BRITISH GEOLOGICAL SURVEY
Natural Environment Research Council

Technical Report WN/92/8/C

PROPOSED RIPON BYPASS NEW URE BRIDGE

PART 1. GEOLOGY, DESCRIPTION AND CAUSES OF SUBSIDENCE IN THE VICINITY

by

A H COOPER

Bibliographic Reference

Cooper, A H. 1992
Proposed Ripon By-pass, new Ure Bridge.
Part 1, Geology, description and causes
of subsidence in the vicinity.

British Geological Survey
Technical Report WN/92/8/C

PROPOSED RIPON BYPASS
NEW URE BRIDGE

PROPOSED RIPON BYPASS
NEW URE BRIDGE

SUMMARY

This report describes the bedrock geology and the superficial or drift geology of the proposed new River Ure Bridge to be built near the existing North Bridge at Ripon, North Yorkshire. The sequence of Permian rocks includes two thick units of gypsum, a rock which has partially dissolved, and continues to rapidly dissolve underground, to produce an expanding cave system beneath the site and most of the adjacent city of Ripon. Catastrophic collapse of caverns within the cave system frequently results in large subsidence hollows at the surface; these are commonly up to 30m across and sometimes up to 20m deep! Existing subsidence hollows are recognised in the vicinity of the proposed bridge, their cause and extent are described. Possible difficulties associated with some potential ground stabilisation works are also outlined.

1. INTRODUCTION

1.1 It is proposed to build a bypass to Ripon with a new crossing of the River Ure at Ure Bank, just downstream of the present North Bridge.

1.2 A site investigation was undertaken in November 1990 by Allied Exploration and Geotechnics Ltd for Bullen and Partners acting for North Yorkshire County Council (Contract No 1176). Dr A H Cooper of the British Geological Survey advised Bullen and Partners on 19th December 1989 of possible subsidence problems associated with the Ure bridge site. A site investigation for the associated road was also undertaken by North Yorkshire County Council Highways Laboratory in December 1990. The factual parts os these investigations were available and utilised for this report; the interpretive sections have not been seen.

1.3 On 28th January 1991 Dr A H Cooper for the British Geological Survey (ref. EN91/35/52) wrote to the County Surveyor (FAO Linda Temple). It was pointed out that the site investigations undertaken for the bridge did not go deep enough to ascertain the stability of the ground which was subject to natural collapse caused by gypsum dissolution at depth.

1.4 A meeting in Northallerton took place on 5th June 1992, between Mr John Hunt and colleagues of North Yorkshire Highways with Drs A H Cooper and D M McCann of the British Geological Survey. The problems of subsidence and gypsum dissolution were outlined along with potential methods of investigating the problems using geophysics. North Yorkshire

Highways requested that the British Geological Survey should prepare a report about the geology of the Ure Bridge Site and the various ways of investigating the potential problems.

1.5 This report represents an interpretation of the geology utilising published and unpublished information held by the British Geological Survey. It is not a substitute for fully investigating the area by a more exhaustive site investigation.

2. LOCATION

2.1 The proposed new route crosses the River Ure about 200m downstream of the present North Bridge, the approximate NGR is SE 319 720 for the middle of the bridge. For the purpose of this report the area considered in detail extends from the northern extent of the new by-pass to about 100m south of the proposed bridge; it is the area covered by NYCC drawing No 001/31.

3. TOPOGRAPHY AND GENERAL SITE DESCRIPTION

3.1 The proposed route for the road and bridge crosses the River Ure obliquely in an approximately north-south direction (Figure 1). South of the river the land is mainly flat representing the flood plain of the Ure, the land surface rises slightly southwards on to fluvioglacial terrace deposits. North of the river the route traverses a narrow strip of the flood plain, and a small area of fluvioglacial terrace before climbing up the slope of Ure Bank comprising glacial till overlying sandstone.

4. GEOLOGY AND CAUSES OF THE SUBSIDENCE

4.1 General

The geology of Ripon has two main classes; there is the "solid" geology (Figure 5) which is the bedrock with its associated gypsum and subsidence problem and there is the "drift" geology (Figure 7) which is the largely glacial and post-glacial cover sequence with deposits partly filling in the subsidence features.

4.2 Solid geology

Most of the Ure Bridge site is underlain by rocks of Permian age with the Triassic Sherwood Sandstone Group present to the east of the River Ure. Four subdivisions or formations are present in the Permian sequence overlain by the Sherwood Sandstone. The sequence is shown in Figure 2 and listed below:

	Thickness
TRIASSIC	Thickness
Sherwood Sandstone Group; red sandstone with subordinate mudstone beds and mudstone conglomerate layers especially near its base	up to 300m
PERMIAN	
Roxby Formation (or Upper Marl): red-brown calcareous mudstone (marl) with subordinate gypsum beds and up to about 10m of gypsum at its base	up to 26m
Brotherton Formation (or Upper Magnesian	

Limestone): pale grey calcitic dolomite mainly in thin beds	8 - 14m
Edlington Formation (or Lower Marl): red-brown calcareous mudstone (marl) with gypsum beds and up to about 30-40m of gypsum at its base	up to 50m
Cadeby Formation (or Lower Magnesian Limestone): pale grey and yellow dolomitic limestone	up to 65m

The Permian and Triassic sequences are in layers which slope gently to the east-north-east with a dip of around 1-3 degrees (Figure 3). The Lower Magnesian Limestone (or Cadeby Formation) is present in the south-west and west parts of Ripon. The remaining formations form NNW-SSE trending sinuous belts running through Ripon with the Upper Marl (or Roxby Formation) approximately following the River Ure and the Sherwood Sandstone forming the rising ground to the east (Figure 5).

4.3 Gypsum

Massive gypsum is present at two levels in the Permian sequence. It forms the lower part of the Edlington Formation (Middle Marl), where it may reach 30-40m in thickness, and the lower part of the Roxby Formation (Upper Marl), where it may reach 10m in thickness (Figures 2,3 & 6). The gypsum is generally pale grey alabastrine and porhyroblastic with fibrous veins; commonly these gypsum beds are incorrectly identified in boreholes and wrongly described as limestone. The overlying red-brown calcareous mudstones generally contain thin beds and nodules of grey, pink and red gypsum plus abundant fibrous veins; commonly these beds are severely contorted in the manner of those exposed at Ripon Parks (James et al., 1981). Where dissolution and collapse have taken place collapse breccias are common in the gypsiferous and overlying parts of the sequence.

4.4 Dissolution of gypsum, caves and subsidence

Gypsum is a very soluble rock and dissolves about one hundred times faster than limestone. A block of gypsum about 3m square, which fell into the River Ure at Ripon Parks dissolved away in only 18 months; this is documented by James, Cooper and Holliday (1981) who also present formulae for calculating the rate at which gypsum will dissolve if the velocity and temperature of the dissolving water are known.

4.5 Caves and subsidence

In subsurface conditions, with suitable water flow, gypsum commonly dissolves resulting in cave systems and a buried karst topography. One such cave system has recently been explored in the Vale of Eden and acts as a model for the Ripon caves (Ryder and Cooper in prep.). Such caves are present beneath many parts of Ripon. Because gypsum dissolves rapidly the cave system is evolving rapidly and catastrophic collapse of the caverns results in dramatic surface subsidence occurring.

4.6 Extent of the subsidence

For the six square kilometres of subsidence-prone land centred on Ripon one such major subsidence occurs approximately every three years; numerous sags and small collapses on farmland probably go undetected. The subsidences are commonly up to 10-30m in diameter and may be up to 20m deep. East of the River Ure even larger subsidence features are present in the vicinity of Hutton Conyers. The dates and distribution of the known subsidences are documented by Cooper (1986 and 1989) and in Figure 4. The distribution of the subsidence belt is limited to the west by the base of the gypsum beds and to the east by the down-dip transition of gypsum to the much less soluble anhydrite.

4.7 Pattern of subsidence and cambering

The subsidence hollows commonly form linear belts related (Figure 4) to the joint pattern in the rock (Cooper, 1986); in the vicinity of Ure Bank the cave/subsidence pattern may also be influenced by the joints opening due to cambering (partial collapse and bending of the strata) towards the valley of the river Ure. The lines of subsidence hollows commonly trend in approximately north-south and east-west directions; diagonal trends are also present, probably relating to the cave system stepping from north-south to east-west routes within it. Several lines of hollows converge near the proposed bridge site; this fact allied to the presence of spring activity probably suggests the outlet area from the cave system is situated in the vicinity.

4.8 Water flow

The distribution of the caves and subsidences also relates to water flow paths from the high ground to the west and east of Ripon towards the low ground in the vicinity of the River Ure. To the west the Magnesian Limestones act as catchment areas for water, which moves down dip and into the adjacent gypsum beds. To the east the Sherwood Sandstone acts as a catchment area, the water then passes down into the Permian sequence before moving up dip towards the River Ure. The water flow is considerably influenced by the presence of a deep gravel-filled buried valley running approximately along the course of the present River Ure. This buried valley cuts down into the Permian sequence and intersects the gypsum in the Roxby Formation (Upper Marl) (Figures 3 & 6), because the gypsum-limestone sequence is largely in hydrological continuity, and because it is perforated by subsidence pipes, this hydrological pathway also allows water to escape from the thick gypsum in the Edlington Formation (Middle Marl). This buried valley may intersect caves and spring activity has been recorded along its course. Just downstream of North Bridge Cameron (1881) recorded that 'In the bed of the Ure below the bridge numerous springs bubble up and burst over the surface of the water. These must take an important part in the subterranean changes that go on.' Visual inspection of the area over the years has not confirmed this observation, but local anglers or the River Authority may be able to add details. Nearby borehole S6 in the bed of the River Ure on the proposed bridge site also proved to be slightly artesian.

4.9 Water flow and tufa cements

Further evidence of water movement in the district comes from the calcareous tufa around springs near Burton Leonard to the south, and at Ripon Parks to the north. Tufa-cemented gravels in the buried valley (Abraham, 1981; Morigi and James, 1984) both to the north and south of the site indicate water flow form the bedrock (and cave systems) into the glacial sand and gravels in the buried valley. Similarly, the presence of sulphate-saturated groundwater in boreholes near Ripon Race Course (Cooper, 1986) attests to the water flow.

Tufa cemented gravels in boreholes S6-S9 at the Ure Bridge site suggest water flow from the bedrock through the gravels into the River Ure reinforcing Camerons (1881) observations about spring activity.

4.10 Breccia pipes, collapses and caves

The phreatic flow of groundwater through the rock dissolves the gypsum mainly along the joints resulting in a cave system with caverns at the intersections of the joints (Cooper, 1986). As the dissolution of the gypsum continues at a rapid rate the caverns enlarge, amalgamate, become unstable and ultimately collapse. When failure of the cavity roof occurs a breccia pipe may work its way up to the surface causing subsidence features to develop (Cooper, 1988). These range from a slight sagging of the ground surface (subsidence sinkholes of Culshaw and Waltham, 1987), to small crown holes with large voids beneath, through to complete catastrophic collapse (collapse sinkholes of Culshaw and Waltham, 1987). The larger subsidences local to the bridge site have been up to 20 m deep and 30 m across. Some of the large failures have been felt as very local earthquakes caused by the roof plug of rock dropping into the cavity. From the sizes of the collapses it is obvious that caves 20-30m high and of similar (or greater) width are present beneath parts of Ripon.

The physical nature of the major subsidence hollows (collapse sinkholes of Culshaw and Waltham, 1987) depends on the surface geology. Cylindrical shafts generally form where rock is present at the surface, but in superficial deposits failure of the sides causes conical depressions to develop.

4.11 Risk of future subsidence

Ripon subsidence features occur in a linear or grid-like pattern directly related to the joint-controlled cave system beneath (Figure 4 & 8 and Cooper, 1986; 1989). Once initiated the cave system appears to maintain its water flow even after a collapse has occurred so that dissolution continues apace in the adjacent gypsum. Consequently areas adjacent to, or in line with, known subsidence hollows are more at risk from future subsidence and hollows commonly occur in close groupings (Figure 4).

4.12 Drift Geology

Most of the Ripon district is mantled by glacial and post-glacial deposits which range from a thin covering to deposits in excess of 20m thick. Along the course of the River Ure there is a buried valley (Figure 3) which is joined by another deep valley along the course of the present River Skell. The valley is cut down to about OD or below in the vicinity of the new bridge site (Figure 6). The Ure Valley is partly filled with sand and gravel of probable glacial origin. In numerous places this sand and gravel has been cemented by calcareous tufa deposited from the sulphate and carbonate-rich groundwater which flows through it. Adjacent to the valley the rising ground is covered by glacial till or boulder clay in places with associated pockets of stiff laminated clay. This is partly overlain by fluvio-glacial river terraces mainly of sand and gravel plus river terraces and alluvium comprising sand and gravel overlain by silt and clay; some of these deposits may also contain interbedded peat layers especially in abandoned meanders. Peat and soft clay deposits are also common around Ripon where many of the subsidence hollows have been partially, or even completely filled, with these deposits. Soft deposits up to 20-30 or so metres thick have commonly been encountered in the subsidence hollows and large areas of amalgamated subsidence hollows may be completely obscured by the later deposits.

5. OTHER GEOLOGICAL CONSIDERATIONS

5.1 Sulphate rich groundwater

The natural subsidence outlined above is the most striking problem associated with the geology of the Ripon district. The presence of gypsum in the bedrock and its active dissolution also result in the groundwater commonly being high in dissolved sulphate. This sulphate-rich groundwater is also encountered in the glacial deposits and is commonly responsible for the formation of tufa cements in superficial gravels along the Ure Valley. Sulphate-rich groundwater has the potential to harm buried concrete and sulphate resistant concrete may need to be used following the guidelines of Anon (1981). Where a proposed structure includes the use of buried concrete the sulphate content of the soil and groundwater should be measured as part of the site investigation. The area most likely to be affected is similar to the area prone to subsidence caused be gypsum dissolution.

5.2 Weak soils

The presence of weak compressible soils, such as peat and laminated clay, both in subsidence hollows and fluvial deposits can cause settlement and foundation problems. Acid ground water may also be associated with peat deposits and this may also harm concrete, metal reinforcements and metal services.

5.3 Made ground

The presence of subsidence hollows in close vicinity to a built up area means that many of the holes have been filled in with domestic refuse and other fill. There are now no traces of many of the subsidence hollows and it is possible that there are many more than have been mapped. It is also possible that thick deposits of made ground could be encountered filling old hollows. On the flood plain of the River Ure it is also possible that made ground could fill old meanders of the river.

5.4 Water abstraction

Water abstraction from the Permian sequence could contribute to the subsidence problem in the Ripon district. If large volumes of sulphate-rich groundwater are abstracted the natural gypsum dissolution of the district may be accelerated. It is also possible that localised dissolution of gypsum at the well site could result in the formation of an underground cavity adjacent to the borehole (Cooper, 1988). Another consideration is the possibility of lowering the water table due to abstraction. It is well documented from many karst areas that there is a close correlation between subsidence sink hole formation and the lowering of the water table (Waltham, 1978; Bell, 1988).

6. DETAILED DESCRIPTION OF THE RIVER URE BRIDGE SITE

6.1 Solid geology

6.1.1 Map, cross-section and sequence at depth

The solid bedrock geology is shown in Figure 5. It differs from that published on the 1:10,560 scale geological map because it utilises borehole information gathered over the last

10 years. The cross-section (Figure 6) is a simplified indication of the likely complexity that might be present on the site. It can be seen that, from the depths of the boreholes, only the upper part of the upper gypsiferous sequence has been penetrated. The presence of the lower gypsiferous sequence is largely confirmed by the sizes of the subsidence features which are too large to have been caused by collapse of the upper gypsum alone. The depths and thicknesses of the units are inferred by extrapolation from up to 1km away. In Figure 6 the extent of caves and breccia pipes is reasonable, but their distribution (except where proved at the surface or in a borehole) is largely artistic licence. Details of the formations at depth are contained in the general description of the area (section 4.1).

6.1.2. Roxby Formation and gypsum

From the limited borehole information available it appears that the whole of the Ure bridge site is underlain by the Roxby Formation (or Upper Marl). This sequence comprises calcareous mudstones with gypsum beds and an approximately 10m thick gypsum sequence at its base; further details are given in section 4.1.Within this sequence numerous thick units of gypsum have been proved in the boreholes, especially S4 and S5 each with about 3m of gypsum proved; S6, S7 and S8 each with 2m or so of gypsum proved (Figure 6). All these boreholes also have evidence of brecciation and an open cavity was present in borehole S4. Boreholes S7 and S8 near the southern bank of the River Ure included thick sequences of breccia caused by dissolution and collapse.

The base of the Roxby Formation was not proved by the current site investigation, but another confidential report suggests that it might lie to the south-west of the area shown in Figure 5. The line for the base is difficult to predict because of the amount of foundering of the underlying strata. Recent investigations about 400m west of the bridge site have proved the Brotherton Formation (or Upper Magnesian Limestone), but it is impossible to geometrically extrapolate the geological surfaces because they have collapsed in an unpredictable way. Only close-spaced boreholes will resolve the position of the base of the Roxby Formation.

6.1.3.Sherwood Sandstone Group

The top of the Roxby Formation and its contact with the overlying Sherwood Sandstone Group is inferred to lie across Ure Bank between boreholes S3 and S1. This line is approximately 50-70m further to the north-east than was inferred by the 1980-81 geological survey. Details of the Sherwood Sandstone Group are given in section 4.1. The sandstone is well exposed in the roadside quarry at the northern limit of the area covered by this report. The quarry exposes about 8m of fine and medium-grained red-brown sandstone in thick beds with sporadic mud-flake conglomerate layers.

6.1.4. Breccia pipes and subsidence hollows

The cross-sections through the area shown in Figures 3 and 6 give an indication of the complexity of the solid geology caused by the dissolution of the gypsum with the sequence. The upward propagation of the breccia pipes over caves that collapse is described in detail by Cooper (1988). The lack of much bulking generated by the soft collapsed material means that eventually even fairly small cavities can work their way up to the surface. The nature of the breccia pipes perforating the sequence is very similar to the breccia pipes exposed on the Durham coast an described by Smith 1972.

6.2 DRIFT GEOLOGY

6.2.1. Map and cross-section

The drift geology and distribution of the surface deposits is shown in Figure 7. It differs slightly from that on the published 1:10,560 scale geological map because it utilises borehole and trial pit information gathered over the last 10 years. The spatial relationships of the deposits is indicated by Figure 6.

6.2.2. Fluvio-glacial sand and gravel

One of the most striking features of the River Ure Valley near Ripon is the fact that it was once much deeper than it now appears. The valley contains up to about 20 or so metres of fluvio-glacial sand and gravel overlain in places by the local boulder clay or glacial till (Figure 6) showing that it predates the main ice-age advance. This sand and gravel is in places cemented to a concrete-like consistency by deposits of calcareous tufa deposited from the sulphate and carbonate rich waters that pass through it escaping from the underlying Permian strata. Such tufa-cemented gravels are present in borehole S6 from 5 to 14.85m ;in borehole S7 between 16 and 23m deep; borehole S8 from 8.5 to 16m deep and borehole S9 from 12 to 18.75m deep; all these occurrences indicate water flow from the gypsiferous strata into the drift.

6.2.3. Glacial till

Over the buried gravels (but largely eroded away along the present river course) there are extensive deposits of glacial till which blankets the rising ground north-east of the river on Ure Bank (Figures 3 & 6). This deposit of sandy and silty clay with abundant pebbles, cobbles and boulders also locally contains laminated clay deposits, but these are usually overcompressed and very stiff.

6.2.4. Fluvio-glacial terrace deposits

North-west of the Ure bridge site the ground west of the old railway station comprises a flat terrace of fluvio-glacial sand and gravel with subordinate laminated clay. The tail end of this deposit just enters the Ure Bridge site, but appears to be affected by foundering. It is probably this deposit that is proved beneath the clay and made ground in borehole S4.

6.2.5. Alluvium

The present flood plane of the River Ure comprises a deposit of silty clay alluvium overlying a lag deposit of sand and gravel. The upper silty clay is proved to 2.4m in borehole S5 and to 1.6m in borehole S8. Because the alluvium is being actively deposited it fills in and obsures many of the subsidence hollows so that only the most recent ones are visible on the flood plain.

6.2.6. Peat

The glacial and post-glacial sequence outline above is in places complicated by later deposits formed within subsidence hollows. Typically these subsidence hollow deposits are laminated silts and clays with thick deposits of peat and subordinate amounts of white shell marl deposited in the fresh water ponds associated with the peat formation. None of the boreholes in the vicinity of the bridge have proved thick peat, but two other site investigation boreholes, to the west of the old railway embankment, have proved 15 and 27m of peat and soft clay filling in subsidence areas. Similar thicknesses of soft deposits have also been encountered to the south of Ripon around Dallamires Lane. It is possible that such thick peat

and clay deposits could occur anywhere in the low ground around the River Ure and be completely obscured by alluvial deposits.

6.3. Subsidence hollows

6.3.1. Distribution

The distribution of the proven and suspected subsidence hollows in the vicinity of the bridge site are shown in Figure 8 on which the individual hollows are numbered and described below. It must be noted that the borehole sites shown on this figure were taken from the diagram included in the original borehole site investigation; some other diagrams show boreholes S3 and S4 in slightly different places.

6.3.2.Subsidence hollow 1

This large depression is shown on the Ordnance Survey map of around 1860 as a pit. It is also shown on Camerons Geological Survey field map of around 1880; unfortunately he does not note the subsidence site referred to in his 1881 paper. The presence of this hole on a basemap that precedes the recorded subsidence suggests that hollow 2 is in fact the 1871 subsidence.

6.3.3.Subsidence hollow 2

This is a moderately-sized subsidence hollow adjacent to the main road. It is reputed to have formed in 1871. Cameron (1881) noted 'A pit fell in 10 years ago, on Hutton Bank, after a waggon load of tiber passed over the spot; water remained two or three days in the bottom. The sides are now all smoothed and grown over with grass, and a drain pipe made to run down one side, the contents rapidly disappearing on reaching the bottom of the pit.'

Kendall and Wroot (1924) noted that 'Another very large subsidence occurred on May 14,1871, close to the road from Ripon to Thirsk, near Ripon railway station. A local newspaper says "A small hole was observed in the ground about 8am; this gradually increased until a portion of the hedge at the side of the road disappeared, and an hole some 20 feet in circumference was left. On the following day the sides fell in and the hole at the bottom disappeared, leaving a crater-like hole" Until it was recently utilised for the disposal of rubbish it was one of the finest in the series.'

6.3.4.Subsidence hollow 3

This is a small depression of unknown age. Its exact position is shown by the contours on NYCC drawing H/893/

6.3.5.Subsidence hollow 4

This small subsidence hollow is also well located on NYCC drawing H/893/. According to this plan it is also the site of borehole S3 which proves silty clay with organic matter to 1.3m on laminated clay to 2.9m. It is probable that these deposits represent fill within the subsidence hollow.

6.3.6.Subsidence hollow 5

This is one of the largest subsidence features in the vicinity, its form is well shown on plan H/893/, it is also the site of borehole S4 and Trial Pit TP S3. The trial pit shows that the hollow was once much deeper than it is now with 2.4m of made ground over laminated silt and clay (also hollow fill) to 3.3m. Borehole S4 also shows thin made ground 0.3m thick

resting on clay to 1.3m; this in turn rests on sand and gravel. It is probable that in the vicinity of Borehole S4 the present subsidence hollow is the full depth of the subsidence.

6.3.7.Subsidence hollow 6

This hollow comprises a small depression it is suspected to be a subsidence hollow because documentary evidence from c.1930/40 in the BGS records noted subsidence and soft strata at the site. It must be noted here that the original record has not been checked for this report.

6.3.8.Subsidence hollow 7

This hole was reported to Dr Cooper by Mr Ellis the farmer during the resurvey of the Ripon district in 1981. He noted that it subsided about 1m a year, but was filled in an no trace of it remained. The exact site of the subsidence is uncertain and should be carefully checked with the farmer and by scraping the topsoil in the vicinity. It would also be shown by geophysical methods. Its close proximity to the proposed new bridge makes it an important target to investigate.

6.3.9.Subsidence hollow 8

This hollow was very subdued when the airborne survey of the Ripon district was undertaken in 1986. It is shown by Cooper (1989) but little trace of it remains. Trial pit 8 hereabouts shows 3m of made ground and borehole S9 also shows made ground on organic silt to 3.4m, both characteristic subsidence hollow fills.

6.3.10.Subsidence hollow 9

This hollow is well defined on plan H/893/. Borehole 42 at the side of it shows a sand and gravel to 5.0m on sandy, gravelly clay to 7.4m. It must be noted that another borehole investigation within the subsidence hollow proved 15m of peat.

6.3.11.Subsidence hollow 10

This subsidence area forms part of a very extensive hollow. Borehole S 10 proves peat and laminated clay to 7m and trial pits TP S7 and 7A prove similar deposits. Borehole 40 proves laminated clay and peat between 10m and 13.4m beneath the made ground of the old railway embankment. Other investigations west of the railway line within this hollow prove up to 27m of peat and clay.

7.POSSIBLE PROBLEMS ASSOCIATED WITH GROUND STABILISATION

7.1.Grouting

7.1.1.Difficulties of grouting gypsum caves

It has been suggested by Bullen and Partners (NYCC Memo LS 215/LT) that the area of the Ure Bridge site could be stabilised by grouting with estimated costs given as £300,000 plus the cost of the grout. It is likely to be a very difficult exercise to try to grout up part of a cave system that contains flowing water and possibly includes caverns up to 30m or so in diameter. Furthermore the presence of sulphate-rich groundwater would require the use of a sulphate resistant grout.

7.1.2.Accelerated dissolution and subsidence

The grouting up of a significant part of a cave system could cause accelerated water flow and

gypsum dissolution in the adjacent ground. Because of the high solubility of gypsum it is possible that, within a short period of time, considerable cavities could develop destabilising the grouted ground. A natural corollary is the close-spaced subsidence hollows of the area around Hutton Conyers where new subsidences have occurred adjacent to collapses which have filled the underground caverns.

7.1.3. Groundwater level changes and subsidence

Filling part of a cave system could radically alter the local water table triggering off subsidence in the immediate and surrounding area. The relationship between lowering the water table and the onset of subsidence is well known throughout the world (summarised by Bell 1988). Localised raising of the water table can also cause collapse in partially consolidated drift deposits or poorly cohesive solid deposits spanning cavities as documented by Waltham (1978). The influence of such alteration to the local groundwater regime could have an effect extending considerably outside the immediate site. The presence of recent catastrophic collapse, adjacent to houses on Magdalens Road in 1979 and 1980, only 200m from the bridge site (Cooper, 1986, 1989) makes any alteration to the local groundwater regime an exercise fraught with risk and possible litigation.

8.AVAILABILITY OF DOCUMENTARY EVIDENCE FOR THE AREA

The River Ure Bridge site included in the 1:50,000 scale geological map 52 (Thirsk) which is in press. The site is also included in 1:10,560 scale geological map SE 37 SW which is available for purchase. To answer this enquiry part of map SE 37 SW has now been slightly revised using the new borehole information. The available maps are slightly superseded by the information contained in this report. Unpublished information contained in the original field maps of 1880 and 1980-1 has also been used; these maps are generally classed as confidential.

A BGS open file report describes the Permian rocks of the Ripon district (Cooper 1987). An open file report also describes the glacial deposits of the area with emphasis on the sand and gravel deposits (Cooper, 1983). A Mineral Assessment Report (Morigi and James, 1984) gives details of the drift deposits with emphasis on the sand and gravel, but also includes a brief description of the solid geology and simplified geological maps at a scale of 1:25,000. A Memoir describing the geology of the district is in press (Powell, Cooper and Benfield, in press).

BGS in Keyworth also has borehole records for about 200 boreholes in the Ripon district. These may be consulted by appointment at a standard charge in BGS Keyworth.

Published scientific papers describing the gypsum and subsidence phenomenon in the Ripon area are: Smith, 1972; James, Cooper and Holliday, 1981.; Cooper, 1986; Cooper, 1988 and Cooper 1989. The historical documentation of the subsidence is listed and referenced in Cooper (1986).

9 REFERENCES

ABRAHAM, D A. 1981. The sand and gravel resources of the country west of Boroughbridge, North Yorkshire. Description of 1:25 000 resource sheet SE 36. *Mineral Assessment Report of the Institute of Geological Sciences*, No. 78.

ANON. 1981. Concrete in sulphate-bearing soils and groundwaters. *Building Research Establishment Digest* No. 250. HMSO, London.

BELL, F G. Subsidence associated with the abstraction of fluids. pp. 363-376 in BELL, F G, CULSHAW, M G, CRIPPS, J C and LOVELL, M A (Editors) *Engineering Geology of Underground Movements*. Geological Society of London, Engineering Geology Special Publication No.5.

CAMERON, A G. 1881. Subsidences over the Permian boundary between Hartlepool and Ripon. *Geological Magazine*, Vol. 6, 342-351.

COOPER, A H. 1983. The geology of the country north and east of Ripon, North Yorkshire, with particular reference to the sand and gravel deposits; description of 1:25 000 sheet SE 37. *Open File Report, Institute of Geological Sciences*. 33pp.

COOPER, A H. 1986. Foundered strata and subsidence resulting from the dissolution of Permian gypsum in the Ripon and Bedale areas, North Yorkshire. 127-139 in HARWOOD, G M and SMITH, D B (Editors). *The English Zechstein and related topics*. Geological Society of London, Special Publication. No. 22.

COOPER, A H. 1988. Subsidence resulting from the dissolution of Permian gypsum in the Ripon area; its relevance to mining and water abstraction. 387-390 in BELL, F G, CULSHAW, M G, CRIPPS, J C and LOVELL, M A (Editors) *Engineering Geology of Underground Movements*. Geological Society of London, Engineering Geology Special Publication No.5.

COOPER, A H. 1989. Airborne multispectral scanning of subsidence caused by Permian gypsum dissolution at Ripon, North Yorkshire. *Quarterly Journal of Engineering Geology* (London), Vol. 22, 219-229.

CULSHAW, M G and WALTHAM, A C. 1987. Natural and artificial cavities as ground engineering hazards. *Quarterly Journal of Engineering Geology* (London), Vol. 20, 139-150.

JAMES, A N, COOPER, A H and HOLLIDAY, D W. 1981. Solution of the gypsum cliff (Permian Middle Marl) by the River Ure at Ripon Parks, North Yorkshire. *Proceedings of the Yorkshire Geological Society*, Vol. 43, 433-450.

MORIGI, A N and JAMES, J W C. 1984. The sand and gravel resources of the country north-east of Ripon, North Yorkshire: description of 1:25 000 resource sheet SE 37

and part of SE 47. *Mineral Assessment Report of the British Geological Survey*, No. 143.

POWELL, J H, COOPER, A H and BENFIELD, A C. in press. Geology of the country around Thirsk. *Memoir of the British Geological Survey*, Sheet 52 (England and Wales).

RYDER, P F, and COOPER, A H. in prep. A cave system in Permian gypsum at Houtsay Quarry, Newbiggin, Cumbria, England. Prepared for Cave Science.

SMITH, D B. 1972. Foundered strata, collapse breccias and subsidence features of the EnglishZechstein. 255-269 in RICHTER-BERNBURG, G. (Editor). *Geology of saline deposits. Proc. Hanover Symposium, 1968.* (Earth Sciences, 7). (Paris: U.N.E.S.C.O.) 316pp.

WALTHAM, A C, 1978. *Catastrophe - the violent earth.* Macmillan, London, 170 pp.

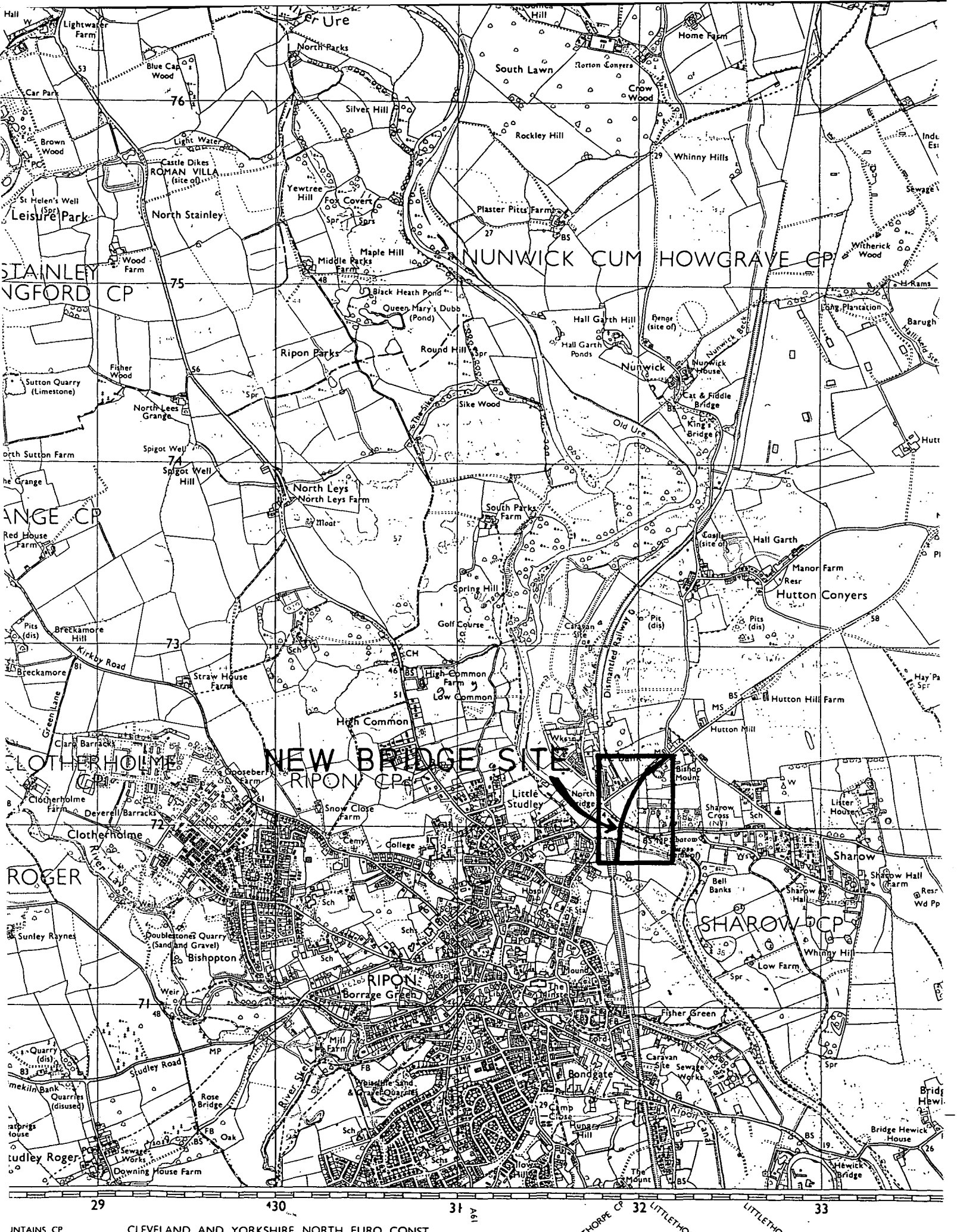


Figure 1. 1:25,000 scale location map for the Ripon area showing the position of the proposed Ure Bridge site.

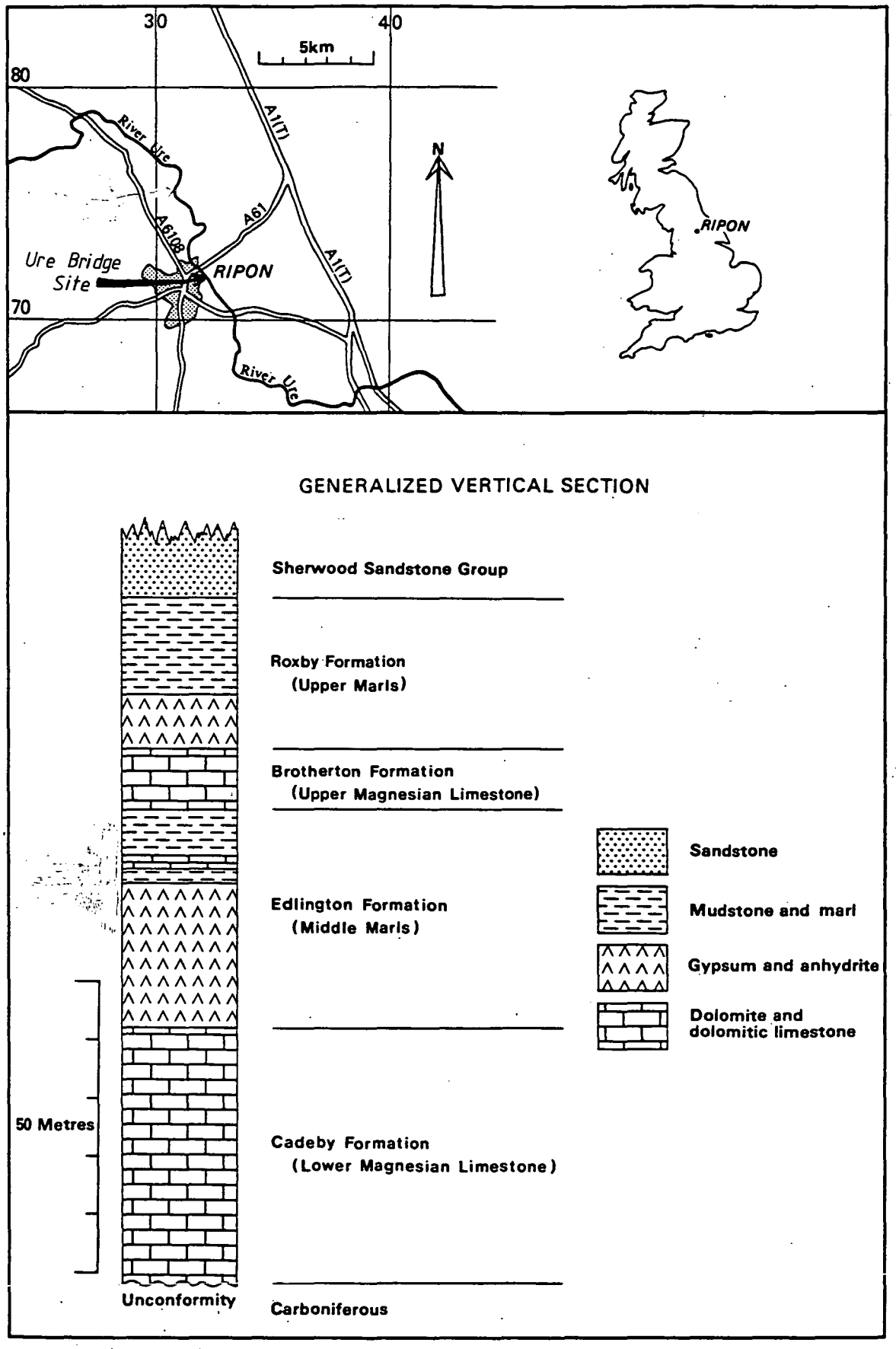


Figure 2. Generalised vertical section through the solid strata in the Ripon area, note the presence of thick gypsum sequences in the Edlington and Roxby formations.

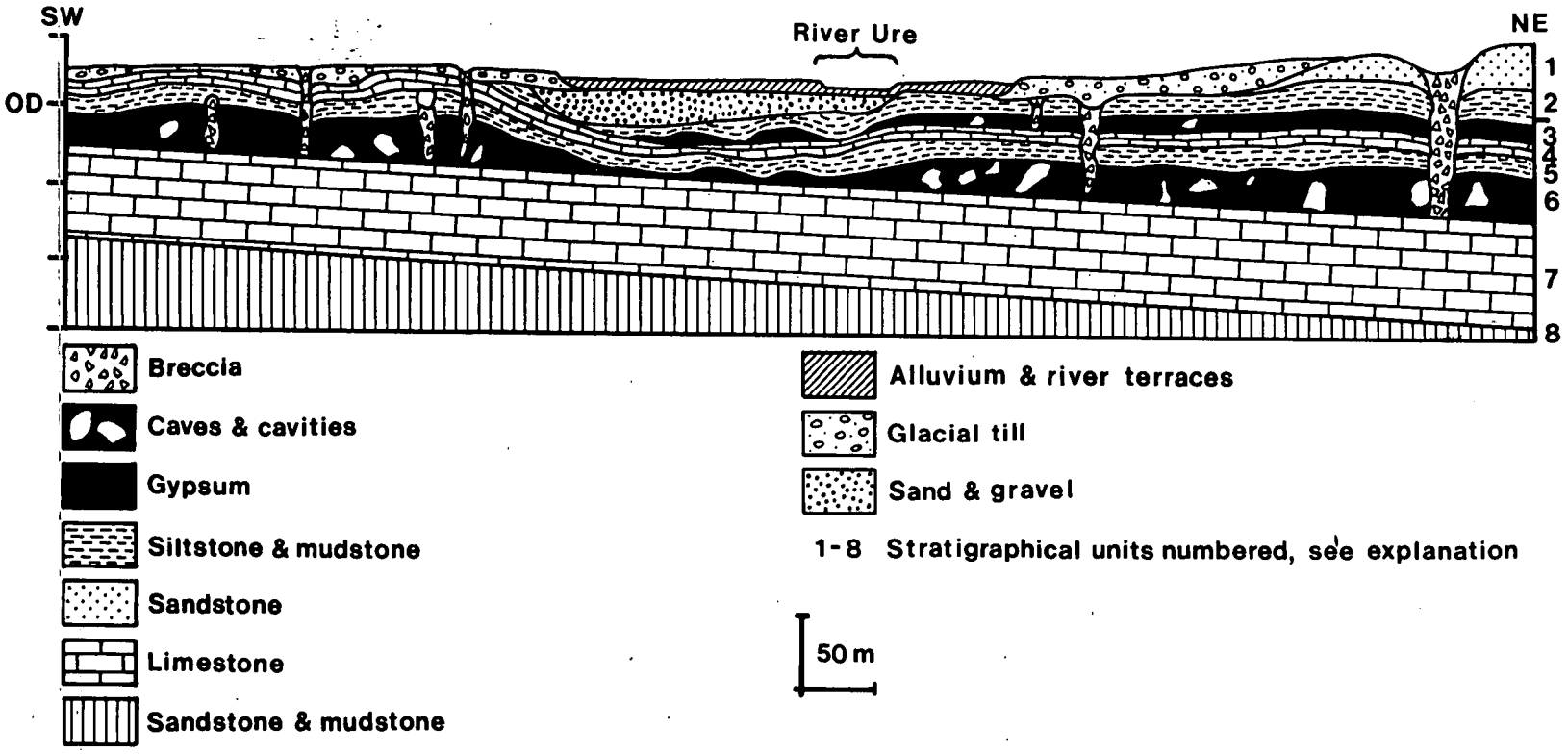


Figure 3. Cross-section from south-west to north-east just north of the proposed River Ure Bridge site to Ure Bank. The section is slightly stylised but is based on about 20 boreholes in the vicinity. The stratigraphical units are numbered as follows: 1 -Sherwood Sandstone Group; 2 - Roxby Formation; 3 - Gypsum in Roxby Formation; 4 - Brotherton Formation; 5 - Edlington Formation; 6 - Gypsum in Edlington Formation; 7 - Cadeby Formation; 8 - Carboniferous strata undivided. The cross-section shows the development of caves in the gypsum sequences and their upward propagation as breccia pipes. Numerous ages of breccia pipes are present, some filled in with glacial deposits and others only recently breaking the surface. Thick glacial sand and gravel deposits are shown in the Ure Valley below the present alluvial deposits; glacial till blankets much of the area adjacent to the Ure valley.

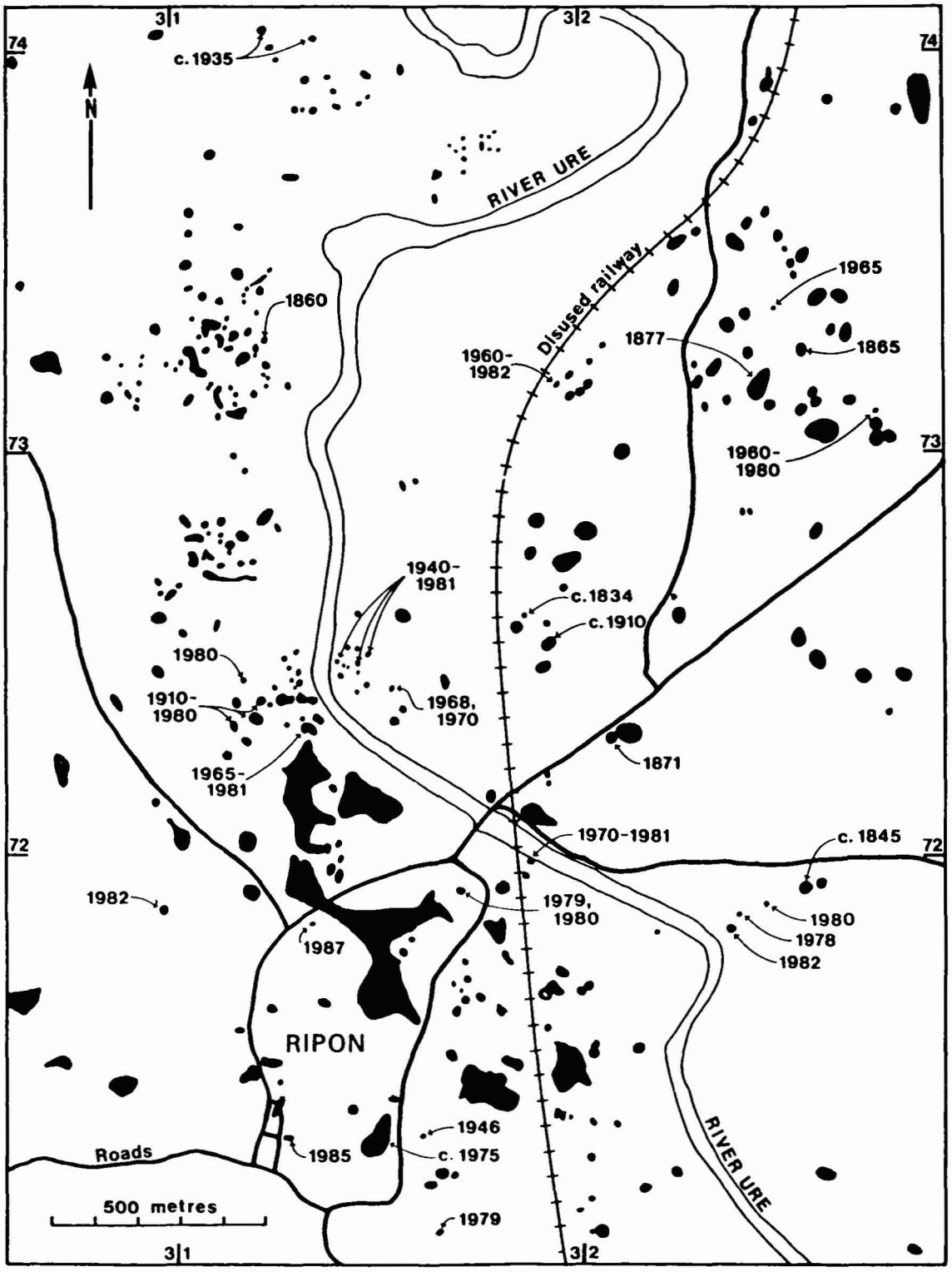


Figure 4. The distribution of subsidence hollows in the Ripon area with dates of subsidences where known (after Cooper 1989).

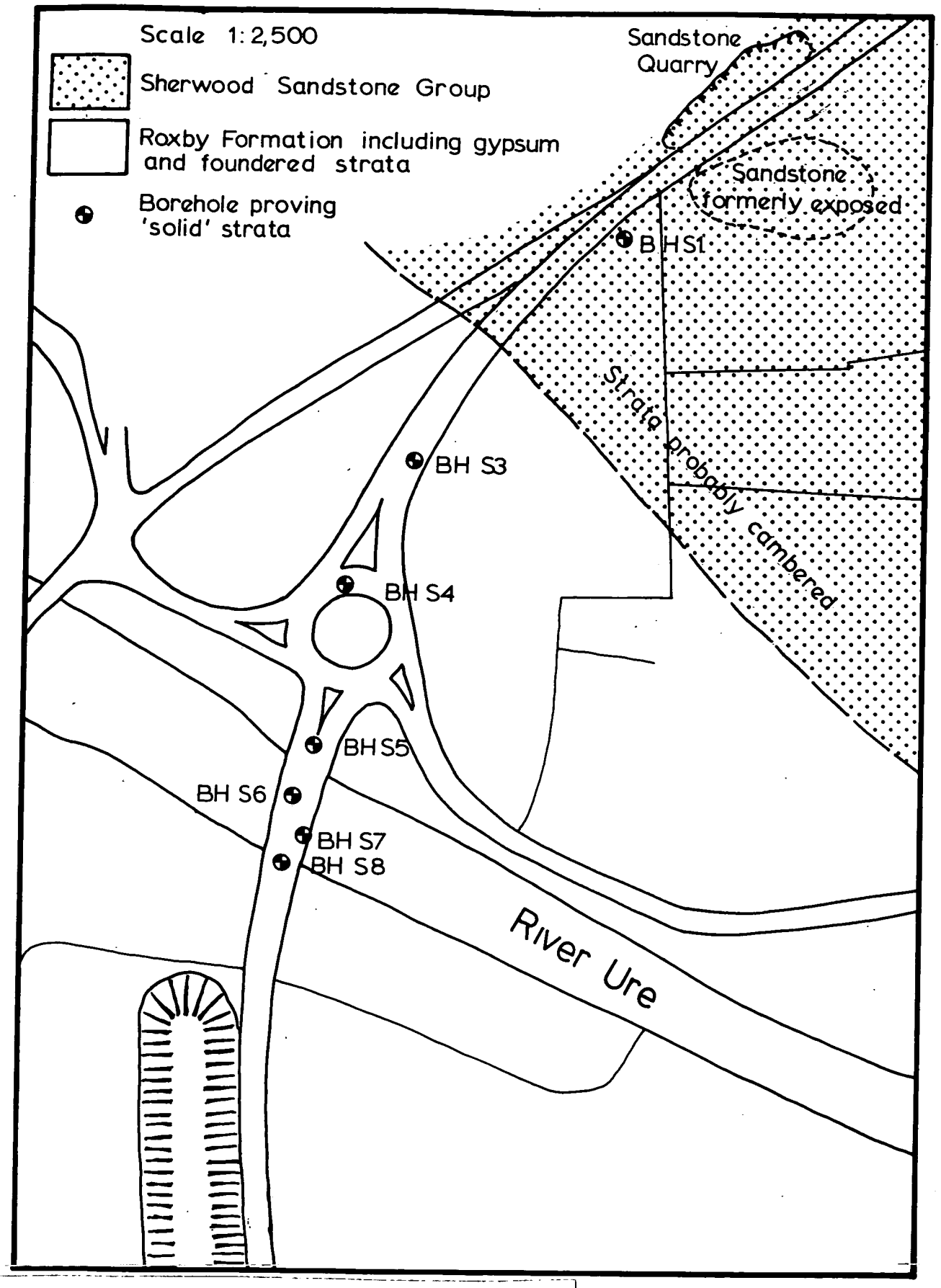


Figure 5. Solid geology of the proposed Ure bridge site

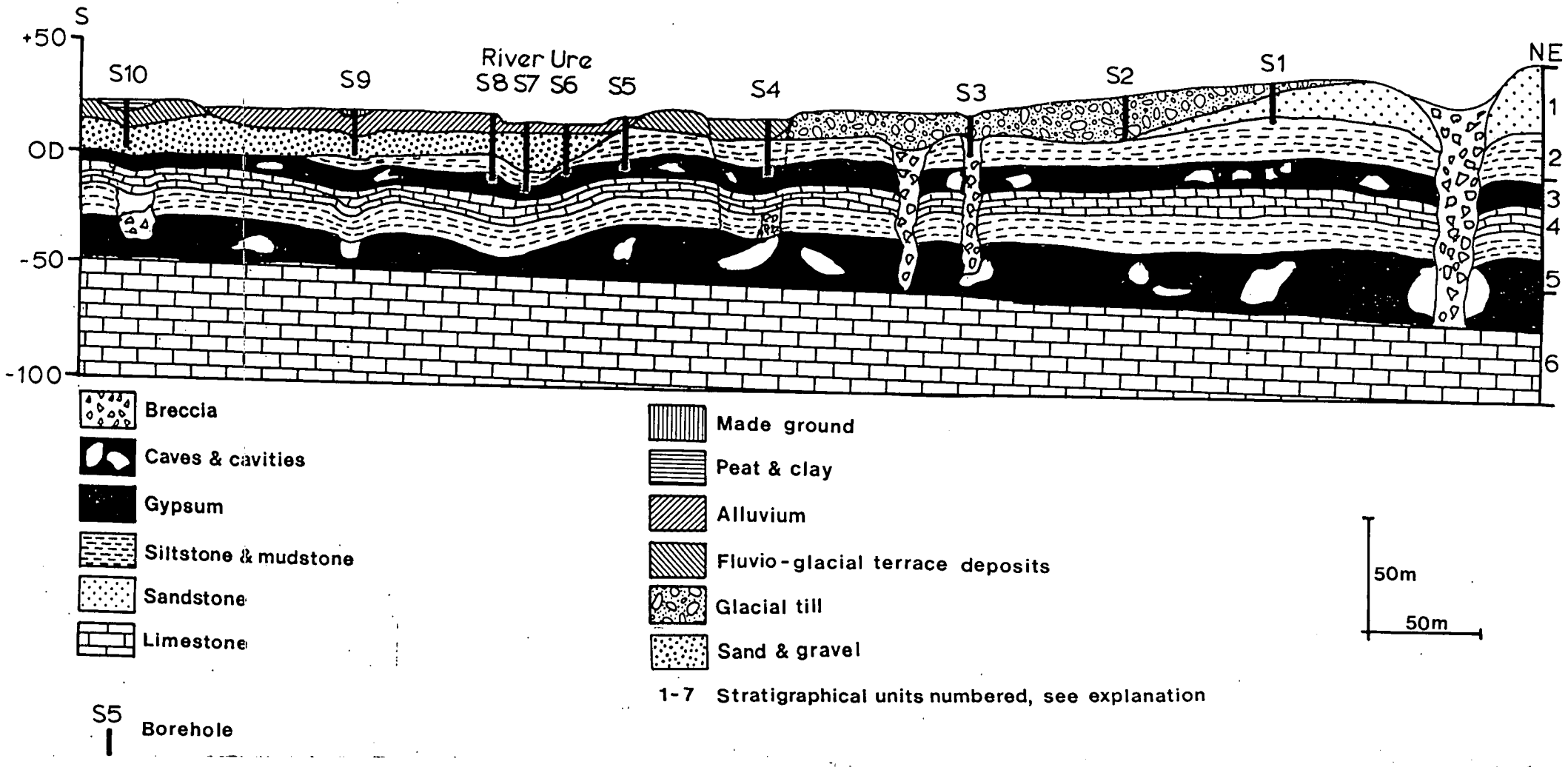


Figure 6. Cross-section through the Ure Bridge site investigation boreholes from south-west to north-east to Ure Bank. The section is stylised based on 10 boreholes along the line of the road. The stratigraphical units are numbered as follows: 1 -Sherwood Sandstone Group; 2 - Roxby Formation; 3 - Gypsum in Roxby Formation; 4 - Brotherton Formation; 5 - Edlington Formation; 6 - Gypsum in Edlington Formation; 7 - Cadeby Formation. The cross-section shows the development of caves in the gypsum sequences and their upward propagation as breccia pipes. Numerous ages of breccia pipes are present, some filled in with glacial deposits and others only recently breaking the surface. Thick glacial sand and gravel deposits are shown in the Ure Valley below the present alluvial deposits; glacial till blankets much of the area adjacent to the Ure valley. Except where a borehole has penetrated a breccia pipe, or where there is a subsidence hollow at the surface, the presence of caves and breccia pipes is artistic licence; the true distribution of caves and breccia pipes will only be determined by site investigation.

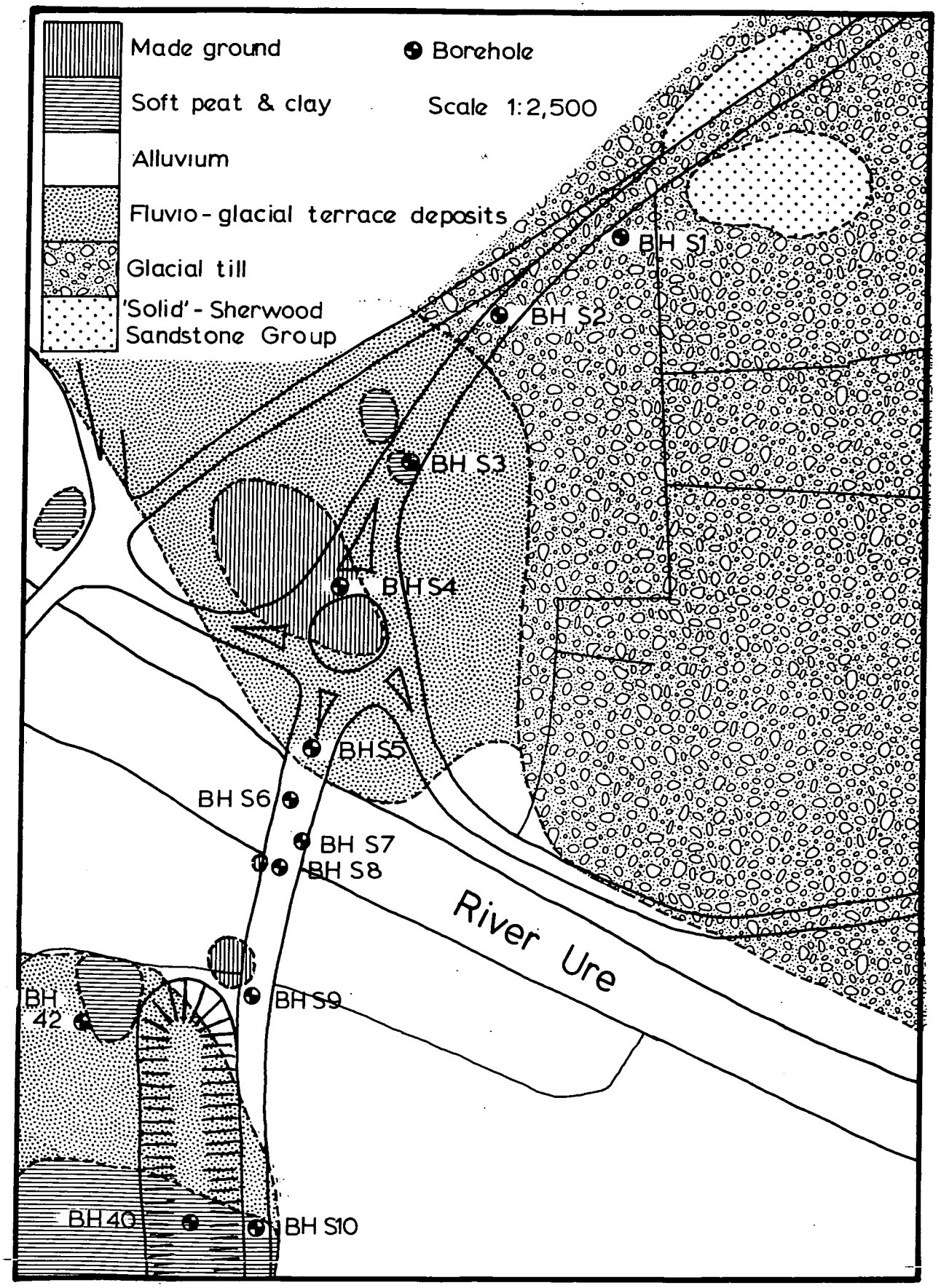


Figure 7. Drift geology of the proposed Ure bridge site

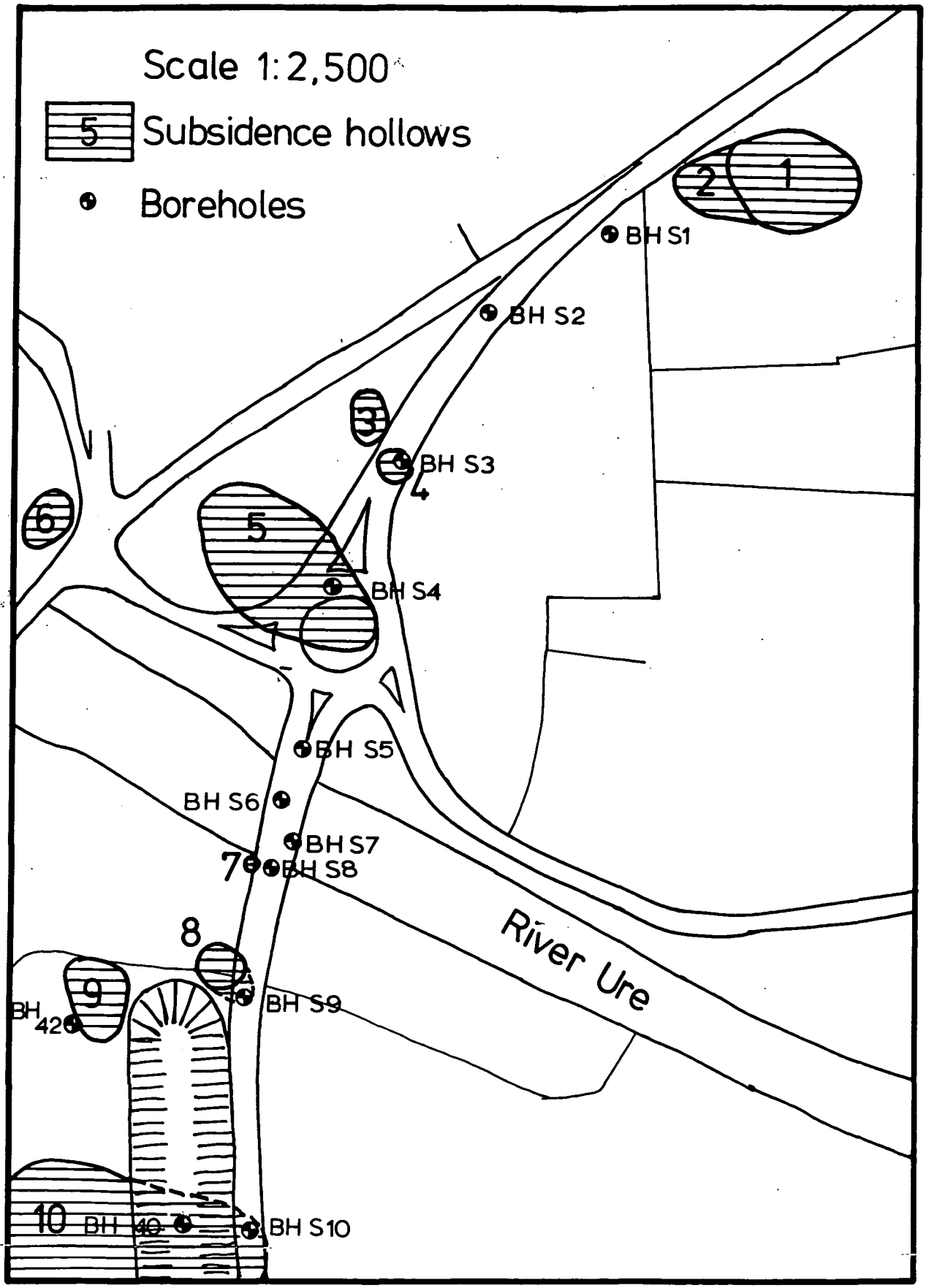


Figure 8. Subsidence features and borehole locations in the vicinity of the proposed Ure bridge site.

KEY SHEET

1. General

1.1 The comments in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. There may, however, be special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.

1.2 The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted, however, that groundwater levels vary owing to seasonal or other effects.

2. Borehole Records : Symbols and Abbreviations

2.1 Soil Samples

U General purpose : 100mm diameter undisturbed sample. Blow count is shown in brackets
U̸ Sample not obtained
J Small disturbed sample (Jar)
B Bulk disturbed sample
W Water sample

NOTE : Depths are given to the tops of samples

2.2 In situ Tests

S Standard penetration test (SPT). A 50mm diameter split spoon sampler is driven 450mm into the soil using a 65kg hammer with a 760mm drop, and the penetration resistance is expressed as the number of blows required to obtain 300mm penetration below an initial penetration of 150mm through any disturbed ground at the bottom of the borehole.

In the borehole record, the depth of the test is that at the start of the normal 450mm penetration. The number of blows to achieve the standard penetration of 300mm (the 'N' value) is shown after the test index letter, prefixed by the letter N, but the seating blows through the initial 150mm penetration are not reported. Where the full penetration has not been achieved, the number of blows fo. the actual penetration have been reported.

C In coarse granular soils, a 50mm diameter, 60° apex cone has been used in preference to the split spoon sampler. In this case, the symbol C has been used instead of the letter S.

V Vane test.

K Permeability test.

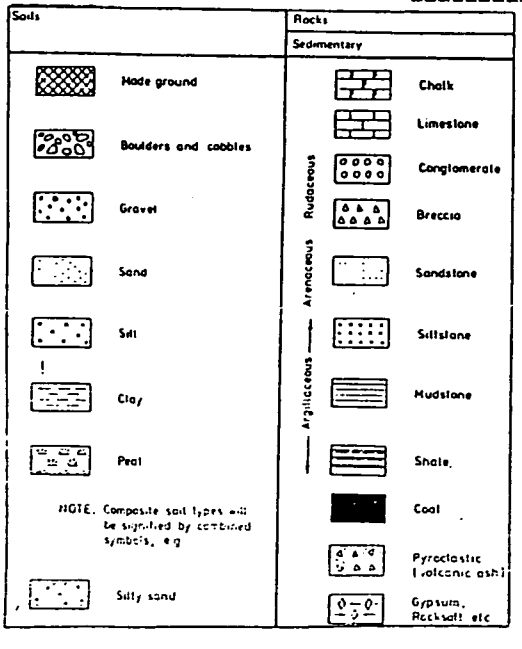
2.3 Rock Core Descriptions

TCR Total core recovery. The length of the total amount of core sample recovered expressed as a percentage of the length of core run.

SCR Solid core recovery. The length of core recovered as solid cylinders, expressed as a percentage of the length of core run.

RQD Rock quality designation. The sum length of all core pieces that are 10cm or longer, measured along the centre line of the core, expressed as a percentage of the core drilled.

SYMBOLS FOR SOIL AND ROCKS



Consistency		Undrained Shear Strength kN/m²	Field Indication
B.S.5930 1981	Widely Used		
Very Stiff	Hard	150	Brittle or very tough
Stiff	Stiff	100 - 150	Cannot be moulded in the fingers
	Firm to Stiff	75 - 100	
Firm	Firm	50 - 75	Can be moulded in the fingers by strong pressure
	Soft to Firm	40 - 50	
Soft	Soft	20 - 40	Easily moulded in the fingers
Very Soft	Very Soft	20	Exudes between the fingers when squeezed in the fist

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 8.00m BGL) 150mm (8.00 to 9.15m BGL)	Record of	
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 8.00m BGL) 150mm (8.00 to 8.92m BGL)	**BOREHOLE** S1	
Location	Ripon	Ground level (m O D) 40.39	Date commenced 16.8.90	(Sheet 1 of 2)	

Samples and in situ tests		Casing depth (m)	Water depth (m)	Piezometer Details		Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type								
0.20	J				Cover and Grout	0.35	MADE GROUND (Red brown, slightly clayey sandy topsoil, with many plant roots).	40.04	
0.50	J						Medium dense, dry, red brown, fine to medium SAND, with some angular fine to medium gravel.		
1.00	J,S N19				1.00 Sand Filter Tip at 1.40	1.50		38.89	
1.75	B	HSV 21KN/m²			1.50 Bentonite Seal		Stiff to very stiff, red brown, silty very sandy CLAY, with some fine to coarse gravel, some organic matter and occasional angular sandstone cobbles and boulders.		
2.00 - 2.45	U(105)								
2.50	J								
2.75	J								
3.00 - 3.38	U(80)	HSV 38KN/m²			3.30	3.30		37.09	
3.50	J						Medium dense to dense, red brown, silty fine to medium SAND, with some gravel to cobble sized pieces of red sandstone.		
3.75	J								
4.00 - 4.40	U(60)*								
4.50	J								
4.75	J								
5.00	U(80)*				Back-fill				
5.50	J								
5.75	J								
6.00	J	6.00	4.85			6.00			
6.00 - 6.50	J,S N35	6.00	4.85			17/8			
6.75	J						c.6.75m BGL Becoming very clayey with lenses of grey green sandstone.		
7.00	J,S N58						7.00m BGL Very dense and less clayey.		
7.50	B						(Sherwood Sandstone Group : Residual Soil)		
7.75	J								
8.00 - 9.00	J,S,B N84/ 127mm								
9.00	J,S N50/15mm	8.92	7.90			9.15		31.24	
9.15	RUN 1	TCR 48% SCR 22%			9.15	22/8	Dark red brown, fine grained, poorly cemented, moderately weathered SANDSTONE, weak to very weak.		
							(continued on Sheet 2 of 2)		

Remarks:

(1) Borehole advanced by chiselling from 7.90m to 9.15m BGL (2½ hours).
(2) Water added to assist boring from 1.00m BGL.
(3) Hand Shear Vane performed in base of undisturbed samples. Results given above.
* Soil too granular to perform test.
(4) Rotary coring commenced at 9.15m BGL, with coring diameter 76mm and air flush.

Local Grid Co-ordinates E:5069.5m N:11366.5m

Allied Exploration & Geotechnics Ltd.	**BOREHOLE RECORD** Scale 1 : 50 For explanation of symbols and abbreviations see Key Sheet	Contract No.	1176
	Client: North Yorks County Council (Bullen and Partners)	Fig.	4
	Contract: New Ure Bridge		

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 8.00m BGL) 150mm (8.00 to 9.15m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 8.00m BGL) 150mm (8.00 to 8.92m BGL)
Location	Ripon	Ground level (m O D) 40.39	Date commenced 16.8.90

Record of **BOREHOLE** S1 (Sheet 2 of 2)

Samples and in situ tests: Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
10.45	RUN 1 cont'd	RQD 0%			22/8 contd	(Continued from Sheet 1 of 2) Dark red brown, fine grained, poorly cemented, moderately weathered SANDSTONE, weak to very weak. (Triassic : Sherwood Sandstone) Detail: Very closely to closely spaced, horizontal, irregular, open, rough discontinuities, infilled with red brown, fine sand. 9.35 - 9.40m BGL Non-intact. 9.40 - 9.45m BGL Oblique open fracture, inclined at 60°. 10.30 - 10.45m BGL Non-intact. 10.45 - 10.53m BGL Completely weathered. 11.40 - 12.40m BGL Possible sand layer. 12.40 - 12.60m BGL Non-intact.		
10.45 11.40	RUN 2	TCR 40% RQD 37%	SCR 25%					
11.40 12.40	RUN 3	TCR 0% RQD 0%	SCR 0%		Sand Filter			
12.40 13.40	RUN 4	TCR 47% RQD 0%	SCR 14%		12.60		27.79	
					13.40	Grey green, fine grained, moderately well cemented, SANDSTONE, moderately strong. Detail: Closely spaced, subhorizontal, irregular, open, rough, discontinuities.	26.99	
13.40 14.40	RUN 5	TCR 33% RQD 36%	SCR 20%		Tip at 14.40	Dark red brown, thinly laminated, highly to completely weathered, MUDSTONE, weak to moderately strong. Detail: Close to medium spaced, horizontal, open, rough, irregular discontinuities, with red clay infilling on fracture surfaces. 13.55m BGL Oblique, open, rough fracture inclined at 30°. 14.00 - 14.40m BGL Non-intact.	25.99	
					14.40	End of Borehole		

Remarks:

(1) Twin piezometer installed as shown, on completion of drilling.

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1175

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 5

Boring method(s): Light Cable Percussion	Boring diameter (mm): 200mm (G.L. to 18.00m BGL)	Record of BOREHOLE S2
Boring equipment: Pilcon Wayfarer 1500	Casing diameter (mm): 200mm (G.L. to 10.72m BGL)	
Location: Ripon	Ground level (m O D): 33.74 / Date commenced: 20.8.90	(Sheet 1 of 2)

Samples and in situ tests: Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Detail: Cover	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
0.20	J			Cement/ Bentonite Grout	0.40	MADE GROUND (Dark brown, sandy topsoil, with many plant roots).	33.34	
0.50	J					Medium dense, red brown, slightly clayey fine to medium SAND, with some fine to coarse gravel.		
1.00	J,S N19			1.00	1.60		32.14	
1.75	B					Firm to stiff, thinly laminated, dark brown and red brown, sandy silty CLAY, with some fine to coarse gravel, some silt and sand partings and occasional organic material.		
2.00 - 2.45	U(60)	HSV 18KN/m²						
2.50	J			Sand Filter		c.2.50m BGL Band of very stiff, red brown, very sandy clay with some gravel.		
2.75	B							
3.00 - 3.45	U(70)*				3.50		30.24	
3.50	J					Stiff to very stiff, red brown, very sandy CLAY, with some sand layers and occasional gravel.		
3.75	J							
4.00 - 4.45	U(65)	HSV 121KN/m²						
4.50	J							
4.75	J							
5.00	B,Ø			Tip at 5.30				
5.50	J,S N21			5.50 Bentonite Pellets				
6.00	J,S N29			6.00		c.6.00m BGL Very sandy with grey green spots and occasionally laminated.		
6.75	J	6.75	DRY		6.75			
7.00	J,S N38	6.75	DRY		21/8			
7.00 - 7.50	B			Back-fill				
7.75	J							
8.00	J,S N38							
8.00 - 8.50	B							
8.75	J							
9.00	J,S N103					c.9.00m BGL Becoming very stiff.		
9.00 - 9.50	B							
9.75	J							
10.00	J,S N137							

Remarks:

(1) Borehole advanced by chiselling from 10.00m - 11.60m BGL (1 hour).
(2) Hand Shear Vane performed in base of undisturbed samples. Results given above.
* Soil too granular to perform test.

Local Grid Co-ordinates E:5015m N:11325.0m

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 5

Boring method(s): Light Cable Percussion	Boring diameter (mm): 200mm (G.L. to 18.00m BGL)		Record of BOREHOLE S2
Boring equipment: Pilcon Wayfarer 1500	Casing diameter (mm): 200mm (G.L. to 10.72m BGL)		(Sheet 2 of 2)
Location: Ripon	Ground level (m O D): 33.74	Date commenced: 20.8.90	

Samples and in situ tests		Casing depth (m)	Water depth (m)	Piezometer Details		Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type								
							(As sheet 1 of 2) Stiff to very stiff, red brown, very sandy CLAY, with some sand layers and occasional gravel.		
10.75	J								
11.00	J,S N105/ 225mm								
11.00 - 11.50	B								
11.75	J,S N87								
12.00 - 12.50	B								
12.75	J								
13.00	J,S N67								
13.00 - 13.50	B								
13.75	J								
14.00	J,S N107				Back-fill				
14.00 - 14.50	B								
14.75	J								
15.00	U(100)	HSV 124KN/m²							
15.50	J								
15.75	J								
16.00	U(120)	HSV 119KN/m²							
16.50	J								
16.75	J								
17.00	U(120)	HSV 108KN/m²							
17.50	J								
17.75	J								
		10.72	DRY			18.00		15.74	
							End of Borehole		

Remarks:

(1) Borehole advanced by chiselling from 16.00m to 17.50m BGL.
(2) Borehole terminated at 18.00m BGL on clients instruction. No rotary coring required.
(3) Standpipe piezometer installed on completion of boring. Details as shown above.

Allied Exploration & Geotechnics Ltd.	**BOREHOLE RECORD** Scale 1 : 50 For explanation of symbols and abbreviations see Key Sheet.	Contract No. 1175
	Client: North Yorks County Council (Bullen and Partners)	Fig. 7
	Contract: New Ure Bridge	

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 12.85m BGL) 150mm (12.85 to 18.25m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 12.40m BGL) 150mm (12.40 to 13.20m BGL)
Location	Ripon	Ground level (m O D) 25.83	Date commenced 14.8.90

Record of **BOREHOLE S3** (Sheet 1 of 2)

Samples and in situ tests		Casing depth (m)	Water depth (m)	Piezometer Details	Cover	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type								
							TOPSOIL. (1)		
						0.55		25.28	
0.55 - 1.00	B						Firm, orange brown and grey, sandy silty CLAY, with some organic matter.		
1.05 - 1.55	U(29)	HSV 94KN/m²			Cement and Bentonite Grout	1.30		24.53	
1.60	J						Firm, thinly laminated and fissured, brown to red brown, silty CLAY, with silt partings and grey silt veining.		
2.00 - 2.45	U(22)	HSV 13KN/m²							
2.55	J					2.90		22.93	
3.00 - 3.45	J,S N14				3.00		Medium dense, red, silty fine to medium SAND, with some lenses of soft, red brown clay.		
		3.50	DRY			3.50			
		3.50	DRY			15/8			
4.00 - 4.45	J,S N11				Sand Filter				
5.05 - 5.50	J,S N11								
5.60 - 6.00	B								
6.15 - 6.60	J,S N13								
					Tip at 6.80	7.00		18.83	
7.00 - 7.45	J,S N11				7.00		Soft, red brown, very sandy CLAY, with some medium gravel.		
8.00 - 8.60	U,B				Bentonite Pellets				
8.20	W								
8.60 - 9.05	J,S N18								
9.10 - 9.45	B						c.9.00m BGL Becoming firm and very silty, with some cobbles and occasional boulders.		
9.55 - 10.00	U(100)*	HSV 81KN/m²				9.80		16.03	
							(As sheet 2 of 2).		

Remarks:

(1) Description derived from drillers report.
(2) Water added to assist boring from 3.50m BGL.
(3) No definite water strike observed but standing water encountered from 9.00m BGL.
(4) Hand shear vane performed in base of undisturbed samples. Results given above.
* Soil to granular to perform test.

Local Grid Co-ordinates E:4969.7m N:11263.5m

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Client: North Yorks County Council (Sullen and Partners)

Contract: New Ure Bridge

Contract No. 1176

Fig. 8

Boring method(s): Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm): 200mm (G.L. to 12.85m BGL); 150mm (12.85 to 18.25m BGL)	Record of BOREHOLE S3
Boring equipment: Pilcon Wayfarer 1500	Casing diameter (mm): 200mm (G.L. to 12.40m BGL); 150mm (12.40 to 13.20m BGL)	(Sheet 2 of 2)
Location: Ripon	Ground level (m O D): 25.83	Date commenced: 14.8.90

Samples and in situ tests: Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details		Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
10.10	J						Very dense, red brown, silty SAND, with bands of red clay and some grey green veining and angular to subrounded gravel to cobble sized pieces of sandstone.		
10.70 - 11.15	U(130)	HSV 102KN/m²							
11.25	J					11.35		14.48	
11.35 - 11.60	B						Grey green, thickly laminated to thinly bedded, moderately weathered, MUDSTONE, very weak to weak.		
11.65 - 11.79	B,C¥ 50/140mm						Detail: Very closely to closely spaced, horizontal, irregular, rough, infilled with calcite, discontinuities, with bands of vesicular limestone.		
11.90 - 12.40	B						c.14.40m BGL Calcareous bed 30mm thick.		
12.55 - 12.85	B,C¥ 50/90mm						14.30 - 14.85m BGL Highly fractured and non-intact.		
13.00	J,C N50/30mm	12.40	8.10			12.85	15.70 - 16.05m BGL Highly fractured and non-intact.		
13.15	J,C N50/20mm	12.40	8.20			1678	16.47 - 16.51m BGL, 16.70 - 16.74m BGL, 17.40 - 17.44m BGL and 17.60 - 17.64m BGL Calcareous bed.		
13.20	RUN 1	TCR 9% RQD 0%	SCR 0%		Sand Filter		15.70 - 16.05m BGL, 16.10 - 16.20m BGL, 16.26 - 16.38m BGL, 16.50 - 16.70m BGL and 17.65 - 18.25m BGL Highly fractured and non-intact.		
14.30	RUN 2	TCR 27% RQD 0%	SCR 0%				(Permian : Roxby Formation)		
14.85		13.20	8.20			14.85			
14.85	RUN 3	13.20 TCR 0% RQD 0% NI	8.20 SCR 0%			1778			
15.70									
15.70	RUN 4	TCR 100%	SCR 0% RQD 0%						
16.05									
16.05	RUN 5	TCR 100%	SCR 0% RQD 0%						
16.60									
16.60	RUN 6	TCR 56% RQD 0%	SCR 15%						
17.50									
17.50	RUN 7	TCR 80% RQD 0%	SCR 4%		Tip at 18.20				
18.25		13.20	8.20			18.25		7.58	
							End of Borehole		

Remarks:

(1) Borehole advanced by chiselling from 9.00 - 9.40m BGL (½ hour).
(2) Borehole advanced by chiselling from 11.35 - 12.85m BGL (1½ hours).
(3) Borehole continued by rotary coring from 13.20m BGL to 18.25m BGL, with coring diameter 76mm and air-flush.
(4) Piezometer installed on completion of drilling, details as shown above.
¥ Seating blows only.

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 9

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 11.75m BGL) 150mm (11.75 to 25.00m BGL)	Record of	
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 10.00m BGL) 150mm (G.L. to 11.75m BGL)	BOREHOLE	S4
Location	Ripon	Ground level (m O D) 19.97	Date commenced 14.8.90	(Sheet 1 of 3)	

Samples and in situ tests		Casing depth (m)	Water depth (m)	Piezometer Details	Cover	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type								
0.20	J				Cement	0.35	MADE GROUND (Brown, sandy topsoil, with many plant roots).	19.62	
0.50	J						Firm, orange brown grey, sandy silty CLAY, with some gravel sized pieces of coal.		
1.00 - 1.40	U(35)	HSV 28KN/m²				1.30		18.67	
					1.30		Medium dense to dense, brown and grey, subangular to subrounded sandy medium to coarse GRAVEL, with some cobbles.		
1.50	J								
1.75	J								
3.00	B,C N27								
		3.50	2.00			3.50			
		3.50	2.00			15/8			
3.75	J								
4.00	B,C N39								
4.75	J				Granular Back-fill				
5.00	B,C N50								
5.75	J								
6.00	B,C N19								
						6.70		13.27	
6.80	J						Dense to very dense, red brown, subangular, sandy very clayey medium to coarse GRAVEL, with some cobbles.		
7.00	B,B,C N57								
7.75	J								
8.00	B,C N43						c.8.00m BGL Becoming less clayey.		
						8.30		11.67	
					8.50 Sand Filter		Very dense, brown and grey, subangular to rounded, slightly clayey sandy medium to coarse GRAVEL, with some cobbles.		
8.75	J								
9.00	B,C N54				Tip at 9.30				
						9.50		10.47	
9.75	J						Grey, thickly laminated, moderately weathered, calcareous MUDSTONE, weak to very weak.		
10.00	B,C N98/225mm	10.00	1.30						

Remarks:

(1) Attempted Falling Head Permeability at 2.60m BGL. Unable to bring head of water to ground level. Head reached 1.65m BGL. Water level dropped to 1.90m BGL after 20 minutes. (Standing Time 1 hour.

(2) Performed Falling Head Permeability at 4.50m BGL. (1 hour).

(3) Hand Shear Vane performed in base of undisturbed sample. Result given above.

Local Grid Co-ordinates E:4936.7m N:11207.5m

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD

Scale 1 : 50

For explanation of symbols and abbreviations see Key Sheet

Contract No. 1175

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 10

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 11.75m BGL) 150mm (11.75 to 25.00m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 10.00m BGL) 150mm (G.L. to 11.75m BGL)
Location	Ripon	Ground level (m O D) 19.97	Date commenced 14.8.90

Record of **BOREHOLE** S4 (Sheet 2 of 3)

Samples and in situ tests Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details		Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
		10.00	2.70			16/8	(As sheet 1 of 2) Grey, thickly laminated, moderately weathered, calcareous MUDSTONE, weak to very weak.		
10.75	J						Detail: Closely spaced, subhorizontal, planar and irregular, open, rough discontinuities infilled with calcite crystals.		
11.00	B,C 50/45mm						12.25 - 12.31m BGL Discoloured and iron stained.		
11.50	J,C,W 50/30mm	10.00	4.15			11.75	12.31 - 12.43m BGL Open subvertical fracture, inclined at 80° with some calcite infill on fracture surfaces. Iron stained.		
11.75	RUN 1	TCR 100% RQD 0%	2.00 SCR 0%			21/8	12.43 - 12.48m BGL Highly fractured and non-intact.		
12.25							12.48 - 12.55m BGL Vertical open fracture, inclined at 90° infilled with calcite and iron stained.		
12.25	RUN 2	TCR 83% RQD 13%	SCR 20% If 20/ 1000mm				12.55 - 12.70m BGL Non-intact.		
13.15							13.55 - 13.70m BGL Non-intact.		
13.15	RUN 3	TCR 83% RQD 34%	SCR 46% If 16/ 1000mm		Cement and Bentonite Grout		13.70 - 15.03m BGL Dark grey, completely weathered to stiff clay.		
14.40							(Permian : Roxby Formation)		
14.40	RUN 4	TCR 100% RQD 30%	SCR 36% If 12/1000mm						
14.90						15.03		4.94	
14.90	RUN 5	TCR 61% RQD 65%	SCR 44% If 5/ 760mm				Red brown and grey, occasionally laminated, slightly weathered, gypsiferous MUDSTONE, moderately strong. (Permian : Roxby Formation)		
16.15							Detail: 15.03 - 15.21m BGL Completely weathered.		
16.15	RUN 6	TCR 97% RQD 55%	SCR 82% If 8/ 1000mm				15.21 - 16.70m BGL Very closely spaced, horizontal to subhorizontal, open rough discontinuities with calcite infilling and very closely spaced subhorizontal to oblique fibrous gypsum veins.		
18.15							15.28 - 15.30m BGL Prominant fibrous gypsum vein inclined at 10°.		
18.15	RUN 7	TCR 66% RQD 40%	SCR 43% If 11/ 1000mm				15.30 - 16.15m BGL Grey, gypsiferous mudstone.		
19.90							16.74m BGL Recrystallised gypsum.		
							16.96 - 16.99m BGL Horizontal, open discontinuity infilled with clay and calcite.		
							17.41m BGL Prominant fibrous gypsum vein 30mm thick. Open fractures at 17.41 and 17.44m BGL.		
							18.25 - 18.31m BGL Brecciated and non-intact.		
							18.40 - 18.45m BGL Completely weathered to stiff red clay.		
							18.49 - 18.52m BGL Prominant gypsum vein, inclined at 60°.		
							18.53 - 18.71m BGL Very few gypsum veins.		
							19.00 - 19.20m BGL Completely weathered to red clay. Intact.		
							19.20 - 19.60m BGL Solution Cavity.		
							19.60 - 19.90m BGL Vertical, open fracture, infilled with calcite, with zone of brecciation at 19.90m BGL.		
							Continued on Sheet 3 of 3.		

Remarks:

(1) Borehole advanced by chiselling from 10.00 - 11.40m BGL (1 hour).
(2) Borehole advanced by chiselling from 11.40 - 11.75m BGL (1 hour).
(3) Borehole continued by rotary coring from 11.75m BGL to 25.00m BGL, with coring diameter 76mm and air-flush.
(4) Piezometer installed on completion of drilling, details as shown.

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 11

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 11.75m BGL) 150mm (11.75 to 25.00m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 10.00m BGL) 150mm (G.L. to 11.75m BGL)
Location	Ripon	Ground level (m O D) 19.97	Date commenced 14.8.90

Record of **BOREHOLE** S4 (Sheet 3 of 3)

Samples and in situ tests: Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
						Continued from Sheet 2 of 3.		
						20.18 - 20.19m BGL Prominant fibrous gypsum vein with open fractures at 20.18 - 20.20m BGL.		
						20.30 - 20.57m BGL Zone of solid gypsum showing secondary crystallisation at 20.42 - 20.52m (Alabastrine gypsum).		
	RUN 8	TCR 100% RQD 70%	SCR 83% If 7/ 1000mm			20.60m BGL Oblique open fracture inclined at 30° and infilled with soft red clay and gypsum.		
						20.90 - 20.95m BGL Mostly gypsum with very little grey mudstone.		
						20.95 - 21.39m BGL Very gypsiferous.		
						21.45 - 22.16m BGL Alabastrine gypsum with veins of recrystallisation.		
22.37						22.46 - 22.63m BGL Vertical gypsum veining.		
22.37				Cement and Bentonite Grout		22.92m BGL Horizontal, open fracture infilled with red clay.		
						23.15 - 23.63m BGL Gypsum, intact.		
						24.00 - 24.10m BGL Completely weathered to soft red clay.		
	RUN 9	TCR 94% RQD 84%	SCR 79% If 5/ 1000mm			24.68 - 24.80m BGL Gypsum, intact.		
						24.87 - 24.91m BGL Non-intact, moderately weathered.		
25.00					25.00		-5.03	
						End of Borehole		

Remarks:

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1175

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 12

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 7.00m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 7.00m BGL) 150mm (7.00 to 9.50m BGL)
Location	Ripon	Ground level (m O D) 19.91	Date commenced 28.8.90

Record of **BOREHOLE** S5 (Sheet 1 of 3)

Samples and in situ tests Depth (m)	Type	Casing depth (m)	Water depth (m)	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
				0.75	TOPSOIL. (1)	19.16	
1.00 - 1.50	B,W			1.30	MADE GROUND (Brown, slightly clayey sandy fill, with some organic material).	18.61	
1.65	J,S N13			2.40	Firm, orange brown and grey, silty very sandy CLAY, with some grey, silt veining and occasional gravel.	17.51	
2.35	J						
2.80 - 3.25	B,C,W N52			3.75	Dense to very dense, red brown, subangular to subrounded, sandy fine to coarse GRAVEL, with some cobbles.	16.16	
3.80 - 4.25	B,C N43				Light grey green, moderately weathered, calcareous MUDSTONE, weak. (Permian : Roxby Formation)		
		5.00	2.80	5.00			
5.00 - 5.45	B,C N52	5.00	2.80	29/8			
6.00 - 6.45	B,C N89						
7.00 - 7.20	J,C N50/70mm						
7.50 - 7.90	B						
7.90 - 8.00	J,C N50/50mm	7.60					
8.00	RUN 1	TCR 46% RQD 0%	SCR 9%		ROTARY CORING COMMENCED AT 8.00m BGL. Detail: Very closely to closely spaced, subhorizontal, open, rough, irregular infilled discontinuities. 8.00 - 9.00m BGL Non-intact, clacite infilling on fracture surfaces. 8.00 - 8.03m BGL Dolomitic limestone band. 9.10 - 9.20m BGL Subvertical open discontinuities with calcite. Inclined at 80°. 9.20 - 9.30m BGL Dolomitic limestone band. 10.00 - 10.24m BGL Non-intact.		
9.00							
9.20	RUN 2	TCR 75% RQD 0%	SCR 0%				
9.20	RUN 3	TCR 83% RQD 12%	SCR 49%		Continued on Sheet 2 of 3.		

Remarks:

(1) Description derived from drillers report.
(2) Borehole advanced by chiselling from 2.45 - 2.75m BGL (¾ hour).
(3) Borehole advanced by chiselling from 4.00 - 4.85m BGL (½ hour).
(4) Commenced rotary coring at 8.00m BGL. Barrel becoming fast at c.9.20m BGL. Casing advanced by percussive methods, with coring diameter 76mm. Flushing medium : Air.
(5) Borehole advanced by chiselling from 8.00 - 9.50m BGL (3½ hours).

Local Grid Co-ordinates E:4940.0m N:11127.5m

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Sullen and Partners)

Contract: New Ure Bridge

Fig. 13

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 7.00m BGL)	Record of	
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 7.00m BGL) 150mm (7.00 to 9.50m BGL)	BOREHOLE	S5
Location	Ripon	Ground level (m O D) 19.91	Date commenced 28.8.90	(Sheet 2 of 3)	

Samples and in situ tests		Casing depth (m)	Water depth (m)	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type						
10.40	RUN 3 cont'd		If 22/ 1000mm	10.50	Continued from Sheet 1 of 2. 10.30 - 10.50m BGL Completely weathered to dark grey clay.	9.41	
10.40	RUN 4	TCR 28% RQD 29%	SCR 14%	12.00	Dark grey, moderately weathered, gypsiferous MUDSTONE, weak. Very closely to closely spaced, subhorizontal to oblique fibrous gypsum veins.	7.91	
12.00	RUN 5	TCR 78% RQD 64%	SCR 49% If 12/ 1000mm		Dark red brown and dark grey, thinly laminated, completely to moderately weathered, gypsiferous MUDSTONE, moderately weak. Detail: Very closely to medium spaced, horizontal to subhorizontal, open rough irregular infilled, discontinuities. 12.00 - 12.03m BGL Fibrous gypsum vein. 12.03 - 12.15m BGL Completely weathered. 12.20m BGL Some secondary crystallisation. 12.68 - 12.69m BGL Prominant fibrous gypsum. 12.72 - 12.74m BGL Prominant fibrous gypsum vein inclined at 20°. 13.00 - 13.05m BGL Prominant gypsum vein with horizontal fractures at 13.00 and 13.05m BGL. 13.38 - 13.47m BGL Completely weathered to red clay. 13.85 - 13.86m BGL Gypsum vein inclined at 30°. 13.90 - 15.00m BGL Completely weathered. 15.00 - 15.04m BGL Gypsum vein. 15.04 - 15.15m BGL Extremely closely spaced subhorizontal gypsum veins. 15.15 - 15.17m BGL Gypsum vein. 15.25 - 15.70m BGL Grey mudstone. 15.70 - 15.95m BGL Highly to completely weathered and non-intact.		
15.00	RUN 6	TCR 100% RQD 42%	SCR 42% If 6/ 1000mm				
15.70	RUN 7	TCR 48% RQD 0%	SCR 0%	15.95		3.96	
16.75	RUN 8	TCR 84% RQD 22%	SCR 15%	17.00	Dark red, coarse grained, well cemented, moderately weathered, Breccio-CONGLOMERATE, moderately strong. Very closely to closely spaced, open horizontal rough irregular discontinuities.	2.91	
17.55	RUN 9	TCR 74% RQD 68%	SCR 53% If 8/ 1000mm		Red brown and grey, slightly weathered to moderately weathered, gypsiferous MUDSTONE. Detail: Close to medium spaced, horizontal to oblique, open, irregular rough, occasionally infilled discontinuities. 17.50 - 17.55m BGL Non-intact. 17.70 - 17.80m BGL Non-intact. 17.70 - 18.03m BGL Alabastrine Gypsum. 18.03 - 18.30m BGL Red mudstone, with extremely closely spaced gypsum veins. 18.30 - 18.56m BGL Non-intact and brecciated. 18.56 - 18.60m BGL Non-intact. 18.60 - 20.20m BGL Gypsum. Continued on Sheet 3 of 3.		

Remarks:

(1) Boring completed at 8.00m BGL and hole continued using rotary coring techniques, using coring diameter 76mm and air flush.

(2) On completion of drilling, hole backfilled with cement:bentonite grout, tremied down the borehole.

Allied Exploration & Geotechnics Ltd.	BOREHOLE RECORD Scale 1 : 50 For explanation of symbols and abbreviations see Key Sheet	Contract No.	1176
	Client: North Yorks County Council (Bullen and Partners)	Fig.	14
	Contract: New Ure Bridge		

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 7.00m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 7.00m BGL) 150mm (7.00 to 9.50m BGL)
Location	Ripon	Ground level (m O D) 19.91	Date commenced 28.8.90

Record of **BOREHOLE** S5 (Sheet 3 of 3)

Samples and in situ tests Depth (m)	Type	Casing depth (m)	Water depth (m)	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
20.20	RUN 9 cont'd				Continued from Sheet 2 of 3.		
20.20	RUN 10	TCR 100% RQD 77%	SCR 91% If 5/1000mm		20.20 - 20.40m BGL Grey, moderately weathered, mudstone, with some brecciation. 20.48 - 20.75m BGL Vertical gypsum vein 5mm diameter. 21.96 - 22.00m BGL Non-intact. 23.53 - 23.59m BGL Non-intact. 23.60 - 24.15m BGL Alabastrine gypsum. 24.21m BGL Open fracture inclined at 30°. 24.46 - 24.62m BGL Completely weathered to red clay. 24.62 - 25.00m BGL Alabastrine gypsum.		
23.15							
23.15	RUN 11	TCR 100% RQD 59%	SCR 88% If 6/1000mm				
25.10				25.10		-5.19	
					End of Borehole		

Remarks:

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1175

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 15

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 9.00m BRB) 150mm (9.00 to 15.60m BRB)	Record of	
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 9.00m BRB) 150mm (9.00 to 12.70m BRB)	**BOREHOLE** S6	
Location	Ripon	River Bed Level (m O D) 16.40	Date commenced 10.9.90	(Sheet 1 of 3)	

Samples and in situ tests		Casing depth (m)	Water depth (m)			Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type								
						10/9	Medium dense, brown, clayey sandy predominantly fine to medium subangular to subrounded GRAVEL.		
0.90 - 1.35	B,C N25								
2.00 - 2.45	B,C N17						Becoming very silty very gravelly SAND/very silty very sandy GRAVEL, with occasional firm, brown clay pockets and organic material (decomposed timber) at c.2.00m Below River Bed (BRB).		
3.10 - 3.55	B,C N48						Becoming dense, light brown, very sandy predominantly fine to medium subrounded to rounded GRAVEL, with occasional cobbles at c.3.10m BRB.		
4.00 - 4.45	B,C N43					5.00		11.40	
5.00 - 5.50	B,C 50/ 75mm						Very dense, light reddish brown, subangular to subrounded, fine to coarse cemented GRAVEL.		
6.05 - 6.20	B,C N50/ 60mm								
7.10 - 7.45	B,C N50/ 50mm	7.50	(6) 0.50			7.50			
		9.50	0.80			11/9			
8.10 - 8.35	B,C 50/ 50mm								
9.05 - 9.35	B,C 50/ 20mm								
		10.00	1.00			10.00			

Remarks:

(1) Falling Head Permeability test carried out at 2.80m BRB (1 hour).
(2) Borehole advanced by chiselling from 2.75 - 3.10m BRB (½ hour).
(3) Borehole advanced by chiselling from 5.00 - 7.50m BGL (3½ hours).
(4) Borehole advanced by chiselling from 7.50 - 9.00m BRB (3½ hours).
(5) Borehole advanced by chiselling from 9.00 - 10.00m BRB (½ hour).
(6) Water level above river bed.

Local Grid Co-ordinates E:4932m N:11112.8m

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 16

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 9.00m BRB) 150mm (9.00 to 15.60m BRB)	Record of	
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 9.00m BRB) 150mm (9.00 to 12.70m BRB)	**BOREHOLE** S6	
Location	Ripon	River Bed Level (m O D) 16.40	Date commenced 10.9.90	(Sheet 2 of 3)	

Samples and in situ tests		Casing depth (m)	Water depth (m)			Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type								
10.00 - 10.35	B,C N50/ 30mm						As sheet 1 of 3. Very dense, light reddish brown, subangular to subrounded, fine to coarse cemented GRAVEL.		
11.05 - 11.40	B,C N50/ 20mm								
13.55 - 13.70	B,C N50/ 40mm					14.85		1.55	
15.00	J						Pale grey white, slightly weathered, alabastrine GYPSUM, strong, interbedded with red brown, occasionally thinly laminated, weathered, silty MUDSTONE, moderately weak. Detail: 15.60 - 16.10m BRB Narrow irregular gypsum veining within mudstone. 16.10 - 16.46m BRB Occasional grey mudstone laminations within alabastrine gypsum. 16.46 - 16.83m BRB Moderately weathered mudstone, with clay infilling, closely spaced horizontal fractures. 16.83 - 18.23m BRB Alabastrine gypsum with occasional minor dissolution pockets. 18.22 - 18.28m BRB Non-intact alabastrine gypsum. 18.28 - 18.54m BRB Alabastrine gypsum, with occasional grey mudstone laminations, closely spaced, horizontal, rough fractures with some clay infilling. 18.80 - 18.85m BRB Collapse brecciation within gypsum and mudstone. 18.85 - 18.95m BRB Completely weathered mudstone. 19.00 - 19.32m BRB Alabastrine gypsum with occasional irregular veins of recrystallisation. 19.32 - 19.39m BRB Completely weathered mudstone. 19.39 - 19.70m BRB Collapse brecciation with mudstone and gypsum, clay infilling closely spaced horizontal fractures. 19.70 - 19.74m BRB Non-intact. 19.74 - 20.30m BRB Collapse brecciation with mudstone and gypsum, clay infilling closely spaced horizontal fractures.		
15.50 - 15.60	J,C 50/30mm								
15.60 - 16.10	RUN 1	TCR 20% RQD 0%	SCR 14%						
16.10 - 18.10	RUN 2	TCR 88% RQD 72%	SCR 80%						
18.10 - 19.00	RUN 3	TCR 97% RQD 27%	SCR 60%						
19.00	RUN 4	TCR 100% RQD 53%	SCR 84%						

Remarks:

(1) Borehole advanced by chiselling from 10.00 - 11.50m BRB (3½ hours).
(2) Borehole advanced by chiselling from 11.50 - 14.10m BRB (4½ hours).
(3) Borehole continued by rotary coring techniques from 15.60m BRB, with coring diameter 76mm and air flush.

Allied Exploration & Geotechnics Ltd.	**BOREHOLE RECORD** Scale 1 : 50 For explanation of symbols and abbreviations see Key Sheet	Contract No. 1176
	Client: North Yorks County Council (Bullen and Partners)	Fig. 17
	Contract: New Ure Bridge	

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 17.00m BRB) 150mm (17.00 to 26.50m BRB)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 16.20m BRB) 150mm (16.20 to 26.50m BRB)
Location	Ripon	River Bed Level (m O D) 16.66	Date commenced 3.9.90

Record of **BOREHOLE** S7 (Sheet 3 of 4)

Samples and in situ tests Depth (m)	Type	Casing depth (m)	Water depth (m)	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
20.00 - 20.15	B,C 50/ 65mm				(As sheet 2 of 4) Very dense, light brown, subangular to subrounded, fine to coarse, calcareous cemented GRAVEL.		
20.95 - 21.07	J,C N50/ 35mm						
21.25 - 21.85	B						
22.10 - 22.25	B,C N50/ 60mm						
			(1)				
		23.00	0.50	23.00			
23.05 - 23.15	J,C N50/50mm		0.50 (1)	7/9 23.30		-6.64	
23.30 - 23.60	B			23.60	Very stiff, green grey, silty CLAY.	-6.94	
24.00 - 24.50	B,C N50/40mm				Very dense, light brown, SAND, with many angular to subrounded, medium to coarse gravel, occasionally cemented and occasional cobbles.		
				24.80		-8.14	
24.85	J				Stiff, green grey/red grey, silty CLAY, with occasional fine to medium subangular to subrounded gravel and white fibrous gypsum.		
25.00 - 25.30	B,C N88/150mm						
				25.75		-9.09	
25.75 - 26.00	B				Pale grey white, slightly weathered, alabastrine GYPSUM, strong, interbedded with red brown, occasionally thinly laminated, weathered, silty MUDSTONE, moderately weak.		
26.00 - 26.10	J,C N50/50mm						
26.35 - 26.43	J,C N50/35mm						
26.50		TCR 56%	SCR 20%		Detail: 26.70 - 26.91m BRB Moderately to highly weathered mudstone, with irregular gypsum veining.		
	RUN 1	RQD 11%	NI		26.91 - 27.11m BRB Collapse brecciation of mudstone and gypsum. 27.11 - 28.10m BRB Non-intact mudstone. 28.58 - 29.70m BRB Alabastrine gypsum with irregular recrystallisation veins. Showing partial water dissolution at 28.58m BRB.		
28.10					29.70 - 29.75m BRB Highly weathered grey silty mudstone, with occasional subhorizontal gypsum veining.		
28.10		TCR 78%	SCR 59%		29.75 - 31.35m BRB Non-intact highly to completely weathered red/grey mudstone.		
	RUN 2	RQD 59%	NI				
29.70							
29.70	RUN 3	(cont'd on sheet 4 of 4)			Continued on Sheet 4 of 4.		

Remarks:

(1) Depth to water above river bed.
(2) Borehole advanced by chiselling from 23.00 - 26.50m BRB (4½ hours).
(3) Borehole continued by rotary coring from 26.50m BRB, with coring diameter 76mm and air flush.

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 21

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	200mm (G.L. to 17.00m BRB) 150mm (17.00 to 26.50m BRB)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 16.20m BRB) 150mm (16.20 to 26.50m BRB)
Location	Ripon	River Bed Level (m O D) 16.66	Date commenced 3.9.90

Record of **BOREHOLE** S7 (Sheet 4 of 4)

Samples and in situ tests: Depth (m)	Type	Casing depth (m)	Water depth (m)	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
	RUN 3 contd	TCR 47% RQD 0%	SCR 30% NI		Continued from Sheet 3 of 4..		
					31.35 - 31.50m BRB Collapse brecciation with mudstone and gypsum.		
31.50				31.50		-14.84	
					End of Borehole		

Remarks:

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 22

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	250mm(G.L. to 14.70m BGL) 150(19.00 to 200(14.70 to 19.00m BGL) 20.00m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	250mm(G.L. to 14.70m BGL) 150(19.00 to 200(14.70 to 19.00m BGL) 20.00m BGL)
Location	Ripon	Ground level (m O D) 20.54	Date commenced 3.9.90

Record of **BOREHOLE** S8 (Sheet 1 of 3)

Samples and in situ tests Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details	Vandal	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
					Proof Cover	3/9	TOPSOIL (Loose, dark brown, slightly clayey silty fine sand, with occasional fine rounded gravel, organic material (roots and rootlets) and silt bands)		
0.50	B								
1.00 - 1.45	J,S N9								
						1.60		18.94	
1.75	J						Medium dense, brown, slightly clayey silty very gravelly fine to medium SAND, with occasional organic material (rootlets). Gravels are fine to coarse subangular to subrounded.		
2.00 - 2.45	B,C N20								
					Cement and Bentonite Grout				
2.75	J								
3.00 - 3.45	B,C N41						Becoming dense, light brown, very sandy GRAVEL/very gravelly SAND at c.3.00m BGL. Gravels are fine to coarse angular to rounded.		
3.75	J						Becoming medium dense, brown, very sandy fine to coarse angular to rounded GRAVEL, with occasional soft brown red brown, silty clay pockets at c.3.75m BGL.		
4.00 - 4.45	B,C N13								
4.75	J								
5.00 - 5.45	B,C N14		(2) 5.00				Becoming light grey brown, very gravelly fine to coarse SAND, with occasional soft brown silty clay pockets at c.5.00m BGL.		
5.75	J								
6.00 - 6.45	B,C N16						Becoming very sandy predominantly fine to medium subrounded to rounded GRAVEL at c.6.00m BGL.		
6.75	J								
7.00 - 7.45	B,C N8						Becoming loose very gravelly SAND at c.7.00m BGL.		
					7.50 Sand Filter				
7.75	J								
8.00 - 8.45	B,C N25						Becoming medium dense, sandy predominantly medium subrounded to rounded GRAVEL at c.8.00m BGL.		
					Tip at 8.50	8.50		12.04	
8.75	J						Very dense, light red brown, subangular to sub-rounded, fine to coarse cemented GRAVEL.		
9.00	B,C N73/ 125mm	9.30	3.30		Cement and Bentonite Grout	9.30			
		9.30	3.20			4/9			
9.75	J								

Remarks:

(1) Water added to assist drilling from 1.60m BGL.
(2) Groundwater encountered at c.5.00m BGL.
(3) Performed Falling Head Permeability test at 7.60m BGL (1 hour).
(4) Borehole advanced by chiselling from 9.00 - 9.30m BGL (1 hour).

Local Grid Co-ordinates E:4924.6m N:11079.0m

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 23

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	250mm(G.L. to 17.50m BGL) 150(19.00 to 200(14.70 to 19.00m BGL) 20.00m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	250mm(G.L. to 17.50m BGL) 150(19.00 to 200(14.70 to 19.00m BGL) 20.00m BGL)
Location	Ripon	Ground level (m O D) 20.54	Date commenced 3.9.90

Record of **BOREHOLE S8** (Sheet 2 of 3)

Samples and in situ tests Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
10.00 - 10.45	B,C N122					(As sheet 1 of 3) Very dense, light red brown, subangular to subrounded, fine to coarse calcareous cemented GRAVEL.		
10.60	J							
10.75	J							
11.00 - 11.20	B,C 98/ 200mm							
11.75	J							
12.00 - 12.45	B,C N45							
12.75	J							
13.00	W	12.90	2.98		13.00			
13.00 - 13.50	B,C 93/ 200mm	13.00	3.20		5/9			
13.60	J							
13.75	J							
14.00	B,C 50/ 25mm							
15.00	B,C 50/ 38mm			Cement and Bentonite Grout				
					16.00		4.54	
16.00	B,U					Firm to stiff, red brown, silty CLAY, with occasional fine to medium subrounded gravel.		
16.50 - 16.95	U(40)	HSV 34KN/m²						
					17.00		3.54	
17.00	J					Red brown, with occasional green bands, occasionally thinly laminated, highly weathered MUDSTONE, very weak, with occasional veins of white fibrous gypsum.		
17.50 - 17.95	U(60)	HSV 34KN/m²						
18.00	J							
18.50	U(50)	HSV 47KN/m²						
		19.00	3.70		19.00			
19.00	J	19.00	3.20		6/9			
19.50	J,S 50/ 60mm							
19.75 - 20.00	B				20.00	Becoming moderately weathered, moderately strong at 19.75m BGL.		

Remarks:

(1) Borehole advanced by chiselling from 13.00 - 16.00m BGL.
(2) Performed Falling Head Permeability test at 13.00m BGL (45 minutes).
(3) Hand Shear Vane performed in base of undisturbed samples. Results given above.

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 11[illegible]

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 2

Boring method(s)	Light Cable Percussion & Rotary Pendant Attachment	Boring diameter (mm)	250mm(G.L. to 14.70m BGL) 200(14.70 to 19.00m BGL) 150(19.00 to 20.00m BGL)
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	250mm(G.L. to 14.70m BGL) 200(14.70 to 19.00m BGL) 150(19.00 to 20.00m BGL)
Location	Ripon	Ground level (m O D) 20.54	Date commenced 3.9.90

Record of **BOREHOLE S8** (Sheet 3 of 3)

Samples and in situ tests Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
20.00						Continued from Sheet 2 of 3.		
	RUN 1	TCR 96% RQD 28%	SCR 75%			White grey, slightly weathered, alabastrine GYPSUM, strong, interbedded with red brown, occasionally thinly laminated, moderately weathered, silty MUDSTONE, moderately weak.		
21.10						Detail:		
21.10						20.00 - 20.45m BGL Brecciation of mudstone and gypsum within alabastrine gypsum.		
						20.45 - 20.83m BGL Moderately to highly weathered red brown mudstone, claosely spaced, horizontal to subhorizontal fractures and subhorizontal veins of gypsum.		
	RUN 2	TCR 93% RQD 66%	SCR 84%	Cement and Bentonite Grout		20.83 - 22.10m BGL Alabastrine gypsum with occasional irregular recrystallisation veins and thin laminations of grey silty mudstone. Fractures open, inclined 30° moderately smooth showing signs of water dissolution.		
						22.10 - 22.23m BGL Moderately weathered mudstone.		
						22.53 - 22.89m BGL Occasional collapse brecciation with alabastrine gypsum.		
						22.89 - 22.91m BGL Red brown clay infilling open horizontal fractures.		
24.10						24.10 - 25.10m BGL Occasional collapse brecciation with alabastrine gypsum.		
						25.10 - 25.33m BGL Open, horizontal, rough fractures.		
24.10						25.53 - 25.74m BGL Red brown clay infilling open horizontal fractures.		
	RUN 3	TCR 93% RQD 42%	SCR 77%			25.74 - 26.34m BGL Alabastrine gypsum with occasional collapse brecciation and dissolution cavities closely spaced, subhorizontal fractures with some red brown clay infilling.		
						26.86 - 26.90m BGL Highly weathered red brown mudstone.		
26.00						26.90 - 27.60m BGL Closely spaced, horizontal fractures with red brown clay infilling.		
						27.60 - 27.70m BGL Highly to completely weathered mudstone with irregular gypsum veining.		
26.00						27.70 - 28.40m BGL Alabastrine gypsum with occasional red brown and grey mudstone showing collapse brecciation.		
						28.40 - 28.58m BGL Highly weathered, red brown mudstone.		
	RUN 4	TCR 98% RQD 52%	SCR 80%	27.00 Sand Filter		28.58 - 29.00m BGL Occasional collapse brecciation and prominent narrow vertical gypsum veining.		
29.00		20.00	3.70	Tip at 29.00	29.00		-8.46	
						End of Borehole		

Remarks:

(1) Borehole continued by rotary coring from 20.00m BGL, with coring diameter 76mm and air flush.
(2) Piezometer installed on completion. Details as shown.

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD
Scale 1 : 50
For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 25

Boring method(s)	Light Cable Percussion	Boring diameter (mm)	200mm (G.L. to 18.75m BGL)	Record of	
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 18.75m BGL)	BOREHOLE	S9
Location	Ripon	Ground level (m O D) 20.32	Date commenced 28.8.90	(Sheet 1 of 2)	

Samples and in situ tests Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details	Cover	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
							MADE GROUND (Soft to firm, brown, very sandy clay, with some medium gravel and some organic matter).		
0.50	J								
1.00 - 1.43	U(30)								
1.50	J				Cement and Bentonite Grout				
1.75	B								
2.00 - 2.50	U(25)					2.30		18.02	
							Soft, dark grey and brown, clayey sandy SILT, with some organic material. Odorous. c.2.75m BGL Becoming predominantly dark grey.		
2.50	J								
2.75	J								
3.00 - 3.50	U(40)					3.40		16.92	
							Medium dense, orange brown, coarse SAND, with some coarse gravel.		
3.50	J								
3.75	J					3.90		16.42	
4.00	J,S N19						Medium dense, dark red brown, slightly clayey silty fine SAND, with some small to medium gravels. Coarsening with depth to medium to coarse sand with some fine to coarse gravel.		
4.75	J								
5.00	J,S N19				5.00 Sand Filter				
5.75	B								
6.00	J,S N21				Tip at 6.00 6.00				
6.75	J								
7.00	J,S N23								
7.75	B				Back-fill				
8.00	J,S,W N38					8.70		11.62	
							Dense, red brown, subangular to subrounded very sandy fine to coarse GRAVEL, with many cobbles and boulders.		
8.75	J								
9.00	J,S								
9.00 - 9.50	N34 B								
10.00 - 10.50	B,C N45								

Remarks:

(1) Borehole advanced by chiselling from 9.50 - 9.90m BGL (½ hour).

(2) Groundwater encountered at 3.50m BGL. Water level rose to 3.00m BGL after 20 minutes.

Local Grid Co-ordinates E:4901.0m N:11029.2m

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD

Scale 1 : 50

For explanation of symbols and abbreviations see Key Sheet

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Contract No. 1176

Fig. 25

Boring method(s)	Light Cable Percussion	Boring diameter (mm)	200mm (G.L. to 18.75m BGL)	Record of
Boring equipment	Pilcon Wayfarer 1500	Casing diameter (mm)	200mm (G.L. to 18.75m BGL)	BOREHOLE S9
Location	Ripon	Ground level (m O D) 20.32	Date commenced 28.8.90	(Sheet 2 of 2)

Samples and in situ tests		Casing depth (m)	Water depth (m)	Piezometer Details		Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type								
							(As sheet 1 of 2)		
		10.50	3.90			10.50	Dense, red brown, subangular to subrounded very sandy fine to coarse GRAVEL, with many cobbles and boulders.		
		10.50	2.30			29/8			
10.75	J								
11.00	B,C N33								
11.75	J								
						12.00		8.32	
12.00 - 12.50	B,C N86/ 150mm						Very dense, red brown, subangular to subrounded, fine to coarse cemented GRAVEL.		
12.75	J								
13.00 - 14.00	B								
14.00	B,C N50/ 75mm				Back-fill				
		15.00				15.00			
15.00	B,C,W N49	15.00	2.65			30/8	c.15.00m BGL Becoming grey brown.		
15.75	B								
16.00	B,C N72								
16.75	J								
17.00	B,C N120								
17.75	J								
18.00	B,C N78								
		18.75	4.20			18.75		1.57	
							End of Borehole		

Remarks:

(1) Borehole advanced by chiselling from 11.50 to 15.00m BGL (5 hours).
(2) Borehole terminated on clients instruction at 18.75m BGL.
(3) Piezometer installed on completion of boring. Details as shown.

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD

Scale 1 : 50

For explanation of symbols and abbreviations see Key Sheet

Contract No. 1175

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 27

Boring method(s): Light Cable Percussion	Boring diameter (mm): 200mm (G.L. to 20.00m BGL)		Record of BOREHOLES10
Boring equipment: Pilcon Wayfarer 1500	Casing diameter (mm): 200mm (G.L. to 20.00m BGL)		(Sheet 1 of 2)
Location: Ripon	Ground level (m O D): 21.02	Date commenced: 22.8.90	

Samples and in situ tests		Casing depth (m)	Water depth (m)	Piezometer Details	Cover	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
Depth (m)	Type								
0.20	J					0.25	MADE GROUND (Brown, sandy, topsoil).	20.77	
0.50	J				Cement and Bentonite Grout		Soft to firm, orange brown and grey mottled, silty CLAY, with some grey silt veining and occasional gravel, and much organic material.		
1.00 - 1.50	U(25)	HSV 43KN/m²				1.30		19.72	
						1.60	Soft to firm, dark grey, silty CLAY, with much organic material. Odorous.	19.42	
1.75	J						Soft, spongey, black, very clayey PEAT, with occasional gravel. Odorous.		
2.00 - 2.50	U(30)	HSV 43KN/m²							
2.50	J								
2.75	J								
3.00 - 3.50	U(30)	HSV 43KN/m²				3.30		17.72	
					3.50 Sand Filter		Very soft, light grey green, black and brown, very silty CLAY, with much organic material and occasional shell fragments.		
3.75	J								
		4.40	DRY		Tip at 4.40	4.40			
4.40 - 4.96	P	4.40	DRY		4.50	23/8 4.75		16.27	
5.00 - 5.50	U(25)	HSV 59KN/m²			Bentonite Pellets		Soft to firm, dark grey and black brown, silty very peaty CLAY. Odorous.		
5.50	J								
5.75	B					5.90		15.12	
6.00 - 6.50	U(30)	HSV 21KN/m²	(2)				Soft, moist, grey, slightly clayey sandy SILT.		
6.50	J,W								
6.75	B					7.00		14.02	
7.00	J				7.00		Medium dense, grey, subangular to subrounded, sandy fine to coarse GRAVEL, with many cobbles.		
7.50	B,C N23								
					Back-fill				
8.25	J								
8.50 - 9.00	B,C N27								
							c.9.00m BGL Becoming reddish brown.		
9.25	J								
9.50	B,C N31								
10.00	B,C N37					10.00		11.02	

Remarks:

(1) Borehole advanced by chiselling from 8.25 to 8.50m BGL (½ hour).
(2) Groundwater encountered at 6.30m BGL. Water level rose to 5.20m BGL after 20 minutes.
(3) Hand Shear Vane performed in base of undisturbed samples. Results given above.

Local Grid Co-ordinates E:4914.0m N:10925.1m

Allied Exploration & Geotechnics Ltd.

BOREHOLE RECORD

Scale 1 : 50

For explanation of symbols and abbreviations see Key Sheet

Contract No. 1176

Client: North Yorks County Council (Bullen and Partners)

Contract: New Ure Bridge

Fig. 28

Boring method(s): Light Cable Percussion	Boring diameter (mm): 200mm (G.L. to 20.00m BGL)		Record of BOREHOLE S10
Boring equipment: Pilcon Wayfarer 1500	Casing diameter (mm): 200mm (G.L. to 20.00m BGL)		(Sheet 2 of 2)
Location: Ripon	Ground level (m O D): 21.02	Date commenced: 22.8.90	

Samples and in situ tests: Depth (m)	Type	Casing depth (m)	Water depth (m)	Piezometer Details	Date and Depth (m)	Description of Strata	O D level Depth (m)	Legend
						Dense, red brown, slightly clayey silty medium to coarse SAND, with some fine to medium gravel.		
10.75	J							
11.00	J,S N35							
11.75	J							
12.00	J,S N39							
12.75	J							
13.00	J,S N48							
13.75	B			Back-fill				
		14.00	7.80		14.00			
14.00	J,S N55	14.00	5.20		24/8			
14.75	B							
15.00	J,S N50							
15.75	J							
16.00	J,S N45							
16.75	J							
17.00	J,S N51							
17.75	J							
18.00	J,S N53							
18.75	J							
19.00	J				19.00			
					Sand Filter			
19.50	J,S N68							
		20.00	6.30		Tip at 20.00 / 20.00		1.02	

End of Borehole

Remarks:

(1) Twin piezometer installed on completion of boring. Details as shown.

Allied Exploration & Geotechnics Ltd.	BOREHOLE RECORD Scale 1 : 50 For explanation of symbols and abbreviations see Key Sheet	Contract No. 1176
	Client: North Yorks County Council (Bullen and Partners)	Fig. 29
	Contract: New Ure Bridge	

B.H. 40
Sheet 1 of 2

NORTH YORKSHIRE COUNTY COUNCIL
HIGHWAYS LABORATORY

BOREHOLE LOG

LOCATION: Ripon Bypass
DATES OF BORING: 10.11.87 - 17.11.87
BOREHOLE No.: 40 GROUND LEVEL: 26.45 m. A.O.D.

SOIL DESCRIPTION	Legend	Sample	Test, Result	Progress Water-Levels	Instrumentn	Depth, Reduced Level
TOPSOIL						
Brown and dark grey silty sandy CLAY with some gravel						1.11
Red brown very sandy CLAY/clayey SAND with some gravel			(55)	←		
			(28)			
			(32)			
			(50)			
						5.72
Firm dark grey silty laminated CLAY			(63)			5.98
Red brown and grey silty sandy CLAY with some gravel			(65)			
			(98)			
			(95)			

Key to Symbols:
- ● Disturbed Sample.
- ▮ Bulk Disturbed Sample (Depth range).
- Δ Water Sample.
- ▮ 105mm. Undisturbed Sample.
- ▮ S.P.T. Depth range, N=No of blows.
- ←— Water Strike
- V - Vane Test.
- k - Mean Permeability.
- ( ) - Layer Thickness

Scale 1:50 | Loca. Ripon Bypass | Fig. A40

B.H. 40
Sheet 2 of 2

NORTH YORKSHIRE COUNTY COUNCIL
HIGHWAYS LABORATORY

BOREHOLE LOG

LOCATION: Ripon Bypass
DATES OF BORING: 10.11.87 - 17.11.87
BOREHOLE No.: 40 GROUND LEVEL: 26.45 m.A.O.D.

SOIL DESCRIPTION	Legend	Sample	Test Result	Progress Water-Levels	Instrument	Depth, Reduced Level
As sheet 1			(95)			10.47
Firm to stiff dark brown silty laminated CLAY with occasional sand partings			(84)			
			(88)	slight ←		11.93
Dark grey/black silty sandy CLAY (compressed organic PEAT)			(120)			12.80
Soft to firm dark grey silty sandy CLAY				←		13.40
GRAVEL with a little sand			N 16			
BOULDER CLAY			N 36			16.21
BOULDER CLAY						16.36
GRAVEL with a little sand			N 29			17.50
Borehole completed at 17.50m (88) blows for U100 sample						

Key to Symbols:
- ● Disturbed Sample.
- ↕ Bulk Disturbed Sample (Depth range).
- Δ Water Sample.
- ▮ 105mm. Undisturbed Sample.
- | S.P.T. Depth range, N=No of blows.
- ← Water strike
- V - Vane Test.
- k - Mean Permeability.
- ( )- Layer Thickness

Scale 1:50 | Locn. Ripon Bypass | Fig. A40

B.H. 42
Sheet 1 of 1

NORTH YORKSHIRE COUNTY COUNCIL
HIGHWAYS LABORATORY
BOREHOLE LOG

LOCATION: Ripon Bypass
DATES OF BORING: 19.10.87 - 21.10.87
BOREHOLE No.: 42 GROUND LEVEL: 20.60 m.A.O.D.

SOIL DESCRIPTION	Legend	Sample	Test, Result	Progress Water-Levels	Instrument	Depth, Reduced Level
TOPSOIL						0.42
Firm dark brown silty slightly sandy CLAY with a little gravel			(44)			1.25
Soft to firm yellow brown and brown silty very sandy CLAY with some gravel			(29)	Slight ←		2.04
Brown clayey SAND with some gravel				←		5.00
Firm red brown very sandy CLAY with some gravel			(120)			
			(123)			7.40
Borehole completed at 7.40m (120) blows for U100 sample						

Key to Symbols:
- ● Disturbed Sample.
- ↕ Bulk Disturbed Sample (Depth range).
- Δ Water Sample.
- ▮ 105mm. Undisturbed Sample.
- | S.P.T. Depth range, N=No of blows.
- ← Water Strike
- V - Vane Test.
- k - Mean Permeability.
- ( ) - Layer Thickness

Scale 1:50 | Locn. Ripon Bypass | Fig. A42