S) N=4 (1,1/1,1,1,1)	34.94	2.65	Very loose to loose, orangish brown, silty, fine and medium SAND. ALLUVIUM				
2.20 - 2.65									
3.20	D7	SPT(S) N=22 (2,4/5,4,5,8)		(2.55)	Below 4.20m: medium dense.				
3.20 - 3.65	B18								
3.20 - 4.20									
4.20	D8			5.20	Between 5.10m and 5.20m: firm, reddish brown, silty clay. Stiff, reddish brown, slightly gravelly, sandy, silty CLAY. Gravel is subangular to rounded, fine to coarse including mudstone, siltstone and quartzite. Occasional angular fragments (up to 10mm) of black lignite. GLACIAL TILL				
4.20 - 4.65									
5.20 - 6.00	19 0 0	AZCL	32.39						
6.00 - 7.00	100 0 0	NA		(3.30)					
7.00 - 7.50	16 0 0	AZCL							
7.50 - 9.00	67 0 0	NA	29.09	8.50	Assessed zone of core loss, likely clay. GLACIAL TILL				
9.00 - 10.20	21 0 0	AZCL	27.64	9.95					
TCR/SCR/ROD FI Samples & Tests			Continued next sheet						

Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks
1.20	2.20		100	
2.20	3.20		100	
3.20	4.20		100	
4.20	5.20		100	

Checked by:

MHW

Log status:

FINAL

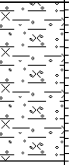
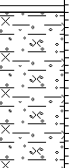
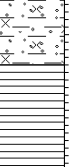
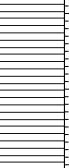
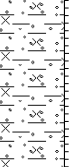
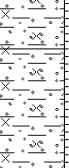
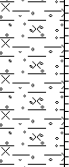
IFA DS v01.01

Remarks:

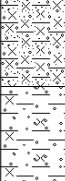
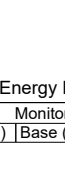
Service inspection pit hand excavated from GL to 1.20m. Between 4.20m and 5.20m: blowing sands.

SPT Hammer: AR3408 Energy Ratio: 63%

Water Strikes					Monitoring Installations				
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
0.90			20	0.90					

 IAN FARMER ASSOCIATES	Plant used:		Comacchio 205		Project:			HyNet North West - Hydrogen Pipeline			Location ID:										
	Dates:		01/11/2022 - 15/11/2022		Client:		Cadent			Sheet 2 of 6											
	Rotary Boring Log		Location:		364615.94E 370251.99N		Ground level:		37.59mOD		Logged by:		FH/CE		Vertical scale:		1:50		Project ID:		2230746
Coring, Samples & In Situ Testing						Strata Details						Groundwater									
Depth		TCR/SCR/ RQD		FI		Samples & Test Result		Level (mOD)		Depth (m) (Thickness)		Strata Description			Legend		Water Strike		Backfill/ Installation		
10.20 - 11.70		100 0 0		NA		10.20m - SPT(S) 50 (25 for 95mm/50 for 155mm) 10.20m - D13 10.35m - D21		26.54		11.10		Very stiff, fissured, reddish brown, silty CLAY, with up to 45 percent angular lithorelicts (up to 25mm) of extremely weak and very weak mudstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP									
				22		11.40m - D22				11.05 (0.65)											Extremely weak to very weak, thinly bedded (5 to 15 degrees) reddish brown MUDSTONE, with rare, light bluish grey reduction spots (up to 5mm). Discontinuities are 0 to 90 degrees, very closely spaced, planar, smooth, tight, with soft, brown, clay infill (up to 25mm) and localised black manganese staining (<1mm) (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP
11.70 - 13.20		27 0 0		AZCL		11.70m - SPT(S) N=12 (1,1/1,3,4,4) 11.70m - D14		25.89		11.70		Very stiff, fissured, thickly laminated (0 to 5 degrees) bluish grey locally mottled reddish brown, clayey SILT, with up to 60 percent angular lithorelicts (up to 25mm) of extremely and very weak siltstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished, with localised, off white, gypsum mineralisation (<3mm). (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP									
								(2.00)		12											
13.20 - 14.70		33 0 0		NA		13.20m - SPT(S) 50 (25 for 80mm/50 for 80mm) 13.20m - D15 13.20m - D23		23.89		13.70		Extremely weak to very weak, reddish brown MUDSTONE, with rare light bluish grey reduction spots (up to 5mm). Discontinuities are 0 to 90 degrees, very closely spaced, planar, smooth, tight, with soft, brown, clay infill (up to 0.25mm) and localised black manganese staining (<1mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP									
				AZCL																	14
14.70 - 16.20		90 0 0		22		14.70m - SPT(S) 50 (6,9/50 for 210mm) 14.70m - D16 15.10m - D24		21.54		(2.35)		Assessed zone of core loss, likely fissured, silty clay. [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 14.70m and 15.0m: drilling disturbed.</i> <i>Between 15.65m and 15.99m: very stiff, reddish brown, locally mottled light bluish grey clay, with up to 50 percent angular lithorelicts (up to 25mm) of extremely weak mudstone and very weak siltstone.</i> <i>Between 15.99m and 16.05m: moderately weak, light bluish grey siltstone.</i>									
				NA						16.05											16
16.20 - 17.70		27 0 0		AZCL		17.30m - D25		20.29		17.30		Very stiff, reddish brown, silty CLAY, with up to 60 percent angular lithorelicts (up to 35mm) of very weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP									
								(1.25)		17											
17.70 - 19.20		100 0 0		NA		17.80m - D26		19.89		17.70		Very stiff, fissured, locally very thinly bedded (10 to 15 degrees) reddish brown, locally mottled grey, silty CLAY, with up to 5 percent angular lithorelicts (up to 5mm) of extremely weak mudstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished, with black manganese staining (<1mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 16.70m and 17.30m: brown clayey fine sand, collapsed material into borehole. Not representative of depth.</i> <i>Between 19.00m and 19.15m: very stiff, light bluish grey, clayey silt.</i>									
								(2.80)		18											
19.20 - 20.70		100 0 0										Continued next sheet							20		
Flush Details				Borehole Diameter		Boring Progress				Remarks:											
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)											
5.20	6.00	Air mist	90	50.70	121	01/11	16:30	1.20		0.90											
6.00	7.50	Air mist	90			02/11	08:00	1.20		0.70											
7.50	9.00	Air mist	90			02/11	16:30	4.20	3.20	0.80											
9.00	10.20	Air mist	90			03/11	08:00	4.20	3.20	0.70											
10.20	11.70	Air mist	90								SPT Hammer: AR3408 Energy Ratio: 63%										
11.70	13.20	Air mist	90																		
13.20	14.70	Air mist	90																		
14.70	16.20	Air mist	90																		
Checked by:				MHW		IFA RC v01.01		Water Strikes				Monitoring Installations									
Log status:				FINAL				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)		
				50.70		139															

 IAN FARMER ASSOCIATES	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH042	
	Dates: 01/11/2022 - 15/11/2022		Client: Cadent				
Rotary Boring Log	Location: 364615.94E 370251.99N		Ground level: 37.59mOD	Logged by: FH/CE	Vertical scale: 1:50	Sheet 3 of 6 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
			20.10m - D27			Very stiff, fissured, locally very thinly bedded (10 to 15 degrees) reddish brown, locally mottled grey, silty CLAY, with up to 5 percent angular lithorelicts (up to 5mm) of extremely weak mudstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished, with black manganese staining (<1mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 19.90m and 20.30m: very closely spaced, off white gypsum veins (up to 20mm).</i>			
			20.70m - C28	17.09	20.50				
		0			(1.00)				
20.70 - 22.20	100 13 13		21.40m - D29	16.09	21.50	Very stiff, fissured, thickly laminated (10 to 15 degrees) light bluish grey, locally mottled reddish brown, clayey SILT, with up to 5 percent angular lithorelicts (up to 5mm) of extremely weak mudstone. Fissures are 0 to 30 degrees, very closely spaced, planar, smooth. Rare, off white, angular fragments (up to 5mm) of crystalline gypsum. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 20.70m and 20.90m: weak, light bluish grey siltstone.</i>			
		NA	22.10m - D30		(1.60)				
22.20 - 23.70	100 0 0		23.40m - D31	14.49	23.10	Very stiff, fissured, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 5mm) of extremely weak mudstone. Fissures are 35 to 50 degrees, closely spaced, planar, smooth, locally polished with black manganese staining (<1mm). Rare, angular fragments (up to 5mm) of light greyish white gypsum. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
		NA	24.00m - C32	13.89	23.70				
		12			(0.45)	Very stiff, fissured, locally thickly laminated (10 to 15 degrees) light bluish grey, clayey SILT, with up to 5 percent angular lithorelicts (up to 8mm) of very weak siltstone. Fissures are 0 to 40 degrees, very closely spaced, planar, smooth, locally polished with black manganese staining (<1mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
23.70 - 25.20	100 30 0		24.90m - D33	13.44	24.15				
		NA			(0.85)	Very weak, thinly bedded (10 to 20 degrees) light bluish grey SILSTONE. Discontinuities are 15 to 30 degrees, very closely spaced, planar, smooth, clean. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
		16	26.70m - D34	12.59	25.00				
25.20 - 26.70	100 19 0					Very stiff, fissured, thickly laminated (20 to 30 degrees) light bluish grey, locally mottled reddish brown, clayey SILT, with up to 20 percent angular lithorelicts (up to 30mm) of very weak siltstone. Fissures are 0 to 45 degrees, very closely spaced, planar, smooth, locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
		NA			(8.15)				
26.70 - 28.20	60 0 0					Very stiff, fissured, reddish brown, locally mottled light bluish grey, silty CLAY, with up to 5 percent angular lithorelicts (up to 8mm) of extremely weak mudstone and siltstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 25.50m and 25.78m: moderately weak, light bluish grey siltstone. Discontinuities are set 1: 15 to 30 degrees, very closely and closely spaced, planar, rough, clean. Set 2: 60 to 80 degrees, smooth, clean.</i>			
		AZCL							
28.20 - 29.70	100 0 0		28.70m - D35			<i>Between 27.60m and 28.20m: assessed zone of core loss, likely fissured silty clay.</i>			
		NA							
						Continued next sheet			

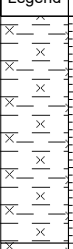
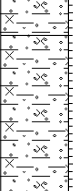
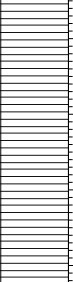
Flush Details				Borehole Diameter		Boring Progress					Remarks:				
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
16.20	17.70	Air mist	90			03/11	16:30	9.00	5.20	9.00					
17.70	19.20	Air mist	90			09/11	08:00	9.00	5.20	0.85					
19.20	20.70	Air mist	90			09/11	16:30	11.70	10.20	0.00					
20.78	22.70	Air mist	90			10/11	08:00	11.70	10.20	0.85					
22.20	23.70	Air mist	90									SPT Hammer: AR3408 Energy Ratio: 63%			
23.70	25.20	Air mist	90												
25.20	26.70	Air mist	90												
26.70	28.20	Air mist	90												
				Casing Diameter		Water Strikes					Monitoring Installations				
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by: MHW				IFA RC											
Log status: FINAL				V01.01											

 IAN FARMER ASSOCIATES	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH042	
	Dates: 01/11/2022 - 15/11/2022		Client: Cadent				
Rotary Boring Log	Location: 364615.94E 370251.99N		Ground level: 37.59mOD	Logged by: FH/CE	Vertical scale: 1:50	Sheet 4 of 6 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
29.70 - 31.20	100 0 0		30.50m - D36			Very stiff, fissured, reddish brown, locally mottled light bluish grey, silty CLAY, with up to 5 percent angular lithorelicts (up to 8mm) of extremely weak mudstone and siltstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
						Between 31.15m and 31.40m: very stiff, light bluish grey, clayey silt.			
31.20 - 32.70	33 0 0	AZCL	31.65m - D37			Between 31.70m and 32.70m: assessed zone of core loss, likely fissured silty clay.			
32.70 - 34.20	100 0 0		33.45m - D38	4.44	33.15	Very stiff, fissured, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 30mm) of extremely weak mudstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
34.20 - 35.70	100 0 0	NA	35.10m - D39		(2.55)				
35.70 - 37.20	100 100 100		36.26m - C40	1.89	35.70	Weak, thickly laminated (0 to 10 degrees) reddish brown, locally mottled light bluish grey SILTSTONE. Discontinuities are 30 to 50 degrees, widely spaced, planar, undulating, rough, clean. 80 to 90 degrees, very closely spaced, planar, rough, clean. (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
37.20 - 38.70	100 100 100	2	38.48m - C41		(3.25)	At 38.48m: very weak.			
						Between 38.70m and 38.80m: non intact, drilling disturbed, recovered as; angular, fine to coarse siltstone gravel.			
38.70 - 40.20	100 30 30	22	39.55m - D42	-1.36	38.95	Extremely weak to very weak, reddish brown MUDSTONE. Discontinuities are 0 to 90 degrees, extremely closely and very closely spaced, planar, smooth, tight, with soft, brown, clay infill (up to 0.25mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
				-2.41	40.00	Continued next sheet			

Flush Details				Borehole Diameter		Boring Progress					Remarks:			
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)				
28.20	29.70	Air mist	90			10/11	16:30	22.20	10.20	17.60	SPT Hammer: AR3408 Energy Ratio: 63%			
29.70	31.20	Air mist	90			11/11	08:00	22.20	10.20	1.85				
31.20	32.70	Air mist	90			11/11	16:30	31.20	11.00	20.00				
32.70	34.20	Air mist	90			14/11	08:00	31.20	11.00	0.00				
34.20	35.70	Air mist	90											
35.70	37.20	Air mist	90			Casing Diameter								
37.20	38.70	Air mist	90			Water Strikes								
38.70	40.20	Air mist	90			Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	
Checked by: MHW				IFA RC										
Log status: FINAL				v01.01										

	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH042	
	Dates: 01/11/2022 - 15/11/2022		Client: Cadent				
Rotary Boring Log	Location: 364615.94E 370251.99N		Ground level: 37.59mOD	Logged by: FH/CE	Vertical scale: 1:50	Sheet 5 of 6 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater		
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation	
40.20 - 41.70	100 0 0	NA	41.14m - D43	-3.91	(1.50)	Very stiff, fissured, reddish brown, locally mottled light bluish grey, silty CLAY. Fissures are 0 to 90 degrees, closely spaced, planar, smooth. (GRADE IVb) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		41		
41.70 - 43.20	100 5 0				(1.25)	Very stiff, fissured, light bluish grey, silty CLAY, with up to 10 percent angular lithorelicts (up to 5mm) of very weak siltstone. Fissures are 30 to 50 degrees, medium spaced, planar, smooth, locally polished. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 42.20m and 42.25m: moderately weak, light bluish grey siltstone.</i> <i>Between 42.40m and 42.43m: moderately weak, light bluish grey siltstone.</i>				42
43.20 - 44.70	100 0 0				(0.90)	Very stiff, fissured, reddish brown, silty CLAY, with up to 25 percent angular lithorelicts (up to 30mm) of very weak mudstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				43
44.70 - 46.20	100 0 0				(2.50)	Very stiff, reddish brown, locally mottled light bluish grey, silty CLAY, with up to 5 percent angular lithorelicts (up to 8mm) of very weak mudstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 45.50m and 45.70m: frequent, extremely closely spaced, thick laminations of off white, fibrous gypsum.</i>				44 45 46
46.20 - 47.70	100 0 0				(1.05)	Very stiff, reddish brown, silty CLAY, with up to 70 percent angular lithorelicts (up to 30mm) of very weak and weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				47
47.70 - 49.20	100 0 0	25	47.80m - D49	-9.61	(2.20)	Very weak, thickly laminated (0 to 15 degrees) reddish brown MUDSTONE. Discontinuities are 0 to 90 degrees, extremely closely and very closely spaced, planar, smooth, clean. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 48.70m and 48.90m: occasional, light greenish grey reduction spots (up to 10mm).</i>		48 49		
49.20 - 50.70	100 87 87				(2.20)	Weak, thinly to thickly laminated (5 to 15 degrees) light bluish grey, locally mottled reddish brown SILTSTONE, with frequent (0 to 5 degree) off white gypsum veins (up to 30mm). Discontinuities are 20 to 40 degrees, widely spaced, planar, smooth, clean, with				50
Continued next sheet										

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
40.20	41.70	Air mist	90			14/11	16:30	37.20	14.00	24.00	
41.70	43.20	Air mist	90			15/11	08:00	37.20	14.00	4.40	
43.20	44.70	Air mist	90			15/11	16:30	50.70	14.00	24.50	
44.70	46.20	Air mist	90			16/11	08:00	50.70	14.00	17.70	
46.20	47.70	Air mist	90								
47.70	49.20	Air mist	90								
49.20	50.70	Air mist	90								

Checked by:		MHW	IFA RC
Log status:		FINAL	v01.01

[illegible]

Plant used: Dando 2000/Comacchio 205	Project: HyNet North West - Hydrogen Pipeline			Location ID: BH096
Dates: 12/10/2022 - 18/10/2022	Client: Cadent			
Location: 369343.97E 383993.98N	Ground level: 71.53mOD	Logged by: JJ/AE	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 2230746

		Plant used: Dando 2000/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH097	
		Dates: 17/10/2022 - 25/10/2022		Client: Cadent				
Cable Percussion and Rotary Boring Log		Location: 369365.95E 384035.95N		Ground level: 72.42mOD	Logged by: JJ/TW	Vertical scale: 1:50	Sheet 1 of 2 Project ID: 2230746	

Samples & In Situ Testing			Strata Details				Groundwater			
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation		
0.00 - 0.30 0.20	B1 D2		72.02	(0.40)	Dark brown, slightly gravelly, silty, fine to coarse SAND with frequent roots and rootlets (<2mm). Gravel is angular to subangular and subrounded, fine to coarse including sandstone and quartz.					
0.50 - 1.00	B3			0.40	TOPSOIL					
0.80	D4			(0.60)	Reddish brown, gravelly, fine to coarse SAND. Gravel is angular to subangular and subrounded, fine to coarse including sandstone, quartz and flint.					
1.50	D6 B5	SPT(S) 50 (4,10/50 for 125mm)	71.42	1.00	GLACIOFLUVIAL DEPOSITS		1			
1.50 - 1.78					(1.30)				Very dense, reddish brown, gravelly, clayey, very silty fine to coarse SAND locally becoming, slightly gravelly, sandy silt. Gravel is angular to subangular, fine and medium including sandstone and siltstone. (Grade IVb) [BOLLIN MUDSTONE MEMBER]	
1.50 - 2.00										MERCIA MUDSTONE GROUP
2.30		SPT(S) 50 (25 for 50mm/50 for 70mm)	70.12	2.30	Very dense, reddish brown, sandy GRAVEL. Gravel is angular and subangular, fine to coarse, including sandstone lithorelicts. (Grade III)[BOLLIN MUDSTONE MEMBER]		2			
2.30 - 2.42				D7					2.50	
2.50 - 4.00				100 100 100					0	69.92
			69.07	3.35	Weak, thickly laminated (0 to 5 degrees) reddish brown, locally mottled light bluish grey, slightly micaceous SILTSTONE. (GRADE I) [BOLLIN MUDSTONE MEMBER]					
				(0.50)	MERCIA MUDSTONE GROUP					
4.00 - 5.50	100 100 100	5.20m - C8		68.57	Between 3.20m and 3.23m: non intact, drilling disturbed.		4			
					68.57				3.85	Very weak to weak, thickly laminated (0 to 5 degrees) reddish brown, locally mottled light bluish grey, fine grained, slightly micaceous SANDSTONE. (GRADE I) [BOLLIN MUDSTONE MEMBER]
									MERCIA MUDSTONE GROUP	
5.50 - 7.00	100 100 100	1		(4.65)	Weak, thickly laminated to very thinly bedded (0 to 5 degrees) reddish brown, locally mottled light bluish grey, fine grained, slightly micaceous SANDSTONE and SILTSTONE, with occasional light bluish grey reduction spots (up to 5mm). Discontinuities are 3 to 5 degrees, widely spaced, planar locally undulating, slightly rough, clean with localised black staining (<2mm). (GRADE I) [BOLLIN MUDSTONE MEMBER]		5			
7.00 - 8.50	100 100 100	7.17m - C9			Between 6.85m and 7.10m: weak, light bluish grey, slightly micaceous siltstone.		6			
8.50 - 10.00	100 100 100			8.50	Weak, thickly laminated (0 to 5 degrees) reddish brown, slightly micaceous SILTSTONE with occasional light bluish grey reduction spots (up to 5mm). Discontinuities are: 3 to 5 degrees, widely spaced, planar and undulating, slightly rough, clean with localised black staining (<2mm). (GRADE I) [BOLLIN MUDSTONE MEMBER]		7			
					Between 7.74m and 7.77m: non intact, drilling disturbed.		8			
					Weak, thickly laminated (0 to 5 degrees) reddish brown, slightly micaceous SILTSTONE with occasional light bluish grey reduction spots (up to 5mm). Discontinuities are: 3 to 5 degrees, widely spaced, planar and undulating, slightly rough, clean with localised black staining (<2mm). (GRADE I) [BOLLIN MUDSTONE MEMBER]		9			
					Between 8.50m and 8.57m: non intact, drilling disturbed.		10			

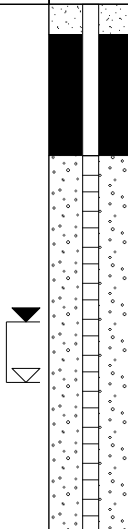
Continued next sheet

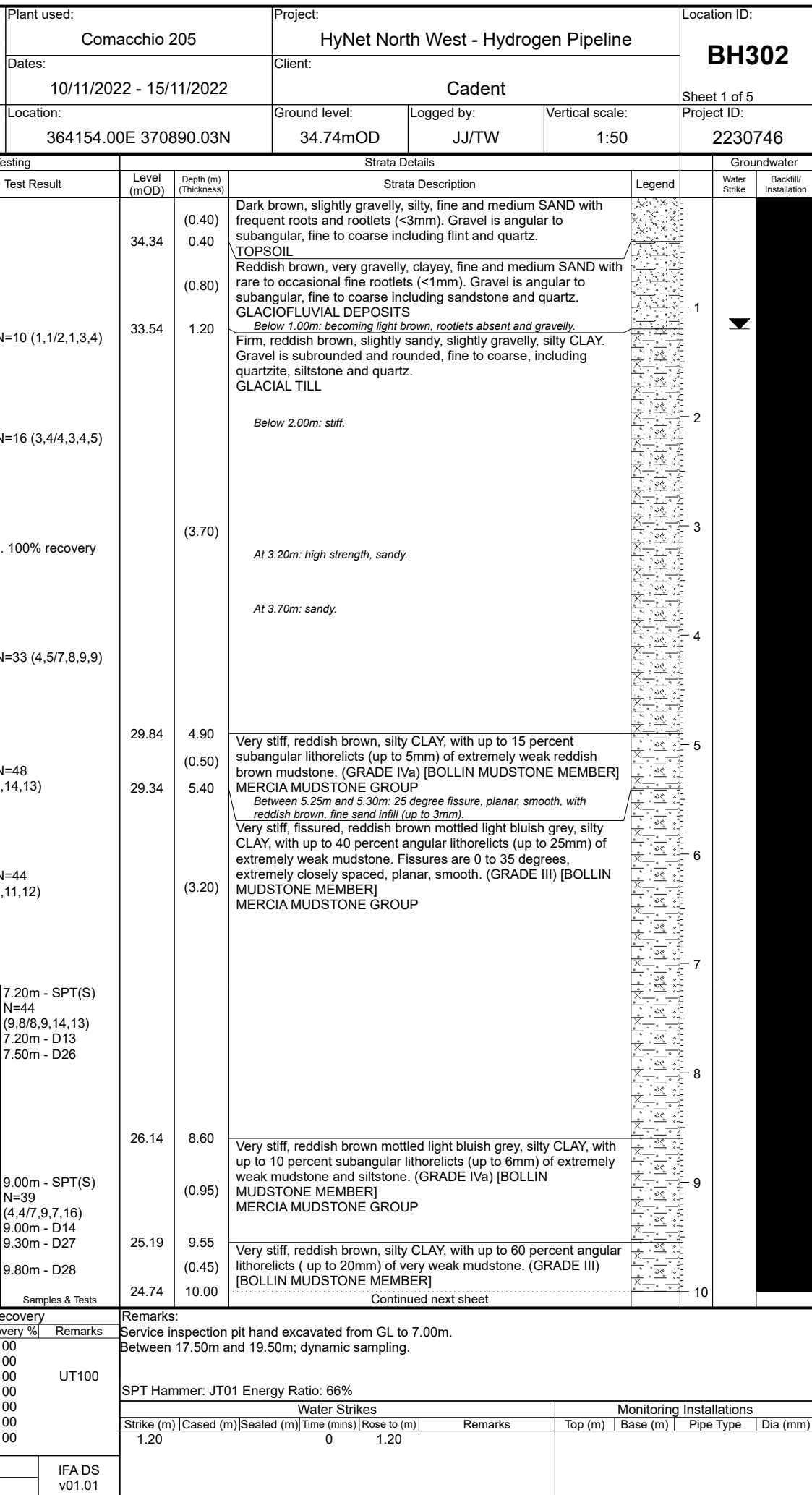
Chiselling			Borehole Diameter		Boring Progress				Remarks:	
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)
1.80	2.30	60		11.50	121	17/10	16:30	2.50		
						21/10	08:00	2.50	2.50	
						21/10	16:30	8.50	2.50	
						24/10	08:00	8.50	2.50	
										SPT Hammer: JT01 Energy Ratio: 66%
Casing Diameter			Water Strikes		Monitoring Installations					
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type
2.50	150									
11.50	139									
Checked by:			MHW	IFA CP						
Log status:			FINAL	v01.01						

[illegible]

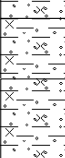
Plant used: Dando 2000	Project: HyNet North West - Hydrogen Pipeline			Location ID: BH106
Dates: 29/09/2022	Client: Cadent			
Location: 372281.03E 388603.95N	Ground level: 23.43mOD	Logged by: TB	Vertical scale: 1:50	Sheet 1 of 2 Project ID: 2230746

[illegible]

 IAN FARMER ASSOCIATES				Plant used: Dando 2000		Project: HyNet North West - Hydrogen Pipeline				Location ID: BH114															
				Dates: 29/09/2022		Client: Cadent																			
Cable Percussion Borehole Log				Location: 372153.01E 388551.97N		Ground level: 25.20mOD		Logged by: FH		Vertical scale: 1:50		Sheet 1 of 1 Project ID: 2230746													
Samples & In Situ Testing												Strata Details												Groundwater	
Depth		Sample ID		Test Result		Level (mOD)		Depth (m) (Thickness)		Strata Description				Legend				Water Strike		Backfill/ Installation					
0.00 - 0.40 0.20		B1 D2				24.80		(0.40)		Dark greyish brown, very silty, fine SAND with rare gravel. Gravel is subrounded to rounded, fine and medium including sandstone. TOPSOIL						1									
0.50 0.50 - 1.00		ES3 B4 D5						(2.60)		Brownish orange, slightly silty, fine SAND. SHIRLEY HILL SAND FORMATION															
1.00		ES6						At 1.20m: medium dense.																	
1.50 1.50 - 1.95		D7						Below 2.00m: loose.																	
1.80 - 2.20		B8																							
2.00 2.00		ES9		SPT(S) N=8 (2,2/2,2,2,2)						2															
2.00 - 2.45		D10								3															
3.00 3.00 - 3.45		D11		SPT(S) N=7 (1,3/2,2,1,2)		22.20		3.00		Loose, brown, very silty, fine SAND. ALLUVIUM						3									
						21.70		3.50		Firm, brown, silty CLAY with frequent bands of brown, fine sand. ALLUVIUM						4									
3.80 4.00		D12		SPT(S) N=8 (2,2/2,2,2,2)												4									
4.00 - 4.45 4.00 - 4.50		D14 B13														5									
4.80 5.00		D15 U		82 blows. No recovery												5									
5.00 - 5.50		B16														6									
5.80 6.00		D17 D18		SPT(S) N=16 (2,3/3,4,4,5)												6									
6.00 - 6.45																7									
6.80 7.00		D19 U		49 blows. No recovery				(6.50)								7									
7.00 - 7.50		B20														8									
7.80 8.20		D21 D22		SPT(S) N=16 (2,3/3,4,4,5)												8									
8.20 - 8.65																9									
8.80 9.50		D23 D24		SPT(S) N=17 (2,4/4,4,4,5)												9									
9.50						15.20		10.00		End of Borehole at 10.00m						10									
Chiselling				Borehole Diameter		Boring Progress				Remarks:															
From (m)		To (m)		Time (mins)		Remarks		Depth (m)		Dia (mm)		Date		Time		Depth (m)		Cased (m)		Water (m)		Service inspection pit hand excavated from GL to 1.20m.			
								10.00		150		29/09		14:00		10.00		9.50				SPT Hammer: LSI2 Energy Ratio: 62%			
				Casing Diameter		Water Strikes				Monitoring Installations															
Depth (m)		Dia (mm)		Strike (m)		Cased (m)		Sealed (m)		Time (mins)		Rose to (m)		Remarks		Top (m)		Base (m)		Pipe Type		Dia (mm)			
9.50		150		2.50		1.50		2.60		20		2.10				0.00		1.00		Plain		50			
																1.00		3.50		Slotted		50			
Checked by:				MHW		IFA CP																			
Log status:				FINAL		v01.01																			



	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH302	
	Dates: 10/11/2022 - 15/11/2022		Client: Cadent				
Rotary Boring Log	Location: 364154.00E 370890.03N		Ground level: 34.74mOD	Logged by: JJ/TW	Vertical scale: 1:50	Sheet 2 of 5 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
10.00 - 11.50	0 0 0	AZCL	11.50m - SPT(S) N=22 (4,3/4,7,5,6) 11.50m - D15			Very stiff, reddish brown, silty CLAY, with up to 60 percent angular lithorelicts (up to 20mm) of very weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Stiff, fissured, reddish brown mottled light bluish grey, silty CLAY, with up to 15 percent angular lithorelicts (up to 15mm) of extremely weak siltstone and mudstone. Fissures are 10 to 45 degrees, extremely closely spaced, planar, smooth and locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 10.00m and 11.65m: assessed zone of core loss, likely clay.</i>			
11.50 - 12.50	85 0 0	NA	12.10m - D29		(4.10)				
12.50 - 13.50	50 0 0		12.50m - SPT(S) N=42 (8,7/8,9,13,12) 12.50m - D16						
13.50 - 14.50	60 0 0	AZCL	13.50m - SPT(S) N=42 (7,6/8,12,9,13) 13.50m - D17						
14.50 - 15.50	100 0 0	NA	14.20m - D30 14.50m - SPT(S) N=42 (3,6/6,12,13,11) 14.50m - D18 14.90m - D31	20.64 20.24	14.10 (0.40) 14.50	Very stiff, thinly laminated (0 to 35 degrees) reddish brown, locally mottled light bluish grey, silty CLAY, with up to 10 percent subrounded lithorelicts (up to 10mm) of extremely weak mudstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 5mm) of extremely weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
15.50 - 16.50	10 0 0			19.14	15.60	Assessed zone of core loss. Soft silty ground, barrel dropped through soft silty ground to 17.50m (drillers description). MERCIA MUDSTONE GROUP			
16.50 - 17.50	0 0 0	AZCL			(2.15)				
17.50 - 18.50	75 0 0		17.50m - SPT(S) N=18 (1,3/5,4,4,5) 17.50m - D19 18.20m - D32	16.99	17.75	Very stiff, fissured, reddish brown locally mottled light bluish grey, silty CLAY, with up to 10 percent subangular lithorelicts (up to 5mm) of extremely weak mudstone. Fissures are 15 to 20 degrees, very closely spaced, planar, smooth, locally polished and striated. Occasional 0 to 90 degree, off white, gypsum veins (up to 2mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 17.75m and 19.50m: drilling disturbed, recovered as very soft.</i>			
18.50 - 19.50	100 0 0		18.50m - SPT(S) N=30 (5,7/6,6,7,11) 18.50m - D20 18.70m - D33						
			19.50m - SPT(S) N=46 (12,12/10,12,14,10) 19.50m - D21						
Continued next sheet									

Flush Details				Borehole Diameter		Boring Progress					Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)						
				45.00	121	10/11	16:30	8.20	7.20	Dry	SPT Hammer: JT01 Energy Ratio: 66%					
						11/11	08:00	8.20	8.20	Dry						
						11/11	16:30	21.00	19.50	19.40						
						14/11	08:00	21.00	19.50	17.90						
				Casing Diameter		Water Strikes					Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)	
				21.00	139											

Checked by:	MHW	IFA RC
Log status:	FINAL	v01.01

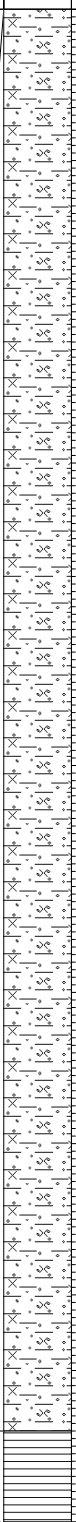
	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH302	
	Dates: 10/11/2022 - 15/11/2022		Client: Cadent				
Rotary Boring Log	Location: 364154.00E 370890.03N		Ground level: 34.74mOD	Logged by: JJ/TW	Vertical scale: 1:50	Sheet 3 of 5 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
19.50 - 21.00	100 0 0	NA	20.10m - D34		(7.45)	Very stiff, fissured, reddish brown locally mottled light bluish grey, silty CLAY, with up to 10 percent subangular lithorelicts (up to 5mm) of extremely weak mudstone. Fissures are 15 to 20 degrees, very closely spaced, planar, smooth, locally polished and striated. Occasional 0 to 90 degree, off white, gypsum veins (up to 2mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
21.00 - 22.50	100 0 0		22.25m - D35						
22.50 - 24.00	100 0 0		22.95m - D36						
24.00 - 25.50	100 30 30		24.75m - D37						
		1	25.20m - C45	9.54	25.20 (0.40)	Very weak, thinly laminated (0 to 5 degrees) reddish brown locally mottled light bluish grey SILTSTONE, with occasional, 0 to 90 degree, off white, gypsum veins (up to 4mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 25.50m and 25.60m: 40 degree joint, planar, smooth with localised black staining (<1mm).</i>			
		NA		9.14	25.60 (0.70)				
25.50 - 27.00	100 10 10	5	26.70m - D38	8.44	26.30 (1.25)				
27.00 - 28.00	100 0 0	NA	27.70m - D39	7.19	27.55 (0.30)	Very stiff, thinly laminated (0 to 5 degrees) reddish brown and light bluish grey, silty CLAY, with up to 30 percent subangular lithorelicts (up to 30mm) of extremely weak mudstone and siltstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 26.82m and 26.88m: very weak, thinly laminated (0 to 5 degrees) reddish brown mottled light bluish grey siltstone.</i>			
28.00 - 29.50	100 0 0		28.45m - D40	6.89	27.85 (2.15)				
				4.74	30.00	Continued next sheet			

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)			Water (m)			
						15/11	08:00	35.50	21.00	13.10	SPT Hammer: JT01 Energy Ratio: 66%				
						15/11	16:30	45.00	21.00	42.30					
				Casing Diameter		Water Strikes					Monitoring Installations				
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	MHW	IFA RC
Log status:	FINAL	v01.01

	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH302	
	Dates: 10/11/2022 - 15/11/2022		Client: Cadent				
Rotary Boring Log	Location: 364154.00E 370890.03N		Ground level: 34.74mOD	Logged by: JJ/TW	Vertical scale: 1:50	Sheet 4 of 5 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater		
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation	
29.50 - 31.00	100 0 0		30.45m - D41			Very stiff, reddish brown locally mottled light bluish grey, silty CLAY, with up to 15 percent subangular lithorelicts (up to 10mm) of extremely weak mudstone and siltstone. Occasional 0 to 90 degree, off white, gypsum veins (2mm). (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, thinly to thickly laminated (5 to 10 degrees) reddish brown locally mottled light bluish grey, silty CLAY, with up to 50 percent subangular lithorelicts (up to 40mm) of very weak mudstone and siltstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 31.30m and 31.39m: very weak, thickly laminated (25 to 30 degrees) light bluish grey siltstone.</i> <i>Between 31.48m and 31.64m: moderately weak, thickly laminated (5 degrees) light bluish grey mottled reddish brown siltstone.</i> <i>Between 32.30m and 32.35m: very weak, light bluish grey siltstone.</i> <i>34.67m and 34.72m: very weak, thinly laminated (10 degrees) light bluish grey siltstone.</i> <i>Between 35.70m and 35.85m: weak, light bluish grey siltstone, with 45 degree, extremely closely spaced, off white, gypsum veins (1mm).</i>				
31.00 - 32.50	100 18 11	0	31.48m - C46							31
32.50 - 34.00	100 0 0	NA	33.55m - D42							32
34.00 - 35.50	100 3 0		35.30m - D43	(9.40)						33
35.50 - 37.00	100 10 10	0	35.70m - C47							34
37.00 - 38.50	100 0 0	NA								35
38.50 - 40.00	100 40 40	0	39.40m - C48	-4.66	39.40					36
						Continued next sheet	37			
							38			
							39			
							40			

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)			Water (m)			
										SPT Hammer: JT01 Energy Ratio: 66%					
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		MHW	IFA RC												
Log status:		FINAL	v01.01												

[illegible]

 IAN FARMER ASSOCIATES	Plant used: Comachio 205/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH303			
	Dates: 31/10/2022 - 07/11/2022		Client: Cadent			Sheet 1 of 5			
Dynamic Sampling and Rotary Boring Log	Location: 364377.59E 370646.22N		Ground level: 38.57mOD	Logged by: JJ/TW	Vertical scale: 1:50	Project ID: 2230746			
Samples & In Situ Testing			Strata Details				Groundwater		
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.10 - 0.30	B1	SPT(S) N=19 (2,2/3,4,6,6)	38.17	(0.40)	Dark brown, slightly gravelly, silty, fine to coarse SAND. Gravel is angular to subrounded, fine and medium including sandstone, quartz and flint.				
0.20 - 0.30	D2			0.40	TOPSOIL				
0.50 - 0.60	D4			(0.80)	Firm, brown, locally mottled orange brown and light grey, slightly sandy, silty CLAY with occasional gravel. Gravel is subangular to subrounded, fine and medium including sandstone.				
0.50 - 1.00	B3				GLACIAL TILL				
1.00 - 1.10	D5				Medium dense, light orangish brown, fine SAND, with occasional pockets (up to 50mm) of soft, brown, silty clay.				
1.20	D7	SPT(S) N=19 (4,6/5,4,4,6)	37.37	(0.30)	GLACIAL TILL				
1.20 - 1.65	B6			1.50	Medium dense, light brown, fine and medium SAND.				
1.20 - 2.00				(0.70)	GLACIAL TILL				
2.20					Stiff, brown, slightly sandy, slightly gravelly CLAY. Gravel is subrounded, fine and medium, including quartzite.				
2.20 - 2.25	D8			(0.30)	GLACIAL TILL				
2.20 - 2.65	D9	SPT(S) N=22 (3,3/4,7,6,5)	36.37	2.50	Medium dense, light brown and greyish brown, locally mottled orangish brown, medium SAND.				
					GLACIAL TILL				
3.20				(1.70)	Between 2.50m and 2.60m: occasional pockets (up to 40mm) of firm, dark brown, silty clay.				
3.20 - 3.65	D11								
3.20 - 4.20	B10								
4.20		SPT(S) N=30 (4,6/5,7,8,10)	34.37	4.20	Very stiff, brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is subrounded, fine and medium, including quartzite and microgranite.				
4.20 - 4.65	D12			(0.30)	GLACIAL TILL				
4.40 - 4.50	D13			4.50	Stiff, brown, slightly sandy CLAY.				
				(0.70)	GLACIAL TILL				
5.20					Medium dense, orangish brown, slightly gravelly, slightly clayey, fine SAND with pockets of clay. Gravel is subrounded, fine and medium, including quartzite, quartz and granite.				
5.20 - 5.65	D14	SPT(S) N=17 (3,4/4,3,5,5)	33.37	5.20	GLACIAL TILL				
5.40 - 6.40	B15			(1.60)	Between 6.00m and 6.20m: firm, brown, slightly gravelly, silty clay. Gravel is subrounded, fine and medium including quartzite and granite. Below 6.20m: medium dense to dense.				
6.20					Between 6.70m and 6.80m: firm, brown, slightly gravelly, silty clay. Gravel is subrounded, fine and medium, including quartzite and quartz.				
6.20 - 6.65	D16			6.80	Greyish brown, silty, fine SAND.				
				(0.40)	GLACIAL TILL				
7.20		SPT(S) N=27 (3,3/4,6,7,10)	31.37	7.20	Very stiff, greyish brown, slightly sandy, gravelly, silty CLAY. Gravel is subangular to subrounded, fine to coarse, including quartzite, quartz and granite.				
7.20 - 7.65	D17			(1.70)	GLACIAL TILL				
7.45 - 7.50	D18								
8.00									
8.00 - 8.45	D19								
8.40 - 8.45	D20	SPT(S) N=43 (7,9/9,10,12,12)	29.67	8.90	Assessed zone of core loss, likely to be slightly sandy, gravelly, silty CLAY.				
8.50 - 9.50	40 0 0			(1.95)	GLACIAL TILL				
		SPT(S) N=50 (6,9/50 for 170mm)							
TCR/SCR/ROD			FI	Samples & Tests					
Dynamic Sample Recovery			Remarks:						
Top (m)	Base (m)	Dia (mm)	Recovery %	Service inspection pit hand excavated from GL to 1.20m.					
1.20	2.20		100						
2.20	3.20		100						
3.20	4.20		100						
4.20	5.20		100						
5.20	6.20		80						
6.20	7.20		100						
7.20	8.00		88						
Checked by:			MHW	IFA DS					
Log status:			FINAL	v01.01					
				SPT Hammer: JT01 Energy Ratio: 66%					
				Water Strikes					
				Monitoring Installations					
				Strike (m) Cased (m) Sealed (m) Time (mins) Rose to (m) Remarks Top (m) Base (m) Pipe Type Dia (mm)					
				4.20 3.00 4.20 20 3.00 Slow					

 IAN FARMER ASSOCIATES	Plant used: Comachio 205/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline		Location ID: BH303
	Dates: 31/10/2022 - 07/11/2022		Client: Cadent		
Rotary Boring Log	Location: 364377.59E 370646.22N		Ground level: 38.57mOD	Logged by: JJ/TW	Vertical scale: 1:50
			Sheet 2 of 5 Project ID: 2230746		

Coring, Samples & In Situ Testing				Strata Details				Groundwater			
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation		
9.50 - 10.50	0 0 0		10.50m - SPT(S) N=33 (6,7/4,6,10,13) 10.50m - D23	27.72	10.85 (1.35)	Assessed zone of core loss, likely to be slightly sandy, gravelly, silty CLAY. GLACIAL TILL					
10.50 - 11.50	65 0 0					Very stiff, fissured, reddish brown, locally mottled light bluish grey, silty CLAY, with up to 20 percent angular lithorelicts (up to 5mm) of extremely weak mudstone and siltstone. Fissures are 15 to 25 degrees, extremely closely spaced, planar, smooth. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP					
11.50 - 13.00	100 0 0		11.80m - D24	26.37	12.20	Very stiff, fissured, reddish brown and light bluish grey CLAY, with up to 65 percent angular lithorelicts (up to 12mm) of very weak mudstone and siltstone. Fissures are 15 to 25 degrees, very closely spaced, planar, smooth, with rare, light orangish brown silt infill (up to 1mm). (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP					
13.00 - 14.50	100 0 0	NA	13.30m - D25			(2.30)	Between 12.57m and 12.72m: 65 degree fissure, planar, smooth, with localised yellowish brown staining (<1mm) Between 13.00m and 13.08m: extremely weak, thinly laminated (0 to 5mm) reddish brown and light bluish grey siltstone.				
14.50 - 16.00	66 0 0		14.50m - D26	24.07	14.50 (0.75)		Very stiff, fissured, light bluish grey, locally mottled reddish brown CLAY, with up to 35 percent angular lithorelicts (up to 8mm) of very weak siltstone. Fissures are 20 to 35 degrees, extremely closely to very closely spaced, planar, smooth, locally polished. Frequent, 0 to 90 degree, off white, gypsum veins (up to 20mm). (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				
16.00 - 17.50	100 73 73	AZCL	15.25m - D27	23.32	15.25	Very stiff, fissured, reddish brown CLAY, with up to 20 percent angular lithorelicts (up to 3mm) of extremely weak mudstone. Fissures are 5 to 30 degrees, very closely spaced, planar, smooth. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP					
				23.07	15.50 (0.50)	Very weak, thinly laminated (10 to 15 degrees) reddish brown, locally mottled light bluish grey MUDSTONE, with very closely spaced, off white, gypsum veins (up to 8mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP					
		1	16.20m - C28		22.57	16.00 (0.60)	Assessed zone of core loss. Possible clay/mudstone. MERCIA MUDSTONE GROUP				
17.50 - 19.00	100 40 40	NA	16.80m - D29	21.97	16.60 (0.40)	Very weak, thinly laminated (0 to 15 degrees) light bluish grey, locally mottled reddish brown SILTSTONE. (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP					
		1	17.40m - C30		21.57	17.00 (0.60)	Between 16.30m and 16.34m: 30 degree fracture, planar, slightly rough, clean.				
19.00 - 20.50	0 0 0	NA	17.80m - D31	20.97	17.60 (1.40)	Very stiff, fissured, reddish brown, locally mottled light bluish grey CLAY, with up to 20 percent subangular lithorelicts (up to 10mm) of extremely weak mudstone. Fissures are 5 to 25 degrees, very closely spaced, planar, smooth. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP					
					19.57	19.00	Between 17.00m and 17.30m: 65 degree joint, planar, smooth, locally polished, clean, localised orangish brown staining (<1mm) Very stiff, reddish brown, silty CLAY, with up to 40 percent subangular lithorelicts (up to 15mm) of extremely weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				
Continued next sheet											

Flush Details				Borehole Diameter		Boring Progress				Remarks:				
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)		Water (m)			
				40.00	121	31/10	16:30	7.20	7.20	6.10				
						01/11	08:00	7.20	7.20	6.50				
						01/11	16:30	16.00	13.00	14.10				
						02/11	08:00	16.00	13.00	Dry				
SPT Hammer: JT01 Energy Ratio: 66%														
				Casing Diameter		Water Strikes				Monitoring Installations				
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
				21.60	139									
Checked by:		MHW		IFA RC										
Log status:		FINAL		v01.01										



IAN FARMER ASSOCIATES

Plant used:

Comachio 205/Comacchio 205

Project:

HyNet North West - Hydrogen Pipeline

Location ID:

BH303

Dates:

31/10/2022 - 07/11/2022

Client:

Cadent

Sheet 3 of 5

Rotary Boring Log

Location:

364377.59E 370646.22N

Ground level:

38.57mOD

Logged by:

JJ/TW

Vertical scale:

1:50

Project ID:

2230746

Coring, Samples & In Situ Testing

Depth

TCR/SCR/ROD

FI

Samples & Test Result

Level (mOD)

Depth (m) (Thickness)

Strata Details

Strata Description

Legend

Groundwater

Water Strike

Backfill/Installation

20.50 - 21.60

000

AZCL

(2.60)

Zone of no recovery. Driller notes soft silt or void. After coring to 20.50m, barrel dropped by its own weight to 21.60m.

21

21.60 - 23.10

10000

21.60m - SPT(S) N=34 (2,4/6,7,6,15)

21.60m - D32

21.80m - D33

16.97

21.60

Very stiff, fissured, light bluish grey, locally mottled reddish brown, silty CLAY, with up to 25 percent subangular lithorelicts (up to 10mm) of extremely weak siltstone. Fissures are 5 to 25 degrees, very closely spaced, planar, smooth. Occasional off white gypsum veins (up to 2mm). (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP

Between 22.75m and 22.90m: 55 degree fissure, undulating, smooth.

Between 23.07m and 23.60m: very soft, light bluish grey clay. Likely drilling disturbed.

22

23.10 - 24.60

10000

NA

23.20m - D34

14.97

23.60

Very stiff, fissured, reddish brown mottled light bluish grey CLAY, with up to 35 percent subangular lithorelicts (up to 10mm) of extremely weak mudstone. Fissures are 10 to 35 degrees, very closely spaced, planar, smooth. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP

24

24.60 - 26.10

1001710

0

24.80m - D36

(4.20)

Between 24.70m and 24.76m: very weak, thinly laminated (10 degrees) light bluish grey and reddish brown siltstone, with frequent, off white gypsum veins (up to 2mm).

Between 25.15m and 25.30m: very weak, thinly laminated (15 degrees) reddish brown and light bluish grey siltstone, with frequent, off white gypsum veins (up to 2mm).

Between 25.43m and 25.47m: very weak, thinly laminated (15 degrees) reddish brown and light bluish grey siltstone, with frequent, off white gypsum veins (up to 4mm).

25

26.10 - 27.60

10050

26.50m - D37

Between 27.02m and 27.10m: very weak, thinly laminated (15 degrees) reddish brown and bluish grey siltstone, with frequent, 0 to 90 degree, off white gypsum veins (up to 10mm).

27

27.60 - 29.10

10090

NA

28.00m - D38

10.77

27.80

Between 27.68m and 27.74m: very weak, thinly laminated (15 degrees) reddish brown and light bluish grey siltstone.

Very stiff, thinly laminated (0 to 15 degrees) reddish brown mottled light bluish grey CLAY, with up to 40 percent subangular lithorelicts (up to 15mm) of very weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP

28

29.10 - 30.60

10040

28.80m - D39

(3.20)

Between 28.70m and 28.78m: very weak, reddish brown siltstone.

29

30.00m - D40

30

Continued next sheet

Flush Details

Top (m)

Base (m)

Flush Type

Flush Return %

Borehole Diameter

Depth (m)

Dia (mm)

Boring Progress

Date

Time

Depth (m)

Cased (m)

Water (m)

Remarks:

SPT Hammer: JT01 Energy Ratio: 66%

Casing Diameter

Depth (m)

Dia (mm)

Water Strikes

Strike (m)

Cased (m)

Sealed (m)

Time (mins)

Rose to (m)

Monitoring Installations

Top (m)

Base (m)

Pipe Type

Dia (mm)

Checked by:

MHW

IFA RC v01.01

Log status:

FINAL

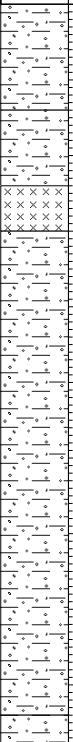
 IAN FARMER ASSOCIATES	Plant used: Comachio 205/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH303	
	Dates: 31/10/2022 - 07/11/2022		Client: Cadent				
Rotary Boring Log	Location: 364377.59E 370646.22N		Ground level: 38.57mOD	Logged by: JJ/TW	Vertical scale: 1:50	Sheet 4 of 5 Project ID: 2230746	

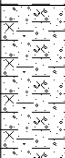
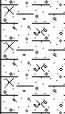
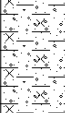
Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
			30.40m - D41			Very stiff, thinly laminated (0 to 15 degrees) reddish brown mottled light bluish grey CLAY, with up to 40 percent subangular lithorelicts (up to 15mm) of very weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 31.60m and 31.00m: assessed zone of core loss, likely clay.</i>			
30.60 - 31.00	0	AZCL		7.57	31.00				
		0		7.37	31.20	Weak, thinly laminated (0 to 15 degrees) reddish brown, locally mottled light bluish grey SILTSTONE. (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Assessed zone of core loss, possible clay. MERCIA MUDSTONE GROUP			
31.00 - 32.50	13 13 13	AZCL			(2.00)				
			32.50m - SPT(S) 50 (6,6/50 for 240mm)						
32.50 - 33.50	20 0 0			5.37	33.20	Very stiff, fissured, light bluish grey, locally mottled reddish brown CLAY, with up to 40 percent subangular lithorelicts (up to 8mm) of extremely weak siltstone and mudstone. Fissures are 15 to 30 degrees, very closely spaced, planar, smooth. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 34.00m and 34.65m: assessed zone of core loss, likely clay.</i>			
		NA	33.40m - D42 33.50m - SPT(S) 50 (25 for 75mm/50 for 125mm)		(1.45)				
33.50 - 34.50	80 20 20	AZCL	33.50m - D43						
		0	34.50m - SPT(S) 50 (25 for 45mm/50 for 50mm)	3.92	34.65	Very stiff, fissured, reddish brown, silty CLAY, with up to 35 percent subangular lithorelicts (up to 20mm) of extremely weak mudstone. Fissures are 20 to 30 degrees, very closely spaced, planar, smooth. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 34.70m and 34.90m: very weak, thinly laminated (15 degrees) light bluish grey locally mottled reddish brown siltstone.</i>			
34.50 - 35.50	80 20 20	NA	34.50m - D44 34.70m - C45 35.10m - D46		(0.95)				
		0	35.70m - C47	2.97	35.60 (0.30)	Weak, very weak diametrically, thinly laminated (20 to 40 degrees) light bluish grey SILTSTONE, with frequent, off white gypsum veins (up to 5mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 35.82m and 35.90m: non intact, drilling disturbed.</i>			
35.50 - 36.50	100 30 30	NA	36.00m - D48	2.67	35.90				
		0	36.70m - C49	1.87	36.70	Very stiff, fissured, light bluish grey CLAY, with up to 40 percent angular lithorelicts (up to 10mm) of extremely weak siltstone. Fissures are 45 degrees, very closely spaced, planar, smooth. Frequent, off white gypsum veins (up to 5mm). (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
36.50 - 38.00	100 30 30		37.50m - D50	1.42	37.15	Very weak, thinly laminated (20 to 40 degrees) light bluish grey, locally mottled reddish brown SILTSTONE, with frequent, 45 degree, off white gypsum veins (up to 5mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 36.85m and 36.94m: non intact, drilling disturbed.</i>			
		NA	38.50m - D51	0.47	38.10	Very stiff, fissured, light bluish grey mottled reddish brown CLAY, with up to 50 percent angular lithorelicts (up to 25mm) of very weak siltstone. Fissures are 45 degrees, very closely spaced, planar, smooth. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
38.00 - 39.00	100 0 0				(2.60)	Very stiff, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 15mm) of extremely weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 39.35m and 39.50m: moderately weak, thinly laminated (0 to 5 degrees) reddish brown siltstone.</i> <i>Between 39.70m and 40.00m: assessed zone of core loss, likely weathered mudstone.</i>			
39.00 - 40.00	70 15 15	0 NA AZCL							

Continued next sheet

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
						07/11	08:00	40.00	21.60	19.20	SPT Hammer: JT01 Energy Ratio: 66%
						07/11	16:30	45.00	21.60	28.50	
						08/11	08:00	45.00	21.60	19.20	
				Casing Diameter		Water Strikes					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Checked by:	MHW	IFA RC
Log status:	FINAL	v01.01

 IAN FARMER ASSOCIATES	Plant used: Comachio 205/Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH303									
	Dates: 31/10/2022 - 07/11/2022		Client: Cadent			Sheet 5 of 5									
	Rotary Boring Log		Location: 364377.59E 370646.22N		Ground level: 38.57mOD	Logged by: JJ/TW	Vertical scale: 1:50	Project ID: 2230746							
Coring, Samples & In Situ Testing				Strata Details				Groundwater							
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation						
40.00 - 41.50	100 26 26	NA	40.60m - D52	-2.13	40.70 (0.50)	Very stiff, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 15mm) of extremely weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 40.41m and 40.50m: weak, thinly laminated (45 degree) light bluish grey and reddish brown siltstone.</i> Very stiff, thinly laminated (3 to 15 degrees) reddish brown and light bluish grey CLAY, with up to 15 percent subangular lithorelicts (up to 6mm) of extremely weak mudstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very weak, thinly laminated (0 to 15 degrees) light bluish grey SILTSTONE. (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 41.25m and 41.30m: 35 degree fracture, planar, smooth, clean.</i> Very stiff, fissured, reddish brown locally mottled light bluish grey CLAY, with up to 30 percent subangular lithorelicts (up to 25mm) of extremely weak mudstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth. Occasional, 0 to 90 degree, off white, gypsum veins (2mm). (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, thinly laminated (0 to 5 degrees) reddish brown, locally mottled light bluish grey CLAY, with up to 10 percent subangular lithorelicts (up to 4mm) of extremely weak mudstone. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP End of Borehole at 45.00m									
		3	41.35m - C53	-2.63	41.20 (0.30)					41					
				-2.93	41.50										
41.50 - 43.00	100 0 0	NA	42.00m - D54					42							
			43.00m - D55		(3.20)			43							
43.00 - 44.50	90 0 0							44							
		AZCL													
44.50 - 45.00	60 0 0	NA	44.70m - D56	-6.13	44.70 (0.30)			45							
				-6.43	45.00										
								46							
								47							
								48							
								49							
								50							
Flush Details				Borehole Diameter		Boring Progress		Remarks:							
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
								SPT Hammer: JT01 Energy Ratio: 66%							
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		MHW	IFA RC												
Log status:		FINAL	v01.01												

 IAN FARMER ASSOCIATES	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH305				
	Dates: 10/11/2022 - 15/11/2022		Client: Cadent			Sheet 1 of 3				
Dynamic Sampling and Rotary Boring Log	Location: 363989.99E 371020.03N		Ground level: 41.42mOD	Logged by: CE/CG	Vertical scale: 1:50	Project ID: 2230746				
	Samples & In Situ Testing		Strata Details			Groundwater				
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation		
0.20	D1	SPT(S) N=15 (2,2/3,4,3,5)	41.12	(0.30)	Grass over, soft, dark grey mottled reddish brown, slightly sandy CLAY with abundant rootlets.					
0.30 - 1.20	D2			0.30	TOPSOIL					
0.40	D3			0.50	Firm, reddish brown speckled black mottled light grey CLAY with occasional rootlets and roots.					
0.50 - 0.70	B4			(0.40)	GLACIAL TILL					
0.60	D5			0.90	Firm to stiff, reddish brown CLAY with root traces and gleyed surfaces and rare rootlets.					
0.70	ES6	SPT(S) N=28 (5,6/6,6,7,9)	40.52	(4.10)	GLACIAL TILL					
1.00 - 1.20	B7				Stiff, fissured, brown, slightly gravelly, slightly sandy, silty CLAY with rare, fragments (up to 5mm) of black lignite. Gravel is angular to subrounded, fine to coarse, including sandstone, quartzite and chert. Fissures are 0 to 90 degrees, extremely closely to very closely spaced, planar, smooth, with localised light bluish grey silt infill (1mm).					
1.20	D8				GLACIAL TILL					
1.20 - 1.65	D9									
1.50 - 1.55	D9									
2.00	D10	SPT(S) N=22 (4,4/4,5,6,7)	36.42	5.00	Stiff, reddish brown, sandy, clayey SILT, drilling disturbed, recovered as; very soft, sandy, clayey silt.					
2.00 - 2.45					D11				GLACIAL TILL	
3.00	D13	SPT(S) N=25 (5,5/5,6,6,8)	35.72	5.70	Firm, reddish brown, sandy, gravelly, silty CLAY. Gravel is subrounded and rounded, fine to coarse including quartzite and quartz.					
3.00 - 3.45					D12				GLACIAL TILL	
4.00	D14	SPT(S) N=16 (3,3/3,4,4,5)	34.72	6.70	Stiff, reddish and orangish brown, slightly gravelly, slightly sandy, silty CLAY with a low cobble content. Gravel is subrounded and rounded, fine to coarse, including quartzite and quartz. Cobbles are subrounded of quartzite.					
4.00 - 4.05					D15				GLACIAL TILL	
4.00 - 4.45	D16	6.00m - SPT(S) N=48 (25 for 145mm/12,12,12,12) 6.00m - D17	34.72	(1.00)	Between 7.30m and 7.93m: assessed zone of core loss, likely clay.					
5.00	30 0 0				AZCL				7.00m - SPT(S) 50 (5,6/50 for 150mm)	7
5.00 - 5.45									7.00m - B18	
5.30 - 5.35	43 0 0				NA				7.00m - D19	8
5.90 - 5.95	54 0 0				AZCL				7.00m - D20	
6.00 - 7.00	52 0 0	AZCL	8.20m - SPT(C) 50 (6,9/50 for 190mm)	9						
7.00 - 7.70			NA		9.00m - SPT(C) 50 (7,9/50 for 135mm)					
7.70 - 8.20	50 0 0	AZCL	9.80m - D21	10						
8.20 - 9.00			NA							
9.00 - 10.00	TCR/SCR/ROD FI		Continued next sheet							
Dynamic Sample Recovery			Remarks:							
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks						
1.20	2.00		100	Service inspection pit hand excavated from GL to 1.20m.						
2.00	3.00		100							
3.00	4.00		100							
4.00	5.00		100							
5.00	6.00		100							
SPT Hammer: JN01 Energy Ratio: 65%										
Water Strikes				Monitoring Installations						
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)	
Checked by:		MHW	IFA DS v01.01							
Log status:		FINAL								

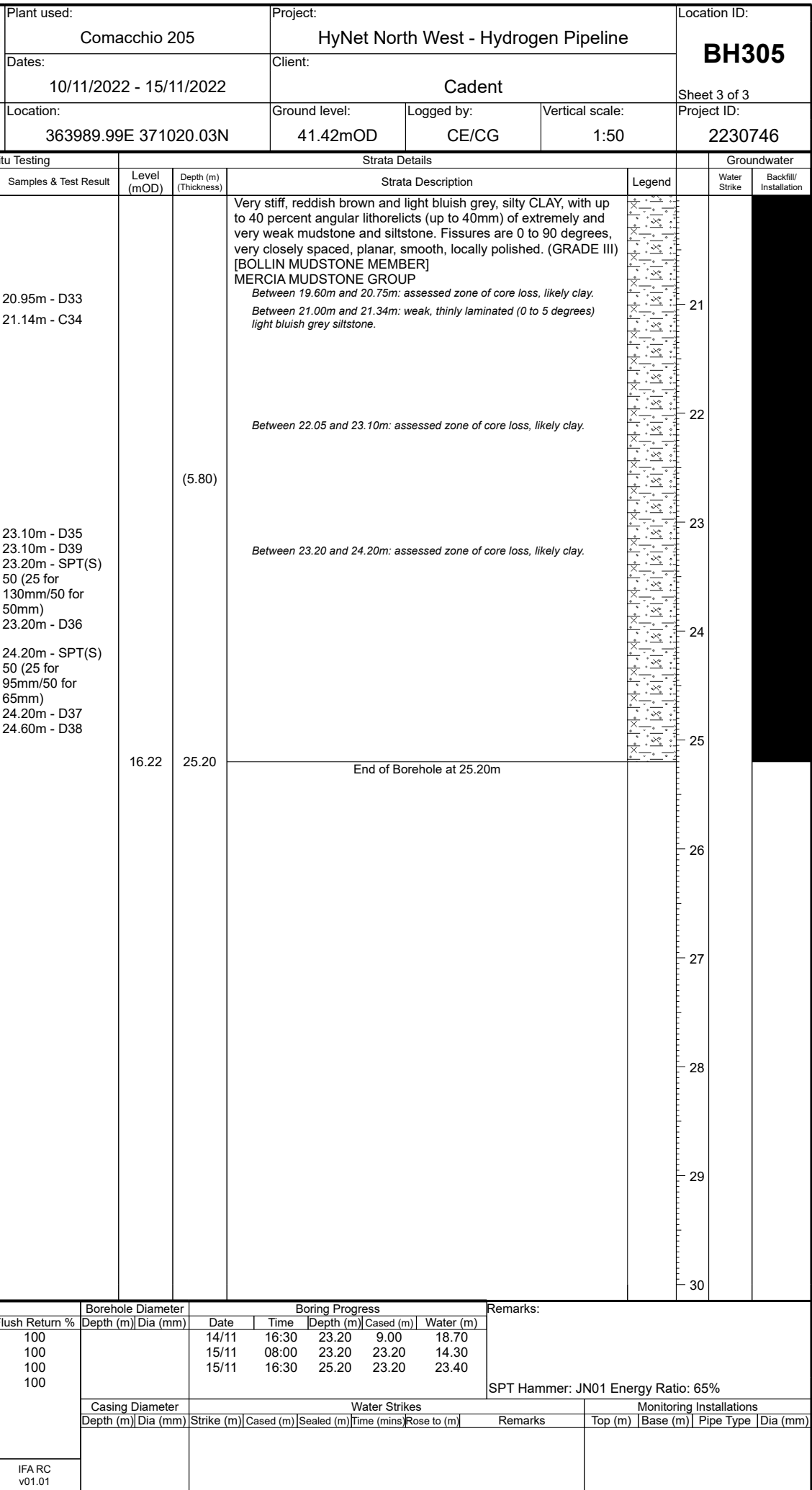
 IAN FARMER ASSOCIATES	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH305	
	Dates: 10/11/2022 - 15/11/2022		Client: Cadent				
Rotary Boring Log	Location: 363989.99E 371020.03N		Ground level: 41.42mOD	Logged by: CE/CG	Vertical scale: 1:50	Sheet 2 of 3 Project ID: 2230746	

Coring, Samples & In Situ Testing				Strata Details				Groundwater		
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation	
10.00 - 11.00	60 0 0	AZCL	10.00m - SPT(C) 50 (25 for 145mm/50 for 90mm) 10.00m - D22	26.92	(7.80)	Stiff, reddish and orangish brown, slightly gravelly, slightly sandy, silty CLAY with a low cobble content. Gravel is subrounded and rounded, fine to coarse, including quartzite and quartz. Cobbles are subrounded of quartzite. GLACIAL TILL <i>Between 10.00m and 10.40m: assessed zone of core loss, likely clay.</i> <i>Between 11.30m and 12.00m: assessed zone of core loss, likely clay.</i>				
11.00 - 12.00	30 0 0	NA	11.00m - SPT(S) 50 (9,12/50 for 205mm) 11.00m - D23							11
12.00 - 13.00	100 0 0	NA	12.00m - D24							12
13.00 - 14.50	90 0 0		13.95m - D25							14
14.50 - 15.50	100 0 0	AZCL	14.50m - SPT(S) 50 (5,9/50 for 205mm) 14.50m - D26 14.50m - D27 15.00m - D28	24.62	16.80	Very stiff, fissured, reddish brown locally mottled light bluish grey, silty CLAY, with up to 15 percent angular lithorelicts (up to 20mm) of extremely and very weak mudstone. Fissures are 0 to 90 degrees, extremely and very closely spaced, planar, smooth, locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP				
15.50 - 16.20	100 0 0	NA	17.10m - D29							15
16.20 - 17.70	100 0 0	NA	17.10m - D29							16
17.70 - 19.20	50 0 0	AZCL	19.20m - SPT(S) 50 (3,8/50 for 225mm) 19.20m - D30 19.20m - D31 19.20m - D32	22.02	19.40	Very stiff, fissured, reddish brown, silty CLAY, with up to 5 percent angular lithorelicts (up to 5mm) of extremely weak mudstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth and polished. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 17.35m and 17.50m: thinly and thickly laminated.</i> <i>Between 17.70m and 18.45m: assessed zone of core loss, likely clay.</i> <i>Between 18.50m and 18.70m: very stiff, light bluish grey, clayey silt.</i>				
19.20 - 20.20	40 0 0	NA								19.20m - D30 19.20m - D31 19.20m - D32
Continued next sheet										

Flush Details				Borehole Diameter		Boring Progress				Remarks:	
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)		
6.00	7.00	Air	100	25.20	121	10/11	16:30	5.00		Dry	
7.00	7.70	Air	100			11/11	08:00	5.00		4.67	
7.70	8.20	Air	100			11/11	16:30	15.50	9.00	15.20	
8.20	9.00	Air	100			14/11	08:00	15.50	9.00	12.00	
9.00	10.00	Air	100								
10.00	11.00	Air	100								
11.00	12.00	Air	100								
12.00	13.00	Air	100								

Casing Diameter				Water Strikes				Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
25.20	139										

Checked by:	MHW	IFA RC
Log status:	FINAL	v01.01



Plant used:

Comacchio 205

Dates:

28/11/2022 - 01/12/2022

Project:

HyNet North West - Hydrogen Pipeline

Client:

Cadent

Location ID:

BH318

Dynamic Sampling and Rotary Boring Log

Location:

364667.03E 369647.01N

Ground level:

33.47mOD

Logged by:

JM/CE

Vertical scale:

1:50

Sheet 1 of 4

Project ID:

2230746

Samples & In Situ Testing			Strata Details				Groundwater		
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.20	D1	SPT(S) N=13 (2,2/2,3,4,4)	33.07	(0.40)	Grass over soft, dark greyish brown, silty CLAY with frequent rootlets.				
0.40 - 0.70	B2			0.40	TOPSOIL				
0.50	D3			(0.30)	Firm, reddish brown, grey mottled yellowish brown, slightly silty, slightly gravelly, sandy CLAY with occasional rootlets and root traces. Gravel is angular, fine, and includes chert and quartzite.				
0.80	D4			0.70	GLACIAL TILL				
1.00 - 1.20	B5			(0.50)	Firm becoming stiff, reddish brown mottled light grey, slightly sandy, slightly gravelly CLAY. Gravel is angular to well rounded, fine and medium including sandstone, siltstone, occasional chert and quartzite.				
1.20	D6			1.20	GLACIAL TILL				
1.20 - 1.65	D6	127 blows. 100% recovery	(2.00)	Stiff, light brown locally mottled light grey, slightly silty, slightly gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse including mudstone, siltstone, sandstone and quartzite.					
1.90 - 1.95	D9								
2.20 - 2.70	UT8								
2.70									
2.70 - 3.07	D7	SPT(S) 50 (5,5/50 for 220mm)	30.27	3.20	Very stiff, brown, sandy, gravelly CLAY with low cobble content. Gravel is angular to subrounded, fine to coarse including mudstone, siltstone, sandstone, quartzite and chert. Cobbles are subrounded of quartzite.				
3.20 - 4.20	100 0 0	3.50m - D10							
4.20 - 5.70	86 0 0	5.00m - D11		(3.70)					
5.70 - 6.20	50 0 0	6.90m - D12		26.57					
6.20 - 7.20	100 0 0	NA	23.92	9.55					
7.20 - 8.00	44 0 0	AZCL		9.55					
8.00 - 8.70	64 0 0	NA		(2.65)					
8.70 - 9.20	90 0 0	NA							
9.20 - 10.20	100 45 45	0	23.47	10.00	Weak, thinly and thickly laminated (0 to 15 degrees) light grey and reddish brown SILTSTONE, with frequent veins (up to 10mm) of light greyish white, crystalline gypsum. (GRADE I) [BOLLIN				
TCR/SCR/ROD		FI	Continued next sheet						
Dynamic Sample Recovery		Remarks:							
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m.				
1.20	2.20		100						
2.70	3.20		100						
SPT Hammer: JN01 Energy Ratio: 65%									
Water Strikes					Monitoring Installations				
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
1.30			20	1.20	Slow				
12.80	8.70		20	10.20	Fast				
Checked by:		MHW		IFA DS					
Log status:		FINAL		v01.01					

Plant used:

Comacchio 205

Project:

HyNet North West - Hydrogen Pipeline

Dates:

28/11/2022 - 01/12/2022

Client:

Cadent

Location ID:

BH318

Rotary Boring Log

Location:

364667.03E 369647.01N

Ground level:

33.47mOD

Logged by:

JM/CE

Vertical scale:

1:50

Sheet 2 of 4

Project ID:

2230746

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
10.20 - 11.70	80 6 0	NA	11.00m - D15		(1.70)	Weak, thinly and thickly laminated (0 to 15 degrees) light grey and reddish brown SILTSTONE, with frequent veins (up to 10mm) of light greyish white, crystalline gypsum. (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 25mm) of extremely and very weak mudstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 10.20m and 10.32m: very stiff, light bluish grey silt.</i>		11	
11.70 - 13.20	100 61 61	1	12.40m - C16	21.77	11.70 (1.00)	Very weak, thinly and thickly laminated (0 to 10 degrees) light bluish grey SILTSTONE, with rare veins (up to 5mm) of light greyish white, crystalline gypsum. Discontinuities are 5 to 15 degrees, widely spaced, planar, smooth, tight with soft, brown, silt infill (up to 0.25mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 12.00m and 12.09m: very stiff, light bluish grey and reddish brown, silty clay.</i>		12	
13.20 - 14.70	100 0 0		14.00m - D17	20.77	12.70 (2.25)	Very stiff, fissured, reddish brown and light bluish grey, silty CLAY, with up to 20 percent angular lithorelicts (up to 20mm) of extremely and very weak mudstone. Fissures are 0 to 90 degrees, very closely spaced, planar, smooth, locally polished. Occasional frequent fragments (up to 5mm) of light greyish white, crystalline gypsum. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		13	
14.70 - 16.20	100 0 0	NA	15.70m - D18	18.52	14.95	Very stiff, fissured, reddish brown locally light bluish grey, silty CLAY, with up to 5 percent angular lithorelicts (up to 5mm) of extremely and very weak mudstone. Fissures are 0 to 90 degrees, very closely and closely spaced, planar, smooth, polished. Occasional fragments (up to 30mm) of light greyish white, crystalline gypsum. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP <i>Between 16.40m and 16.60m: very stiff, reddish brown, silty clay, with up to 25 percent angular lithorelicts (up to 20mm) of very weak mudstone.</i>		14	
16.20 - 17.70	87 0 0		17.20m - D19		(5.85)			15	
17.70 - 19.00	92 0 0	NA						16	
19.00 - 20.50	100 0 0							17	
								18	
								19	
								20	

Continued next sheet

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
3.20	4.20	Air	100			28/11	16:30	3.20	3.20	Dry	SPT Hammer: JN01 Energy Ratio: 65%
4.20	5.70	Air	100			29/11	08:00	3.20	3.20	1.80	
5.70	6.20	Air	100			29/11	16:30	17.70	8.70	15.10	
6.20	7.20	Air	100			30/11	08:00	17.70	8.70	7.60	
7.20	8.00	Air	100								
8.00	8.70	Air	100								
8.70	9.20	Air	100								
9.20	10.20	Air	100								

Casing Diameter				Water Strikes				Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:

MHW

Log status:

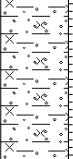
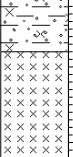
FINAL

IFA RC

v01.01

	Plant used:		Comacchio 205		Project:		HyNet North West - Hydrogen Pipeline		Location ID:																
	Dates:		28/11/2022 - 01/12/2022		Client:		Cadent		BH318																
Rotary Boring Log			Location:		364667.03E 369647.01N		Ground level:		33.47mOD		Logged by:		JM/CE		Vertical scale:		1:50		Sheet 3 of 4		Project ID:		2230746		
Coring, Samples & In Situ Testing			Level (mOD)		Depth (m) (Thickness)		Strata Details		Legend		Groundwater		Water Strike		Backfill/ Installation										
Depth			TCR/SCR/ ROD		FI		Samples & Test Result		Strata Description		Legend		Water Strike		Backfill/ Installation										
20.50 - 22.00			100 0 0		NA		20.70m - D20		12.67		20.80		Very stiff, fissured, reddish brown locally light bluish grey, silty CLAY, with up to 5 percent angular lithorelicts (up to 5m) of extremely and very weak mudstone. Fissures are 0 to 90 degrees, very closely and closely spaced, planar, smooth, polished. Occasional fragments (up to 30mm) of light greyish white, crystalline gypsum. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		21										
21.50m - D21											(1.25)		Very stiff, reddish brown, silty CLAY, with up to 40 percent angular lithorelicts (up to 25mm) of very weak mudstone. Rare fragments (up to 5mm) of light greyish white, crystalline gypsum. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		22										
22.00 - 23.50			100 100 57		2		22.40m - C22		11.42		22.05		Weak, thinly and thickly laminated (0 to 10 degrees) reddish brown and light bluish grey MUDSTONE. Discontinuities are 5 to 15 degrees, medium spaced, planar, smooth, clean with black staining (<1mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		23										
23.50 - 25.00			73 73 17		AZCL		24.05m - C23		10.57		22.90		Very weak, locally thickly laminated (0 to 10 degrees) reddish brown and light bluish grey MUDSTONE. Discontinuities are 0 to 90 degrees, very closely spaced, planar and undulating, smooth, tight, with soft, brown, silt infill (up to 0.25mm) and black staining (<1mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		24										
24.75m - C24			0								(2.10)		Between 24.75m and 25.00m: extremely weak, thinly laminated (0 to 10 degrees) light bluish grey siltstone. (grade I)		25										
25.00 - 26.50			100 0 0		NA		25.55m - D25		8.47		25.00		Very stiff, fissured, reddish brown, silty CLAY, with up to 55 percent angular lithorelicts (up to 25mm) of very weak mudstone. Fissures are 0 to 90 degrees, closely spaced, planar, smooth, locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		26										
26.50 - 28.00			40 20 20		1		26.90m - C26		6.67		26.80 (0.30)		Very weak, thickly laminated (0 to 10 degrees) reddish brown and light bluish grey MUDSTONE. (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		27										
28.00 - 28.50			80 16 0		AZCL				6.37		27.10		Between 26.80m and 26.90m: 65 degree joint, planar, rough, tight, with soft, reddish brown, silt infill (up to 0.25mm)		28										
28.50 - 29.50			90 25 25		NA		29.00m - D27		4.57		28.90		Very stiff, thickly laminated (0 to 10 degrees) bluish grey, clayey SILT, with up to 80 percent angular lithorelicts (up to 30mm) of weak siltstone. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP		29										
					2						(1.80)		Between 28.42m and 28.75m: very weak, light bluish grey siltstone. (grade I)		30										
					AZCL						(1.85)		Very stiff, fissured, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 30mm) of very weak and weak mudstone. Fissures are set 1: 10 to 30 degrees, closely spaced, planar, smooth. Set 2: 60 to 75 degrees, closely spaced, planar, smooth, locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP												
Continued next sheet																									
Flush Details				Borehole Diameter		Boring Progress				Remarks:															
Top (m)		Base (m)		Flush Type		Flush Return %		Depth (m)		Dia (mm)		Date		Time		Depth (m)		Cased (m)		Water (m)					
10.20		11.70		Air		100						30/11		16:30		29.50		8.70		15.70					
11.70		12.20		Air		100						01/12		08:00		29.50		8.70		9.10					
12.20		13.20		Air		100						01/12		16:30		40.00		8.70		24.60					
13.20		14.70		Air		100																			
14.70		16.20		Air		100																			
16.20		17.70		Air		100																			
17.70		19.00		Air		100																			
19.00		20.50		Air		100																			
Checked by:				MHW		IFA RC						Casing Diameter				Water Strikes				Monitoring Installations					
Log status:				FINAL		v01.01																			
Depth (m)				Dia (mm)		Strike (m)		Cased (m)		Sealed (m)		Time (mins)		Rose to (m)		Remarks		Top (m)		Base (m)		Pipe Type		Dia (mm)	

	Plant used: Comacchio 205		Project: HyNet North West - Hydrogen Pipeline			Location ID: BH318	
	Dates: 28/11/2022 - 01/12/2022		Client: Cadent				
Rotary Boring Log	Location: 364667.03E 369647.01N		Ground level: 33.47mOD	Logged by: JM/CE	Vertical scale: 1:50	Sheet 4 of 4 Project ID: 2230746	

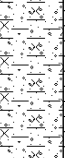
Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
29.50 - 31.00	100 0 0	NA	31.00m - D28	2.72	30.75	Very stiff, fissured, reddish brown, silty CLAY, with up to 30 percent angular lithorelicts (up to 30mm) of very weak and weak mudstone. Fissures are set 1: 10 to 30 degrees, closely spaced, planar, smooth. Set 2: 60 to 75 degrees, closely spaced, planar, smooth, locally polished. (GRADE III) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Very stiff, fissured, reddish brown, silty CLAY, with up to 5 percent angular lithorelicts (up to 5mm) of very weak mudstone. Fissures are set 1: 0 to 20 degrees, closely spaced, planar, smooth, locally polished. Set 2: 60 to 80 degrees, closely spaced, planar, smooth, locally polished. Occasional fragments (0 to 10mm) of light greyish white, crystalline gypsum. (GRADE IVa) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
31.00 - 32.50	100 0 0								
32.50 - 34.00	100 5 0								
			33.00m - D29		(3.65)	Between 33.50m and 33.58m: weak, very weak diametrically, light bluish grey siltstone.			
			33.50m - C30						
34.00 - 35.50	100 17 17	25	34.70m - C31	-0.93	34.40	Extremely weak to very weak, locally thinly laminated (0 to 10 degrees) reddish brown SILTSTONE, with rare, light bluish grey reduction spots (up to 5mm). Discontinuities are: 0 to 90 degrees, extremely closely and very closely spaced, planar, smooth, tight with soft, brown silt infill (up to 0.25mm). (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP At 34.70m: extremely weak.			
35.50 - 37.00	100 77 61	3	36.50m - C32 36.68m - C34	-2.38	35.85	Very weak, thinly laminated (0 to 10 degrees) light bluish grey and reddish brown SILTSTONE, with occasional veins (up to 10mm) of light greyish white, crystalline gypsum. Discontinuities are: 0 to 15 degrees, medium spaced, planar, smooth, tight, with soft, bluish grey, silt infill (up to 0.25mm). (GRADE I) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP			
37.00 - 38.50	67 67 55	AZCL	37.88m - C33		(3.05)				
38.50 - 40.00	100 49 40	0	39.50m - C35	-5.43	38.90	Extremely weak to very weak, reddish brown MUDSTONE, with occasional veins (up to 1mm) of light greyish white, crystalline gypsum. Discontinuities are: 0 to 90 degrees, very closely spaced, planar, smooth, clean. (GRADE II) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Between 39.50m and 39.70m: very weak, reddish brown siltstone (grade I).			
		20							
		0							
		15							
				-6.53	40.00	End of Borehole at 40.00m			

Flush Details				Borehole Diameter		Boring Progress				Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	
20.50	22.00	Air	100							
22.00	23.50	Air	100							
23.50	25.00	Air	100							
25.00	26.50	Air	100							
26.50	28.00	Air	100							
28.00	28.50	Air	100							
28.50	29.50	Air	100							

Checked by:		MHW	IFA RC
Log status:		FINAL	v01.01
SPT Hammer: JN01 Energy Ratio: 65% Water Strikes Monitoring Installations Top (m) Base (m) Pipe Type Dia (mm)			

 IAN FARMER ASSOCIATES	Plant used: Competitor Dart		Project: HyNet North West - Hydrogen Pipeline			Location ID: WS32			
	Dates: 15/11/2022		Client: Cadent						
Dynamic Sample Borehole Log	Location: 364975.99E 381081.96N		Ground level: 58.71mOD	Logged by: OG	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 2230746			
	Samples & In Situ Testing		Strata Details				Groundwater		
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.00 - 0.30 0.20 0.30 - 1.00 0.50	B1 D2 B3 D4		58.38	(0.33) 0.33	Grass over soft, dark brown, slightly sandy CLAY with occasional rootlets. TOPSOIL Grey mottled orangish brown, slightly clayey, silty, fine to coarse SAND. ALLUVIUM	 			
1.20 1.20 - 2.00	B5	SPT(S) N=13 (2,3/3,3,4,3)		(2.07)	At 1.20m: medium dense.		1		
2.00 2.00 - 2.45	D6	SPT(S) N=1 (1,1/1,0,0,0)			At 2.00m: very loose.		2		
3.00 3.00 - 3.45	D7	SPT(S) N=50 (7,7/12,12,13,13)	56.31 55.51 55.26	2.40 (0.80) 3.20 3.45	Soft, reddish brown, slightly sandy CLAY. (GRADE IVb) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP Firm, reddish brown CLAY. (GRADE IVb) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP End of Borehole at 3.45m	  	3		
							4		
							5		
							6		
							7		
							8		
							9		
							10		
Dynamic Sample Recovery			Remarks:						
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks					
1.20	2.00		100	Service inspection pit hand excavated from GL to 1.20m.					
2.00	3.00		100	Terminated due to refusal.					
			SPT Hammer: DART504 Energy Ratio: 68%						
			Water Strikes				Monitoring Installations		
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
1.20			20	1.00	Seepage				
Checked by:		MHW	IFA DS v01.01						
Log status:		FINAL							

Plant used:	Project:			Location ID:
Competitor Dart	HyNet North West - Hydrogen Pipeline			
Dates:	Client:			WS33 Sheet 1 of 1
14/11/2022	Cadent			
Location:	Ground level:	Logged by:	Vertical scale:	Project ID:
365122.97E 381044.02N	58.32mOD	OG	1:50	2230746

 IAN FARMER ASSOCIATES	Plant used: Competitor Dart		Project: HyNet North West - Hydrogen Pipeline			Location ID: WS34						
	Dates: 16/11/2022		Client: Cadent			Sheet 1 of 1						
Dynamic Sample Borehole Log	Location: 366336.03E 381693.97N		Ground level: 59.70mOD	Logged by: OG	Vertical scale: 1:50	Project ID: 2230746						
Samples & In Situ Testing			Strata Details				Groundwater					
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation				
0.00 - 0.35 0.20	B1 D2	SPT(S) N=14 (2,3/3,3,4,4)	59.10	(0.60)	Grass over soft, dark greyish brown, slightly sandy CLAY. TOPSOIL		1					
0.60 - 1.00 0.80	B4 D3			0.60	Soft, reddish brown, slightly silty, slightly gravelly, sandy CLAY. Gravel is subangular to subrounded, fine to coarse including siltstone. GLACIAL TILL <i>At 1.00m: saturated ground.</i>							
1.20 1.20 - 1.65	D5			(1.10)								
1.70 - 2.00 1.90 2.00	B6 D7			58.00	1.70				Firm, reddish brown, slightly silty, slightly gravelly, sandy CLAY. Gravel is very angular to subrounded, fine and medium including quartz and siltstone. GLACIAL TILL	2		
2.00 - 2.45 2.00 - 3.00	D9 B8	SPT(S) N=24 (3,5/5,5,6,8)	58.00	(2.10)			3					
3.00 3.00 - 3.45	D10								SPT(S) N=32 (5,6/6,7,9,10)			
3.80 - 3.90 3.90 - 4.00 4.00	D11 D12								55.90 55.80	3.80 3.90	Firm, reddish brown, slightly sandy, gravelly CLAY. Gravel is very angular to subrounded, fine and medium including mudstone. Multicoloured (GRADE IVb) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP	4
4.00 - 4.19	D13								55.51	4.19	Stiff, reddish brown, slightly sandy, slightly gravelly CLAY. Gravel is very angular to subangular, fine to coarse including quartz, sandstone and siltstone. (GRADE IVb) [BOLLIN MUDSTONE MEMBER] MERCIA MUDSTONE GROUP End of Borehole at 4.35m	5
							6					
							7					
							8					
							9					
							10					
Dynamic Sample Recovery			Remarks:									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks								
1.20	2.00		100	Service inspection pit hand excavated from GL to 1.20m.								
2.00	3.00		80									
3.00	4.00		80									
				SPT Hammer: DART504 Energy Ratio: 68%								
				Water Strikes			Monitoring Installations					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)			
3.30			0	3.30								
Checked by:		MHW	IFA DS v01.01									
Log status:		FINAL										

Plant used: Competitor Dart	Project: HyNet North West - Hydrogen Pipeline			Location ID: WS37
Dates: 24/11/2022	Client: Cadent			
Location: 368394.00E 383415.01N	Ground level: 53.47mOD	Logged by: FH	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 2230746

Appendix 3
Summary of Brine Well Information

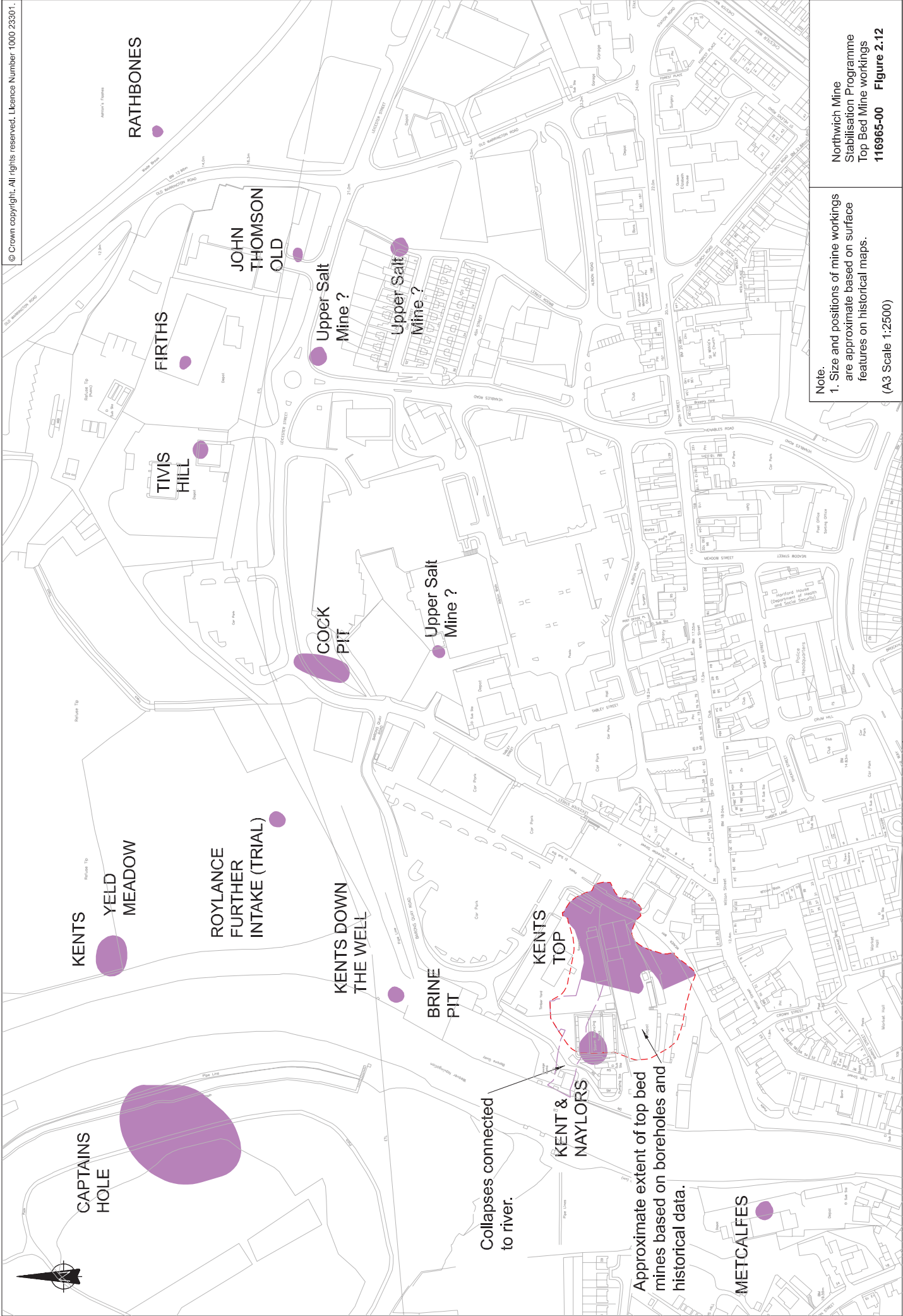
Appendix 3 - Summary of Brine Well and Boreholes within, and within influencing distance of the Preliminary Order Limits																
Area	Name	Shaft Type	Wharmby Reference Number	Possible BGS Borehole Reference	Eastings	Northings	Approximate distance from POL (m)	Surface Level (mAOD)	Depth (m)	Departure (m)	Zone of Instability (m)	Diameter (m)	Alias	Description of Feature (from Wharmby)	Recommended Further Works	Wharmby Hazard
Winsford	Moulton Hill	Natural brine shaft	3-3-318	SJ66NE8	365770	368800	17	38.81	92.35	10	92.35		Moulton Hall No. 4	Located near south side of pond O.S. No. 7886 to the south west of Moulton. Sunk 1881. Location taken from 1/10,560 Geological Map SJ66SE, other details from Calvert, ICI and British Geological Survey. Sunk as a prospective natural brine shaft. Stopped by quicksand. Deepened by boring. Lining tube cut off in 1957 - presumably near surface. Possibly filled but underwater.	Verify position of wells by obtaining source records and undertaking a "best plot" exercise. Based upon the "best fit" exercise and if landowner permissions allow than further investigation and stabilisation (if required) may be recommended. Alternatively there is the potential option to construct a grout plug and the intallation of a geosynthetic membrane in the areas where the potential zone of instability encroaches into the POL.	1.20
Winsford	Meadowbank No.4 Shaft	Shaft	3-1-307		366356	368738	73	42.07	186.23	0	N/A			Located off Jack Lane, Wharton, Winsford. Sunk 1964. Location from 1/2500 O.S.66/67 68 other details from ICI. A shaft to the currently operational Meadowbank mine.	N/A	0.00

Appendix 4
Prescribed Notices of Damage Summary

PNOD Reference	Property Name	Location	PNOD Status	PNOD Date	Claims	Damage	Claim Date
3075/2878	Heatley Heath Farm	Lymm	Accepted	03/09/1959	Claim 32	Not provided	25/06/1991
					Claim 33	Not provided	17/12/1990
3798	Hillside Farm	Northwich	Accepted	22/05/1973	Claim 10	Installing new main drains in fields O.S. 7600, 0077, 0003 and 1600	21/05/1974
					Claim 22	Renewing the land drains in fields O.S 23, 24 and 25	05/11/1976
3178	Brook House Farm, Brick Kiln Lane	Bostock Estate	Accepted	17/06/1960	Claim 13	Fields 9311,0006,0979,0958	29/03/1994
					Claim 16	Land drainage field 6067	20/05/1984
3178	Brook House Farm, King Street	Bostock Estate	Accepted	18/06/1960	Claim 15	Not provided	09/06/1976
					Claim 40	Not provided	08/11/1972
3178	Addawshaw Farm	Bostock Estate	Accepted	16/06/1960	Claim 76	Not provided	04/11/1993
4161	Dairy Farm, Whatcroft Hall Lane	Bostock Estate	Accepted	22/03/2004	Claim 6	Farm Land - 3 areas of subsidence in OS fields 2944, 1762, 3800	07/02/2002
3023	Jack Lane Farm	Northwich	Accepted	26/03/1959	Claim 8	Not provided	21/04/1976
					Claim 50	Not provided	08/01/1972

Appendix 5

**Northwich Mine Stabilisation Programme Top Bed Workings, reference
116965, Figure 2.12 obtained from Top Bed Salt Desk Study Report
prepared by Arup.**



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