

CROMWELL WOOD ESTATE COMPANY LIMITED
Mining Engineers and Development Consultants

February 2007

REFERENCE NO. JGP/SHQ/HRA-001

Prepared by:-

Cromwell Wood Estate Company Limited
Butterfield House
59 Oakenshaw Lane
Wakefield
WF2 6NJ

Tel : 01924 255666
Fax : 01924 255666

On behalf of:-

J.G.Pears Limited
Bella Vista
Harthill
Penistone
S36

Tel : 01226 712696

CONTENTS

1.0	Introduction	1
2.0	Conceptual Hydrogeological Site Model: Sources	3
3.0	Conceptual Hydrogeological Site Model: Pathways	8
4.0	Conceptual Hydrogeological Site Model: Receptors.....	16
5.0	Hydrogeological Risk Assessment	18
6.0	Numerical Modelling	23
7.0	Emissions To Groundwater	26
8.0	References	

DRAWINGS

Drawing JGP/00/0001	Planning Application Boundary
Drawing JGP/SH/WS/01	Existing Site Layout
Drawing JGP/SH/WS/02	Phase 1
Drawing JGP/SH/WS/03	Phase 2
Drawing JGP/SH/WS/04	Phase 3
Drawing JGP/SH/WS/05	Phase 5
Drawing JGP/SH/151007/01	Water Features
Drawing JGP/SHQ/HRA01	Conceptual Hydrogeological Site Model (Plan)
Drawing JGP/SHQ/HRA02	Conceptual Hydrogeological Site Model (Section)
Drawing JGP/SH/GEOL 01	Regional Geology
Drawing JGP/SH/GEOL 02	Local Geology 1932 edition
Drawing JGP/SH/GEOL 03	Local Geology 1872 edition
Drawing sh 2002/273	Extrapolated Geology

TABLES (in Text)

Table HRA1.	The prior investigations that have occurred at the site.
Table HRA2.	Results of water quality analysis on a sample of runoff from existing waste areas in a Sandstone Quarry at the East Sump.
Table HRA3.	Summary of priority contaminants modelled at a Sandstone Quarry Landfill site
Table HRA4.	Suggested Control Levels for Groundwater Monitoring (based on predicted leachate concentrations at L/S= 10) using WAC for inert sites
Table HRA5.	Suggested Trigger Levels for Groundwater in Boreholes
Table HRA6.	Surface Water Monitoring Determinands,.
Table HRA7.	Suggested Contingency Actions for Breach of Control and Trigger Levels.

1.0 INTRODUCTION

Report Context (Part B Section 1.1)

- 1.1 J.G. Pears Ltd (JGP) is the operator of the proposed quarry
- 1.2 The agent that has completed this report is the Cromwell Wood Estate Company Limited (CWECL).
- 1.3 This hydrogeological risk assessment (HRA) report relates to the site that is the subject of a planning application for the extraction of sandstone and gritstone at Spicer House Farm between Penistone and Shepley.. There are approximately 10 years worth of actual sandstone operations in the site, with a restoration programme to be implemented on completion of quarrying and some infilling to provide soils and material to buttress the faces when they are open.
- 1.4 This report has been completed in conjunction with the Planning Application and the Method Statement. It is not a stand alone document and factual data related to the site, its setting and the receiving environment is located in the Application and referred to in this document.
- 1.5 The application boundary is shown on Drawing No. 00/0001

Site Location

- 1.6 Spicer House Quarry is located at Annat Royd five miles south east of Huddersfield in West Yorkshire at NGR SE 420500 406500. Road access to the site is by a well-established lorry route along A629 and A628 accessible from Spicer House Lane.

Site Detail

- 1.7 The proposed quarry site lies within an area of land known as Spicer House farm and Greenley Carr where Hepworth's mine blue pipe clay from beneath the Grenoside Rock.. The site lies at the north eastern end of a prominent southeast-northwest trending outcrop of Grenoside rock and Greenmoor rock that forms an escarpment above the Upper Don valley around 1 km south of the quarry.
- 1.8 The quarry has been designed to a depth of around 10 m to extract all the Grenoside rock which has been delineated by a borehole programme to ascertain the reserves of Sandstone and Blue Pipe clay at Spicer House. The quarry will be worked from the side of the highway to the north in a series of phase to allow benching of the quarry faces and provide levels to work on.
- 1.9 The location of the proposed quarry and the application boundary is shown on Drawing No.00/0001

- 1.10 To the south of site is a quarry which is now disused and has regenerated with gorse and heather and was known as Annat Royd Quarry and the Grenoside Rock can be seen in the old face.
- 1.11 The quarry site is currently a green field site but has been designated as an area of mineral search for Grenoside and Greenmoor rock in the Barnsley Unitary Development Plan
- 1.12 The site will be operated as a dimension stone quarry in phases to extract the stone in lifts so that it can be operated on a scale conducive to dimension stone quarries and could be restored temporarily at any time if the market is reduced for dimension stone which is unlikely in the foreseeable future.
- 1.13 The proposed quarry will be worked in 4 phases to the top of the underlying black shale which separates the Grenoside rock from the Lower Greenmoor beds and the blue pipe clay between the two sandstone beds. The blue pipe clay is worked by Hepworth's at the near by Greenley Carr quarry.
- A total base area of c. 2.6 hectares.
 - A total surface area when utilised for soil storage and working with final restoration will be 3 ha.
- It is assumed from the site levels in phase 4 that the average depth of the working will be 12.5 m with a minimum depth of soil being 1 metre and the sandstone being 10 m.
- 1.14 The base of the proposed quarry will be on blackshale and the operation of the quarry will leave a running surface on the lowest bed of Grenoside rock so that it is hard and the shale does not degrade beneath the quarry floor. The last bed of rock will be removed as the working retreats back to the haul road shown in phase 4.
- 1.15 A set of drawings are included with this hydrogeological report to show that the quarry is within the top bed of sandstone. The blackshale and the blue pipe clay beneath are impermeable and will not under normal circumstances allow the downward migration of water.

Prior Investigations undertaken at the site

- 1.16 Some limited site investigation work has been undertaken as part of this risk assessment:

Table HRA1. Prior Investigations Undertaken at the Site	
Date	
June 1993	Borehole drilling to prove the geology
10 March 2004	Site walkover of Spicer House land and the nearby streams and reservoirs..
March 2007	Further walkover for the water courses and the ecology survey that was undertaken in August 2007

2.0 CONCEPTUAL HYDROGEOLOGICAL SITE MODEL: SOURCES (

- 2.1 A conceptual hydrogeological model of the site is shown in Drawings No. JGP/SHQ/151007HRA01 (plan) and JGP/SHQ/GEOL01 (section). This details the source, pathways and receptors, and places the quarry site in the context of surrounding geology, hydrology and groundwater.
- 2.2 The direct source in the case of this groundwater risk assessment is quarry water, which arises as a result of excavating rock at the quarry and which seeps into the workings from the south, up dip of the proposed quarry.

Waste Types

- 2.3 Some reclamation material will be brought to site as the Grenoside rock will be worked out and used for a wide range of product and it is estimated only 10% will be waste stone and overburden.

Waste Quantities & Rates of Filling

- 2.4 Mineral waste input rates have been assumed to be between 60,000 and 90,000 tonnes for the whole operation which is 15% of the total volume of stone worked.
- 2.5 The total estimated volume of stone worked life of the site is approximately 289 000 m³ (665 000 tonnes).

Leachate Quantity

- 2.6 During the operational phase before restoration and the site is covered with mineral waste on the floor it is likely that water will seep through the Grenoside Rock and flow into the quarry. At this present time the site is pasture and to the north on the opposite side of the road the former Annat Royd Quarry has some very shallow ponds which are recharged by rainfall and possibly water seeping through the sandstone waste that has been tipped against the faces. Face seepage is produced from a combination of direct rainfall infiltrating through the soil and sandstone, water contained within the cover soils themselves and potential seepages into the quarry from the confining quarry faces. The mineral waste will absorb a finite amount of moisture and the excess within the quarry will infiltrate to the floor of the quarry.

Water Balance

- 2.7 The volume of water produced can be estimated by undertaking a water balance for the site where the effective rainfall available for infiltration to either the quarry or cover materials is derived from the mean annual rainfall for the site from which is subtracted the annual potential evapotranspiration.

Rainfall

- 2.8 Rainfall is not monitored for the site. However, an estimated mean rainfall of 1151 mm (minimum 660 mm maximum 1,650 mm) is derived using data for 'Area 10' in which the sites are located in the Eastern Pennines, contained in MAFF Technical Bulletin 34 (MAFF, 1975).

Potential Evapotranspiration

- 2.9 There are no potential evapotranspiration data available for the site. However, an estimated potential evapotranspiration estimate of 39 mm (Winter) and 376 mm (Summer) hence 415 mm (annual) is derived from MAFF (1975).

Infiltration

- 2.10 On the basis of the site mean rainfall value and mean evaporation estimates in sections 2.8 and 2.9 the mean infiltration depth per unit area entering the site is:

$$1151 - 415 \text{ mm} = \mathbf{736 \text{ mm (0.736 m)/year}}$$

- 2.11 For the purpose of this assessment it is assumed that infiltration to open faces during the operational phases is 2007-2025 is 736 mm +/- 73.6 mm (1SD).

Water Volumes: Phase 1 to 4 Operation Phase

- 2.12 The site will be operated as a dimension stone quarry. Water will be produced from a combination of direct rainfall infiltrating through the sandstone and water contained within the mine waste themselves when deposits in the exhausted workings. The waste will absorb a finite amount of moisture and the excess will infiltrate to the base of the waste and infiltrate onto the quarry floor and hence pond on the Blackshale beneath the sandstone which is a Minor Aquifer.

- 2.13 Phases 1 to 4 have a combined area of c. 2.5 ha (25,000 m²). In the absence of absorption by the waste, the area would produce a quarry volume of:

$$25,000 \text{ m}^2 \times 0.736 \text{ m}^3 = \mathbf{18400 \text{ m}^3/\text{year} \text{ (50 m}^3/\text{day, 0.6 l/second)}}$$

- 2.14 The floor of the site will have a soil cover specified for phases 1 to 4 comprising of a restoration cover of 300 mm compacted clay soils. The cap will be laid with a minimum slope of 1:20 falling to the north side. The stone dips to the north east and water will flow through the stone upstream where the Grenoside rock outcrops and flow through the joint sets and fissures to the site.

- 2.15 The water will flow to the site through the sandstone into the quarry and over the soils in the pasture. The area to the south is approximately 10 hectares and most of the water falling on the land to the south will flow to Spicer House beck and other

watercourses that lead into Ingbirchworth Reservoir. Refer to plan number JGP/SH/LOC 02.

- 2.16 The mean permeability of the existing soil under the pasture is expected to be typical of compacted soils: in the order of $1.0E-07$ m/s so rainfall will be absorbed by the soil the grass and there will be evapotranspiration.
- 2.17 The base of the quarry will be restored with mineral waste and this will be mainly a stone based waste and it will be restored with 100-150 mm of topsoil.
- 2.18 Infiltration through the restoration material is controlled by the thickness of the restoration soil cover, the gradient of the quarry floor and the hydraulic conductivity of the compacted waste and the black shale beneath.

Water Quality

- 2.19 As the site was previously pasture and agricultural use is common all around the site the water quality is expected to be good but could be contaminated with effluent from livestock rearing and the addition of fertilisers for the silage growth.
- 2.20 Water samples will have been obtained from the water courses and the reservoirs in the area and the water bodies provide a water supply for Penistone and Sheffield. The quality is not expected to have been derogated by the quarrying activity at Greenley Carr or the agricultural use.
- 2.21 No comprehensive List I analysis has been undertaken on quarry drainage water. The water is not expected to carry such contaminants but there may be slightly elevated levels of arsenic and iron from the coal measures sandstone.

Iron

- 2.23 Iron could well be above the relevant MAC (UK/EC Drinking Water Standard (DWS)).

Other List II substances

- 2.26 Concentrations of list II substances are expected to be well below their respective MAC.

General leachate quality parameters

- 2.27 The pH of the water is likely to be effectively neutral, the total alkalinity is low, which to be expected in this geology and with the mine waste types. The TON, COD and TOC concentrations area could be elevated consistent with a semi improved (low nutrient rich) upland area surrounding an old quarry site.

- 2.28 The electrical conductivity value is likely to be low from typical of values found in quarry sumps in the South Pennines. Runoff from unimproved upland areas is generally less than 200 $\mu\text{s}/\text{cm}$.

Water control

- 2.29 Water levels at site are not currently monitored but it is proposed to monitor water levels in the bore holes that have been drilled and to provide a borehole upstream on the southern boundary to monitor water levels and quality and collect water in a quarry sump in Phase . The sump will be maintained at all times during the quarrying operation to provide water for damping down the workings in dry weather and washing the stone product of fines before it is transported from site to reduce dust blow.
- 2.30 The water make in the quarry will be seeping from the floor of the face in the Grenoside rock where it is in contact with the underlying blackshale and it will be directed to the sump. The sump will have an overflow arrangement that will allow water to re enter the sandstone on the north side and flow uninterrupted through the Grenoside rock into the strata and Annat Royd Quarry.
- 2.31 It is not envisaged that the flow will be restricted to Annat Royd Quarry as the ponds in that disused delve are mainly recharged by surface water.

Refer to next page

Table HRA2 Results of water quality analysis on a sample of runoff from existing quarry face areas in a sandstone quarry in similar coal measures near Halifax.

Determinand in mg/l Unless otherwise Indicated	Sample 040021711	MAC/ MRV mg/l
Ammoniacal-N	<0.05	0.5
Ca	39.4	250
Cd	<0.005	0.0001
Cl	29.4	250
Cr	<0.01	0.050
Cu	<0.01	2
Fe	0.548	0.200
Pb	<0.03	0.010
Hg	<0.03	0.00001
Mg	11.9	50
Mn	<0.05	0.05
K	1.39	12
Na	10.8	200
Ni	<0.01	0.02
Zn	<0.02	5.0
SO ₄	39.4	250
PH	7.2	-
Alkalinity (CaCO ₃)	82.7	-
COD	<17	-
Conductivity µs/cm	322	-
DO % SAT	97.8	-
TON	0.851	-
TOC ²	<5	-
<i>Italicised</i> concentrations <u>may</u> be below, at or above the MRV or MAC because laboratory detection limits are also above the MRV or MAC ² reported as TOC but more properly represents DOC		

3.0 CONCEPTUAL HYDROGEOLOGICAL SITE MODEL: PATHWAYS

- 3.1 Pathways linking the source to the potential receptors are shown on drawing JGP/SHQ/151007HRA01 and JFP/SH/GEOL 01 on the section and is defined as migration down through the soil materials and into the underlying and down gradient Lower Carboniferous Lower Coal Measures sandstone and shale units. It is probable that groundwater discharges beyond the northern boundary of the proposed quarry. However, transport deeper into the sandstones cannot be discounted even though there is over 19 metres of clay based strata. Subsequent aquifer transport conveys groundwater to down-hydraulic gradient boreholes, springs and surface channels to the north. There are streams flowing to the reservoirs to the north which are mainly fed by rainfall and the outcrop of the Grenoside sandstone that dips gently from Whitley Edge, Maythorn and Low Common into Broadstone Reservoir, Royd Moor Reservoir, Ingbirchworth Reservoir and Scout Dike Reservoir which feed the River Don.

Regional Geology

Lithology

- 3.2 The regional geology is based on information contained in the British Geological Survey (BGS) 1:50 000 Sheets. Refer to JGP/SH/GEOL 01 +
- 3.3 The rocks of the area are sedimentary in origin, derived from the breakdown of igneous rocks such as granite, and older sedimentary rocks, which lay to the north and north east of the area. Rivers brought down these sediments, which were deposited in the South Pennine area in the form of a delta. These sediments were lithified into the Millstone Grit rocks of Namurian age, which underlie Lower Carboniferous Coal Measures deposits.
- 3.4 The coal measures were deposited in fresh water swamp like conditions with abundant vegetation. The death of the vegetation and its burial by sediment resulted in the formation of coal. Over a period of some 30 million years the coal measures were built up forming alternating series of clay, coal and sandstone. At a later date these sediments were uplifted during the Pennine folding when the Pennine chain was pushed up in the form of an anticline with the axis running north-south. The Axis runs through Denshaw, Greenfield and Mossley, such that the rocks on the Yorkshire side of the axis dip to the east and those of Greater Manchester dip to the west.
- 3.5 Subsequent denudation has eroded much of the overlying rock leaving the hills to the north and west of Huddersfield, the west of Penistone and Barnsley and south to the Dark Peak with sandstone 'caps', chiefly of the 'Rough Rock' (the top bed of the Millstone Grit) and producing the dip and scarp topography typical of the West Yorkshire area. The rocks in this area tend to be tabular in that they are formed on the beds of the stone and the fields do not undulate from the outcrop of the rock. This structure can be seen at Spicer House and Hartcliff Hill.

Structure

- 3.6 The region is heavily faulted with most of the faulting brought about during the Pennine orogeny. The faults tend to trend in a north east direction with south east offshoot faults that control groundwater flow where sandstone is positioned against the clay type rocks. No mining has taken place at Spicer House so it is unlikely the ground will have subsided from coal mining activity unlike the stone beds at Hartcliff Hill that are underlain by the Halifax Hard bed coal.

Site Geology

- 3.7 Reference Sheets;-
Yorks County Sheet Series No. 273 reference sh2002/273 and
refer to the Geological Plans - **JGP/SH/GEOL-01 to 03**
- 3.8 The site is situated within the outcrop of the Grenoside Rock, on the northern flank of the Don valley, at Spicer House. The land use is level pasture and below this, the strata dips to the northeast on a gentle gradient. The rock has been examined at this location and the blocks of stone are seen to be widely spaced and thickly bedded up to 2 metres, with thinner beds of laminated gritstone. Refer to the section on the plan.
- 3.9 The deposit is described on the geological sheet as a gritty sandstone and extends eastwards beyond the site, towards Ingbirchworth Reservoir. The rock is covered by a coal measures mudstone and the Grenoside Coal seam and the base of the sandstone is underlain by Blackshale.
- 3.10 Drilling has indicated that the base of the sandstone horizon is gritty and weak, which is possibly due to the action of water. The sandstone appears to be freely draining due to it being heavily jointed and the underlying shale will act as an impermeable plane. It is possible that at this interface, groundwater has weakened the matrix that holds the sandstone particles together.
- 3.11 There is a fault 0.5 kilometre to the south west of the site that downthrows the strata to the southwest but the general trend of the fault system is south south east to north north west. There is no evidence of any faults in the application area and the stone beds are relatively undisturbed. The site geology is illustrated in the local geology plan shown on JGP/SH/GEOL 01 and the section on that plan
- 3.12 The dip of the strata is north eastward around 1 in 18 to 1 in 10 (a gradient of 0.056 and 0.1 respectively). There is little evidence of significant faulting within the proposed quarry although bedding planes are likely to be well developed and vertical joints will be open with little infill materials. The rock and strata beneath the proposed quarry can be inspected at the quarries at Lane Head where the same horizon is worked.

Exploratory boreholes

- 3.13 Exploratory boreholes have been drilled in the past and borehole records are available with this report. The boreholes were drilled in June 1993 to assess the clays in the area. It would appear from the borehole records no water strike was noted but the gradient of the cap rock is relatively steep and water would flow to the reservoirs rather quickly. See section on the plan JGP/SH/GEOL01.

Regional Hydrogeology

- 3.14 The strata at site are designated as a Minor Aquifer on Groundwater Vulnerability Sheets provided by the Environment Agency dated 2000.
- 3.15 The soil leaching potential is designated as Medium to High on the Groundwater Vulnerability Sheet. However, soil leaching potential is not considered relevant to this site when the soils are removed from the footprint of the proposed quarry.
- 3.16 Given the Minor Aquifer status the overall groundwater vulnerability of the site could be considered to be low. However, there are a large number of potential groundwater issues within 2 km of the site but this proposal is unlikely to affect the water supply as the mineral extraction area is above the groundwater table. Hence, the vulnerability of certain strata within the Namurian strata may be considered low.

Aquifer Characteristics

- 3.17 The strata comprise of alternating sequences of sandstones, mudstones and seat earths with some thin coal seams of varying thickness. Given the gradient and fissured nature of the sandstones and interbedded shale units, it is considered unlikely that there is an extensive groundwater table. Rather, there are a series of perched water tables within the sandstone units overlying lower permeability mudstone beds and shale partings.

Groundwater flow

- 3.18 The regional hydraulic gradient is unknown because of the absence of data on groundwater levels in the strata, and extensive faulting. However, locally in the absence of faulting, the shale/mudstone beneath the quarry is likely to be of lower permeability than the sandstone and will confine recharge from the overlying Grenoside Grit into the sandstones of the Greenmoor sequence some 20 metres beneath the base of the Grenoside. The resulting groundwater appears likely to flow north eastward to intersect the valley where the reservoirs are. Therefore, the sandstones are likely to recharge the Reservoirs via springs and seepage at the point the base of the sandstone and top of the underlying mudstone crop out on the valley side. There is a clear correlation between the head of the three southernmost streams on the south side of the Reservoirs and the Grit/ Shale junction on the geology map. The local hydraulic gradient is therefore assumed to be approximately the same as the dip of the strata, which is taken to be 1:18 or 0.056.

3.19

Groundwater monitoring boreholes

- 3.20 There are, at present, no groundwater monitoring boreholes located at the site but boreholes have been drilled in the Spicer House area to the Greenmoor. There can be a borehole drilled to the south of the quarry to monitor groundwater levels and quality.

Groundwater levels

- 3.21 There are no available groundwater level data for the site as no water strikes were noted in the boreholes.
- 3.22 There is evidence of perching of groundwater at the site. For example, the Annat Royd Quarry which is located in the remnant in situ Grenoside Grit sandstone overlying the basal shale or mudstone. The perching may be due to reduced permeability in the waste sandstones down hydraulic gradient, due to washing out of fine sediment from the mining waste deposited on the remnant faces in Annat Royd quarry, and the base of the quarry on top of the fissured sandstone left in the bottom.

Purifying powers of soils/subsoil

- 3.23 Assuming that there is a sump at a water body level (c. 310 mAOD) represents the point at which the quarry intersected a perched water table, it is likely that much of the rock below this level is unsaturated, at least in part. Consequently, there is a significant unsaturated zone beneath the geological barrier of black shale. Hence, any water migrating from the phased working is likely to discharge to the water table by draining through the Grenoside face on the north side across the top of the underlying lower permeability mudstone and shale unit and into the down gradient Grenoside Grit aquifer.

CEC data

- 3.24 There is data available on chemical attenuation of individual contaminants within the geological sequence of shale at the base and the coal measures strata as a whole. It is well documented that the organic fraction of the clay based minerals can retard contaminants from mineral working and other more contaminative uses.
- 3.25 Retardation is also likely to be assisted by the presence of organic carbon. The fraction of organic carbon (FOC) of the materials that will be used that form the geological sub strata has not been measured but the black shale has an elevated level of carbon.

Hydrology

- 3.26 Water features within the vicinity of the site are shown on drawing number JGP/SH/151007/01. The water courses lie to the east and west of the site and flows from south to north. The nearest distance the beck at Spicer House the site is 300 m and the beck to the west known as Annat Royd beck is 300 metres away.
- 3.27 The water balance estimation in section 2 indicates that the 2.5 ha site should produce around 0.6 l/second and the land as a whole should discharge 5 litres per second to the perched aquifers draining to spring discharge points on the north side of the quarry.

Surface water monitoring

- 3.28 The only surface water monitoring data for the streams was undertaken by Leeds University for a thesis and these results are being obtained. Surface water sampling can be undertaken in Annat Royd Quarry and the watercourses but it is not thought to be necessary as the site is for a dimension stone quarry and apart from suspended solids no other contaminant is likely.

Pathway Summary

- 3.29 Groundwater fulfils a dual role of being both a receptor and a pathway to other receptors. Groundwater is likely to occur within the Lower Carboniferous strata at the site, particularly where fissured sandstones of significant bulk permeability overlie lower bulk permeability mudstones or shales, but only where the shales or mudstones are relatively un-fissured.
- 3.30 The presence of a widespread water table up hydraulic gradient and across hydraulic gradient of the site is considered unlikely in these heterogeneous strata, rather, perched water tables are likely to have formed within fractured sandstones confined by underlying lower permeability units such as mudstones and shales. Therefore, the site cannot reasonably be described as being sub-water table and hence cannot directly discharge contaminants to groundwater.
- 3.31 Indirect discharges of substances could be introduced to groundwater bearing strata following migration of quarry water through the geological barrier. Therefore, the risk of contamination of a groundwater aquifer is not negligible, and the proposed site needs to be quantitatively risk assessed.
- 3.32 Two potential conceptual pathways for contaminant migration from the phases of the site have been derived from the site geology and hydrogeology data. These are illustrated in Drawing HRA1 and are considered below.

Conceptual Pathway 1 Vertical transmission through the geological barrier into the perched groundwater body represented by the present standing water body in Annat Royd Quarry with subsequent discharge to surface water from down gradient springs and seeps.

- 3.33 Once a head is established on the base of the quarry leakage from the base will be controlled by the sump and infiltration rate through the open face or capped areas and then by the hydraulic conductivity of the sandstone and shale geological barrier.
- 3.34 The mean horizontal permeability of sandstone is $< 1 \times 10^{-5}$ metre per second and the mean vertical matrix permeability of the shale geological barrier is the equivalent of 1×10^{-7} m/s.
- 3.35 Once quarry water has migrated through the sandstone geological barrier in the north face it will enter the down gradient Grenoside that is confined by an underlying shale bed. The dip of the sandstones and shales indicate that the groundwater is most likely to be conveyed to the springs and seeps arising on the north side of Ingbirchworth Reservoir.

Conceptual Pathway 2 Vertical transmission through the geological barrier into the perched groundwater body represented by the Greenmoor Rock 20 metres beneath the site through migration in the underlying shale/mudstone to the Greenmoor Flags and then to springs/seeps arising on the north side of Ingbirchworth Reservoir.

- 3.36 Once quarry water has migrated through the geological barrier it will enter the down gradient Greenmoor and the Grenoside sandstones. The majority may be conveyed in groundwater within the Grenoside sandstone. However, some water may migrate vertically through the underlying shale/mudstone into the Greenmoor and then to springs/seeps arising on the north side of Ingbirchworth Reservoir.
- 3.37 This pathway is considered to be much less likely than conceptual pathway 1 as water will prefer to migrate laterally within the fissured Grenoside Grit and sandstone rather than vertically through the lower permeability shale and mudstone. Hydraulic heads in the Grenoside Grit are likely to be transient and unlikely to persist for long enough during the water year to drive significant quantities of water through the mudstone. Moreover, the quantitative risk assessment and technical measures proposed will ensure that groundwater quality in the Grenoside Grit aquifer is acceptable, and hence the vertical transmission pathway is not considered further in this HRA.

Groundwater Quality

- 3.38 No routine sampling and analysis of groundwater quality has previously been undertaken.
- 3.39 Data for specific contaminants important to include in the quantitative risk assessment (the List II contaminant ammoniacal nitrogen, the conservative ion chloride, List I substances cadmium and mercury and the mobile metal nickel) are summarised in the following sections. Note that where the term 'gradient' is used it refers to the direction of groundwater flow and may or may not coincide with topographic gradient or geological dip or strike. Water samples have been taken from other springs in Coal Measures strata and these are likely to be not dissimilar to the water quality at Spicer House.

Ammoniacal-nitrogen

- 3.40 Ammoniacal nitrogen concentrations in all down gradient spring and surface water samples were 0.2 mg/l (the Limit of Detection (LOD) of the method used was <0.2 mg/l). This is below the EC/UK drinking water standard (DWS) of 0.5 mg/l. A quarry sump sample concentration (Table HRA 2) was <0.05 mg/l against an LOD for the method used of <0.05 mg/l. The use of two different laboratories and samples obtained on two different occasions makes comparison difficult. However, the general background concentration in surface and groundwater (including compensation water from Scammonden Dam (site SWM3) appears to be around 0.2 mg/l.

Chloride

- 3.41 Chloride concentrations in all down gradient spring and surface water samples were below 77 mg/l (LOD of the method used was <1 mg/l). These concentrations are well below the EC/UK DWS of 250 mg/l. A quarry sump sample (Table HRA2) was 29.4 mg/l, well below the next highest concentration of 40 mg/l recorded for SP07. The use of two different laboratories and samples obtained on two different occasions makes comparison difficult. However, the general background concentration in surface waters and groundwater (including compensation water from Scammonden Dam (site SP03) appears to be >40 mg/l perhaps reflecting the presence of chloride from anthropogenic sources such as the road network (de-icing salt) and inputs from septic tanks.

Cadmium

- 3.42 Cadmium is a List I substance. Cadmium concentrations in all down gradient spring and surface water samples were <0.4 µg/l (the LOD of the method used). The detection limit is above the 0.1 µg/l Minimum Reporting Value (MRV) for cadmium in clean water but below the Maximum Admissible Concentration (MAC): the EC/UK DWS of 5 µg/l. The cadmium concentration in the quarry sump SP1 (Table HRA2) was <5 µg/l (the LOD of the method used). Although the site and down gradient concentrations cannot be readily compared, it is likely that cadmium concentrations at site and in the surrounding groundwater and surface waters are generally low.

Mercury

- 3.43 Mercury is a List I substance. Mercury concentrations in all down gradient spring and surface water samples were <0.05 µg/l (the LOD of the method used). The detection limit is above the 0.01 µg/l MRV for mercury in clean water but below the MAC: the EC/UK DWS of 1 µg/l. The mercury concentration in the quarry sump SP1 (Table HRA2) was <30 µg/l (the LOD of the method used). Although the site and down gradient concentrations cannot be readily compared, it is likely that mercury concentrations at site and in the surrounding groundwater and surface waters are generally low.

Nickel

- 3.44 Nickel concentrations in all down gradient spring and surface water samples were either 1 or 2 µg/l (LOD of the method used was <1 µg/l). This is well below the EC/UK DWS of 20 µg/l. The quarry sump sample concentration (Table HRA 2) was <10 µg/l, the LOD for the method used. The use of two different laboratories and samples obtained on two different occasions makes comparison difficult. However, the general background concentration of nickel in surface and groundwater (including compensation water from Scammonden Dam (site SP03) appears to be around 2 µg/l.

Summary

- 3.45 Although there is no data available from up gradient groundwater monitoring wells it is unlikely that the proposed mineral working at Spicer House Quarry will have a significant impact on the quality of water in the minor aquifers down gradient to date.

4.0 CONCEPTUAL HYDROGEOLOGICAL SITE MODEL:

Primary receptors

- 4.1 For substances in the quarry water and in particular list 1 substances, the receptor/compliance point is the point at which the substance will enter groundwater below or adjacent to the site. As the site is a quarry and there will be no import of controlled waste there is unlikely to be any list 1 substances in the water unless they occur naturally. This is shown on Drawing HRA1.
- 4.2 For List II substances, the primary receptor/compliance point will be the springs on the outcrop of the Grenoside Rock down hydraulic gradient of the site between the application boundary and any secondary receptors. These are shown on Drawing HRA1 and described in the previous section of the conceptual model.

Secondary Receptors

Source Protection Zone Abstractions

- 4.3 Based on evidence from the Environment Agency website, the site does not lie within a Source Protection Zone.

Local Abstractions

- 4.4 Information provided by the geology maps show that there are springs and wells on the north west side of the reservoirs and the springs exist between Spicer House Lane and the reservoir. Refer to plan number JGP/SH/151007/01.
- 4.5 As the general hydraulic gradient at the site is north eastward toward Ingbirchworth reservoir, it is proposed to use one new groundwater monitoring well located up hydraulic gradient of the installation and the quarry sump as compliance monitoring

points. It is not proposed to monitor the groundwater quality to the west, or to the south west of the application area towards Greenley Carr and the wind farm as drainage of groundwater toward the reservoir is likely over the surface and in the rock face.

Environmental Assessment Limits (EALs)

- 4.6 The most appropriate EALs for groundwater at the site are the most stringent applicable standard available for the particular contaminant. In the case of List I substances considered (cadmium, mercury) the standard should be the MRV listed in Appendix 7, Environment Agency (2003). However, in a minor aquifer where contaminant levels may be in excess of the MRV (the current Laboratory detection limit is >MRV) it is considered more appropriate to use an EQS or DWS freshwater EAL.
- 4.7 For the List II substances considered (ammonia, chloride, nickel) the standard is the UK/EU DWS listed in Appendix 8, Environment Agency (2003).
- 4.8 The EAL for groundwater contaminant from a similar sandstone quarry for which data is available, compared to baseline groundwater quality is shown as follows:

	EAL	Baseline water quality
Cadmium	5 µg/l (DWS)	<5 µg/l
Mercury	1 µg/l (DWS)	<30 µg/l
Ammonia	0.5 mg/l (DWS)	< 0.05 mg/l
Chloride	250 mg/l (DWS)	30 mg/l
Nickel	20 µg/l(DWS)	<10 µg/l

- 4.9 The sump at that quarry data indicates that ammonia, chloride and nickel concentrations lie well below the appropriate EAL. The one measured cadmium concentration is below the EAL but it is unclear what the actual concentration is due to the Laboratory detection limit being at the EAL.
- 4.10 Environment Agency Guidance (2003) suggests that operators should consider operations to provide potential improvements in groundwater quality. Hence, it is not proposed to set an EAL for iron (Table HRA2). The EAL for the remaining chosen substances are set at the appropriate EAL, in this case the Appendix 8 EC/UK DWS (Environment Agency 2003). Therefore, the proposed EAL for this risk assessment are:

	EAL
Ammoniacal Nitrogen	0.5 mg/l
Cadmium	5 µg/l
Chloride	250 mg/l
Mercury	1 µg/l
Nickel	20 µg/l

5.0 HYDROGEOLOGICAL RISK ASSESSMENT

The Nature of the Hydrogeological Risk Assessment

- 5.1 The quarry is proposed to be opened if planning permission is granted in 2008 and operations will continue for 10 years. The site is a dimension stone quarry that lies over blackshale and blue pipe clay. On the evidence presented in this assessment the site does not lie within an SPZ and overlies two minor aquifers (Grenoside Sandstone and Greenmoor Flag and Block) of limited extent due to outcrop on Whitley Edge and the cover to the north. A risk assessment has been carried out to ensure the risks to groundwater are comprehensively assessed. This will ensure any uncertainty associated with the source, pathway and receptor terms is considered.

The Proposed Assessment Scenarios

- 5.2 The hydrogeological risk assessment is undertaken for the whole lifecycle of the quarry from the start of the operational phase to the point at which the quarry is no longer capable of posing an unacceptable environmental risk when restored.

Lifecycle phases

- 5.3 Two lifecycle phase models have been considered in this risk assessment as shown in the working method drawings in the planning application. Refer to plan numbers JGP/SH/WS01 to 05. These briefly entail:

Proposed operational phase

- 5.4 The operational phase model assumes that soils will be stripped off each phase and stored on the boundary thereby exposing the sandstone. Rainwater will migrate through the joint sets and the bedding planes to the base of the Grenoside and then flow along the top of the black shale. The shale is impermeable and there is little risk of migration below the shale horizon.

Post closure phase

- 5.5 The site will be worked in 4 phases to the south and topsoil and subsoil will be removed in advance of the stone working. The stone is capped with 300 mm of compacted clay soil materials that will be lifted and stored on site for restoration. The bottom of the quarry will receive restoration soil over mineral waste from the stone operation with a cover thickness of 100mm and will reflect the typical soil thickness elsewhere in the area.

6.0 REQUISITE SURVEILLANCE

The Risk-Based Monitoring Scheme

- 6.1 The contaminants modelled in the quantitative risk assessment (ammoniacal nitrogen, cadmium, chloride, mercury and nickel) are all included in the groundwater and quarry water monitoring scheme with ammoniacal nitrogen, chloride and nickel being included in the surface water management scheme. The control and trigger levels are set based on the results of the quantitative risk assessment model.

Quarry Water Monitoring

- 6.2 The objective of monitoring quarry water is two-fold. First, regular monitoring of certain species in the quarry water provides an indication of how the operation affects the water quality and develops with time, and is a useful background data set. Second, it enables the operator to determine any deterioration in water quality. This is especially important with regard to List I substances. For example, if the monitoring shows species to be present in larger concentrations than are usually recorded, this would enable the operator to take action before the quarrying impacts on groundwater. Where appropriate, monitoring of quarry water also provides a useful indicative tool for future areas of the quarry, providing the working method remains the same and the suspended solids from quarrying and processing are monitored.

Compliance Monitoring Points

- 6.3 Currently there are no monitoring wells proposed for the quarry apart for one upstream although the sump in phase 1 would make a suitable compliance monitoring point.

Groundwater Monitoring

- 6.4 The objective of monitoring the groundwater in the monitoring wells surrounding the site is to be able to determine whether the quarry has an impact on the groundwater quality and levels at any time, and inform the process of remedying the situation. If the quality of the groundwater in the wells begins to deteriorate at any point, this may be an indicator that the working may be having an effect on the groundwater.

Compliance Monitoring Points (Groundwater)

- 6.5 The locations of the proposed groundwater monitoring wells are to be agreed with the planning authority and the Environment Agency. It is proposed that a new borehole adjacent to the up gradient boundary of the site with the response zone located in both the Grenoside rock would make a suitable monitoring point for groundwater quality. It is also proposed that boreholes drilled in the Spicer House land if they can be found, located up gradient of the site in both the Grenoside and the Greenmoor stone would make suitable up gradient compliance monitoring points.

- 6.6 Groundwater will be monitored at regular intervals for the determinands in Table HRA5, to be agreed with the Environment Agency:

Table HRA3 Groundwater Monitoring Determinands, a similar quarry in sandstone on the Eastern Pennines Phases 1-4					
Determinand	Units	Current Detection Limits	Frequency¹		
			Operational phase	Aftercare phase	Completion phase
Levels	mAOD	N/A	Quarterly	Annually	Annually
PH	pH units	N/A	Quarterly	Annually	Annually
Electrical Conductivity	µS/cm	N/A	Quarterly	Annually	Annually
Temperature	°C	N/A	Quarterly	Annually	Annually
Dissolved Oxygen	mg/l	N/A	Quarterly	Annually	Annually
Ammoniacal Nitrogen*	mg/l	0.2	Quarterly	Annually	Annually
Chloride*	mg/l	1	Quarterly	Annually	Annually
Nickel*	mg/l	0.001	Quarterly	Annually	Annually
COD	mg/l	10	Quarterly	Annually	Annually
Sodium	mg/l	0.2	Quarterly	Annually	Annually
Potassium	mg/l	0.2	Quarterly	Annually	Annually
TOC FILT	mg/l	1	Quarterly	Annually	Annually
Alkalinity	mg/l	2	Quarterly	Annually	Annually
Calcium	mg/l	0.005	Quarterly	Annually	Annually
Manganese	mg/l	0.001	Quarterly	Annually	Annually
Magnesium	mg/l	0.005	Quarterly	Annually	Annually
Sulphate	mg/l	3	Quarterly	Annually	Annually
TON	mg/l	TBA	Quarterly	Annually	Annually
Iron	mg/l	0.005	Quarterly	Annually	Annually
Zinc	mg/l	0.003	Quarterly	Annually	Annually
Cadmium*	mg/l	0.00004	Quarterly	Annually	Annually
Mercury*	mg/l	TBA	Quarterly	Annually	Annually
Lead	mg/l	TBA	Quarterly	Annually	Annually
Chromium	mg/l	0.001	Quarterly	Annually	Annually
Copper	mg/l	TBA	Quarterly	Annually	Annually
List I screens: PAH (EPA16); VOCS, Semi-VOCS, Pesticides, Organotins	mg/l	TBA	Annually	Annually	Annually
*Substances for which control and trigger levels have been set					
¹ Monitoring frequencies may be reduced if there is evidence of stable conditions					

* Monitoring will be undertaken until agreed no longer required between the operator and the Environment Agency.

Control and Trigger Levels

- 6.7 The Groundwater Regulations (1998) require the derivation of Control and Trigger Levels for groundwater, surface water and effluent. Guidance is provided in the Environment Agency Draft 'Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control and Trigger Levels' (2002).

Control levels are set for the site to:

- allow variations from the conceptual model in monitoring data to be identified;
- allow for natural variation in quality data;
- give sufficient time to take corrective action prior to trigger levels being breached.

Control levels: Groundwater

- 6.8 Chemical monitoring data from the quarry sump monitoring point are used to determine the maximum concentration of species recorded, and in conjunction with the output from the risk assessment, set control and trigger levels for the key contaminants identified in the quantitative risk assessment. It is considered unnecessary to set control and trigger levels for boreholes up gradient of the site as any potential contamination should only migrate in a down-gradient direction.
- 6.9 Control levels are proposed in Table HRA3 for groundwater at the perimeter groundwater monitoring wells and have been set according to green, amber and red action criteria. Groundwater water quality data for the site have been reviewed and the relevant control levels are:

GREEN- <10% increases in maximum-recorded concentrations,
AMBER - > 10%, but < 50% increase in maximum recorded concentrations, and
RED- > 50% increase in maximum-recorded concentration

- 6.10 List I substances are included in the control and trigger levels tables as the short distance from the base of the geological barrier to the monitoring wells in the fractured sandstone aquifer means the latter represent an appropriate and pragmatic monitoring point.

Table HRA4 Suggested Control Levels for Groundwater, Phases 1-4 (based on predicted quarry water concentrations at L/S= 10) using WAC for inert material

SELECTED DETERMINAND FOR A CONTROL LEVEL		Maximum likely value (mg/l)	GREEN (mg/l)	AMBER (mg/l)	RED (mg/l)
LIST I	Cadmium (mg/l)	0.00022	0.00024	>0.00024 <0.00033	>0.00033
	Mercury (mg/l)	0.000001	0.0000011	>0.0000011 <0.0000015	>0.0000015
LIST II	Ammoniacal –Nitrogen	0.05	0.055	>0.055 <0.075	0.075
	Chloride (mg/l)	47	52	>52 <71	>71
	Nickel (mg/l)	0.00003	0.000033	>0.000033 <0.000045	>0.000045

Trigger levels: Groundwater

6.11 Trigger levels for potentially polluting substances are defined as the point at which pollution can be said to occur. There are three main considerations in setting Trigger Levels:

- the selection of appropriate substances for Trigger Levels;
- the concentrations at which they should be set;
- the monitoring locations at which they should be set.

6.12 Trigger levels for groundwater are proposed for the same contaminants identified as significant in both the groundwater quality data and the hydrogeological risk assessment. The trigger levels in Table HRA4 below are applicable to groundwater immediately down gradient of Phase 1 to 4 and have been set as the EALs presented in section 4 derived in accordance with Environment Agency guidance.

Table HRA5 Suggested Trigger Levels for down gradient monitoring wells, Spicer House Quarry Phase 1 to 4

SELECTED DETERMINAND FOR A TRIGGER LEVEL		Trigger Level (mg/l)
LIST I	Mercury	0.001
	Cadmium	0.005
LIST II	Chloride	250
	Nickel	0.020
	Ammoniacal Nitrogen	0.5

Surface Water Monitoring

6.13 The objective of monitoring the surface water surrounding a site is to be able to determine whether the quarry has an impact on the surface water at any time, and inform the process of remedying the situation. If the quality of the surface water

begins to deteriorate at any point, this will be an indicator that the quarry may be having an effect on the water.

Compliance Monitoring Points (Surface Water)

- 6.14 The proposed surface water management system for the site will be monitored at the point or points it is discharged to ground. Typically, it will be necessary to monitor the surface water for the following determinands (Table HRA5) with any additional determinands to be agreed with the Environment Agency.
- 6.15 The nearest surface water body (stream potentially receiving quarry discharge water) is located within 300 m from the site shown on drawing number JGP/SH/LOC02 . The second closest stream (Spicer House Stream) lies to the west within 300 m of the boundary.

Table HRA6. Surface Water Monitoring Determinands, Spicer House Quarry.					
Determinand	Units	Detection Limits	Frequency¹		
			Operational phase	Aftercare phase	Completion phase
Discharge	L/second	N/A	Quarterly	Annually	Annually
PH	pH units	N/A	Quarterly	Annually	Annually
Electrical Conductivity	µS/cm	N/A	Quarterly	Annually	Annually
Temperature	°C	N/A	Quarterly	Annually	Annually
Dissolved Oxygen	mg/l	N/A	Quarterly	Annually	Annually
Ammoniacal Nitrogen*	mg/l	0.2	Quarterly	Annually	Annually
Chloride*	mg/l	1	Quarterly	Annually	Annually
Nickel*	mg/l	0.001	Quarterly	Annually	Annually
COD	mg/l	10	Quarterly	Annually	Annually

*Substances for which control and trigger levels have been set
¹ Monitoring frequencies may be reduced (e.g. monthly to quarterly or quarterly to annually) if there is evidence of stable conditions

Control levels: surface water

- 6.16 Control levels for surface water are set as the same as those for groundwater set in Table HRA3.

Trigger levels: Surface water

- 6.17 Trigger levels for potentially polluting substances are set as the same as those for groundwater set in Table HRA4.

Suggested Contingency Actions

- 6.19 Where site monitoring identifies an increase in determinands then a series of Contingency Actions will be required. Suggested Contingency Actions, *which require agreement with the Environment Agency*, are presented in Table HRA6.

- 6.20 It is recommended that for future groundwater monitoring, consistent laboratory detection limits be adopted. In some cases lower detection limits may be required. This can be discussed and agreed with the laboratory and the Agency if necessary.

Table HRA7 Suggested Contingency Actions for Breach of Control and Trigger Levels			
	Appropriate Contingency Action	Following a breach of	
		Control Level	Trigger Level
GREEN	No Action		
AMBER	Advise Site Management	X	X
	Advise Environmental Manager of JGP	X	X
	Advise Environment Agency	X	
	Confirm by repeat sampling and analysis	X	X
	Review existing monitoring information	X	
	Review site management/operations, implement actions to prevent future failure of a trigger level	X	
	Review assumptions in conceptual site model	X	
RED	Review existing Hydrogeological Risk Assessment, Control and Trigger Levels		X
	Consult Environment Agency about need for corrective action		X

7.0 CONCLUSIONS

Compliance with the Groundwater Regulations, 1998

- 7.1 The impact of the proposed quarry on groundwater down gradient of the site and on the surface water quality appears on the basis of limited data on surface water quality to be minimal. The proposed working method and the containment of water due to the impermeable strata beneath will ensure that the emplaced mining waste and the quarrying operation are compliant with the regulations.

Compliance with the Groundwater Regulations, 1998

- 7.2 No List 1 substances from Phases 1-4 of the quarry are predicted on the basis of the presence of no contaminative uses that could introduce list 1 substances.
- 7.3 It has been demonstrated that the introduction of List II substances to groundwater is sufficiently limited so as not to cause pollution, as required by the Groundwater Regulations, 1998.
- 7.4 Essential and technical precautions include:
- Monitoring of the rates of rainfall infiltration into the quarry and the impounding of that water so that it can be settled and tested prior to outflow into the rock to maintain flow to the existing rate;
 - Limitations on surface water flow into the quarry from the surface by construction of a perimeter drain if required.
 - Limitations on concentrations of suspended solids in the quarry water and settling of the water from any processing area.
- 7.5 The proposed essential and technical precautions should be based on good practice requirements from guidance published by the Environment Agency and the relevant trade bodies.
- 7.6 The requirements of the Groundwater Regulations, 1998 include that the requisite surveillance of the groundwater quality is carried out. At the proposed Spicer House Quarry, requisite surveillance of the groundwater will be carried out regularly as discussed in Section 6. Once agreed with the Planning Authority and the Environment Agency the control and trigger levels set as part of this report will assist with the requisite surveillance and continuing to prevent contamination of the local groundwater.

8.0 REFERENCES

Environment Agency, 2000. *The physical properties of minor aquifers in England and Wales*. British Geological Survey Technical Report WD/00/4. Environment Agency R&D Publication 68.

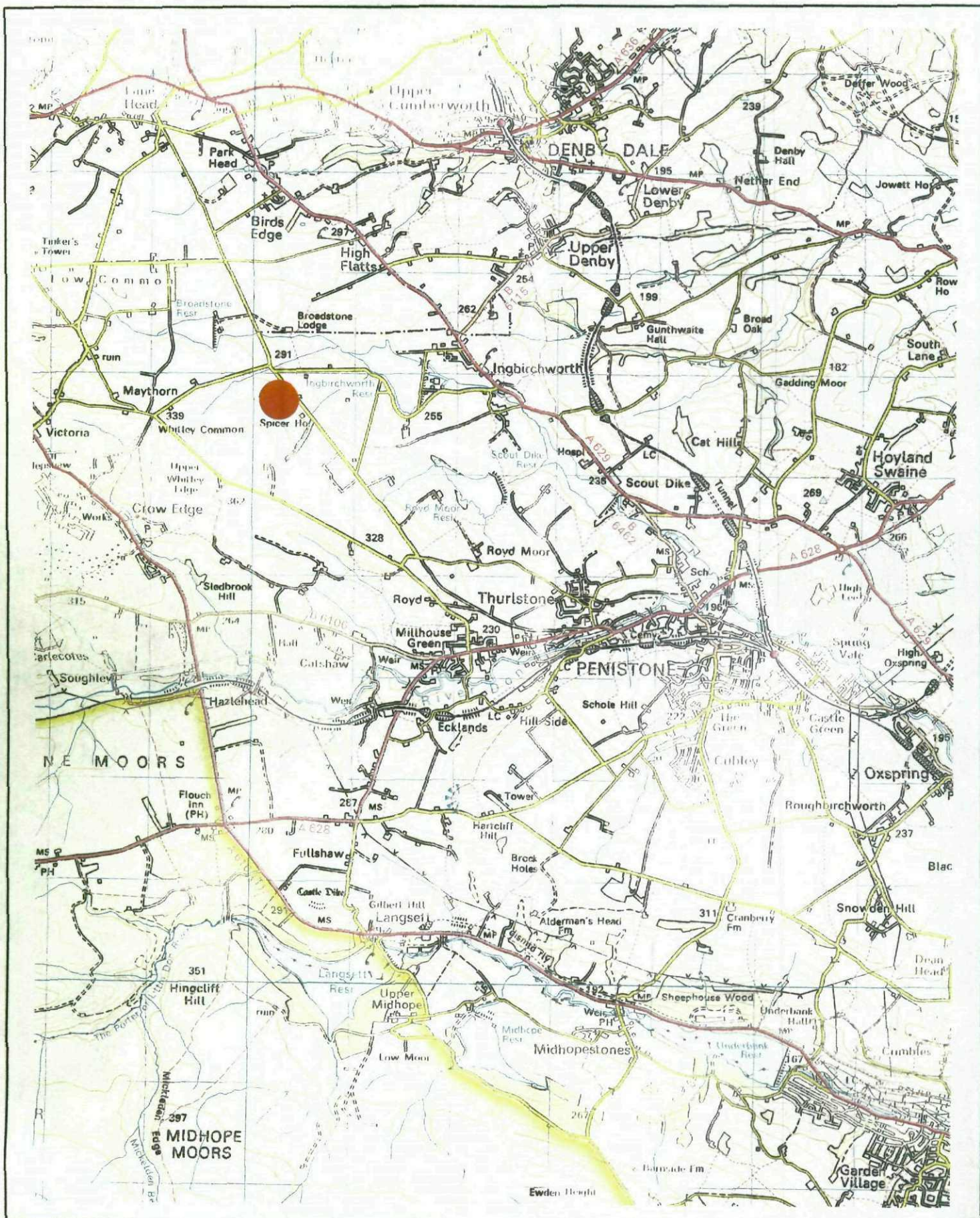
Environment Agency, 1998. *Policy and Practice for the Protection of Groundwater*.

MAFF, 1975. *Climate and Drainage*. Technical Bulletin 34, London, HMSO.

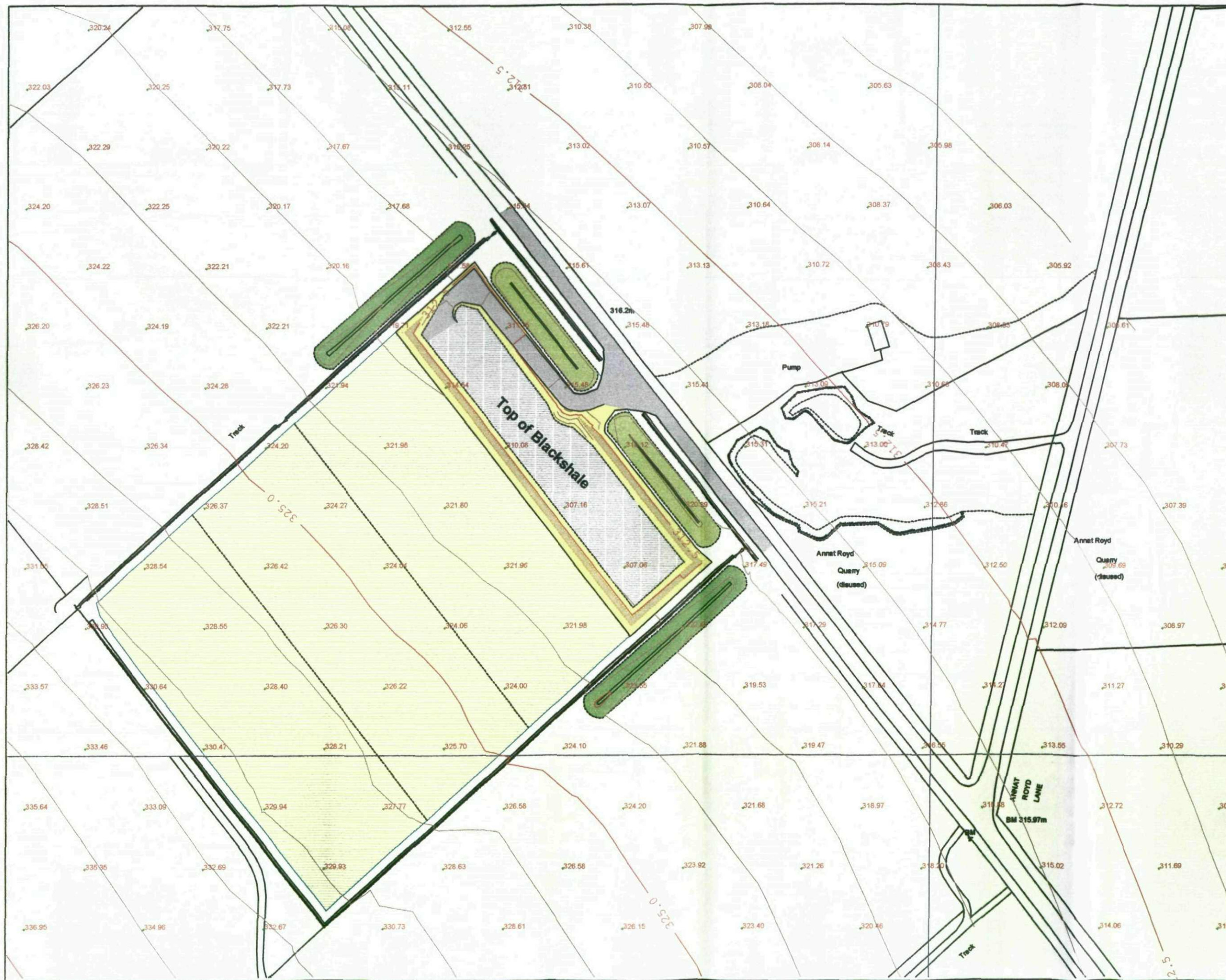
APPENDICES

APPENDIX HRA1

Plans of the Working of the Quarry



Legend: — Main roads — Minor roads — Footpaths — Railway lines — Water courses — Water bodies — Buildings — Trees — Contour lines — Spot heights — Bench marks — Grid lines — Grid squares — Grid coordinates — Grid zone — Grid datum — Grid projection — Grid scale — Grid units — Grid symbols — Grid text — Grid numbers — Grid letters — Grid marks — Grid points — Grid lines — Grid squares — Grid coordinates — Grid zone — Grid datum — Grid projection — Grid scale — Grid units — Grid symbols — Grid text — Grid numbers — Grid letters — Grid marks — Grid points	REVISIONS <table border="1"> <thead> <tr> <th>No.</th> <th>Date</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>15.10.07</td> <td>Initial</td> </tr> </tbody> </table>	No.	Date	Description	1	15.10.07	Initial	N	FGB Fennell, Green & Bates PROJ. GREEN & BATES 21 South Street Wetherby West Yorkshire WF8 3TH Tel: 01937 555555 Fax: 01937 555555 Email: info@fennellgreenbates.co.uk Client: J.G. Pears Belle Vista Farm Hartcliffe Penistone	Job Title: Spicer House Project Title: Working Scheme <table border="1"> <thead> <tr> <th>Drawn</th> <th>Check</th> <th>Approved</th> <th>Date</th> </tr> </thead> <tbody> <tr> <td>JGP</td> <td>SH</td> <td>LOC</td> <td>15.10.07</td> </tr> </tbody> </table> Drawn by: Location Plan Project No: JGP/SH/LOC 02 00	Drawn	Check	Approved	Date	JGP	SH	LOC	15.10.07
No.	Date	Description																
1	15.10.07	Initial																
Drawn	Check	Approved	Date															
JGP	SH	LOC	15.10.07															



REVISIONS		
Date	Description	By

Legend	
Planning Permission Area	Boundary/Track
Land Under Control of Applicant	Distance Survey Bench Mark
Top of Bank	Survey Contour Lines
Top of Ditch	Electricity Pylon
Bottom of Bank	Telephone Pole
Ditch	Lamp Post
Gate	Iron Pole
Wall	Steel Top (Streetlights/Post)
Fence Type 1	Water Level
Fence Type 2	Tree Breakdown
Gate	
Overhead Electricity Cable	
Building	
Iron Column Marker	
Distance Survey Bench Mark	

DRAFT



FIDWELL, GREEN & BATES
 25 Smyth Street
 Walsingham
 Norfolk
 NG24 1ED
 Tel - 01934 372167
 Fax - 01934 380559
 e-mail - fgb@fgb-surveyors.co.uk

Client
J.G. PEARS

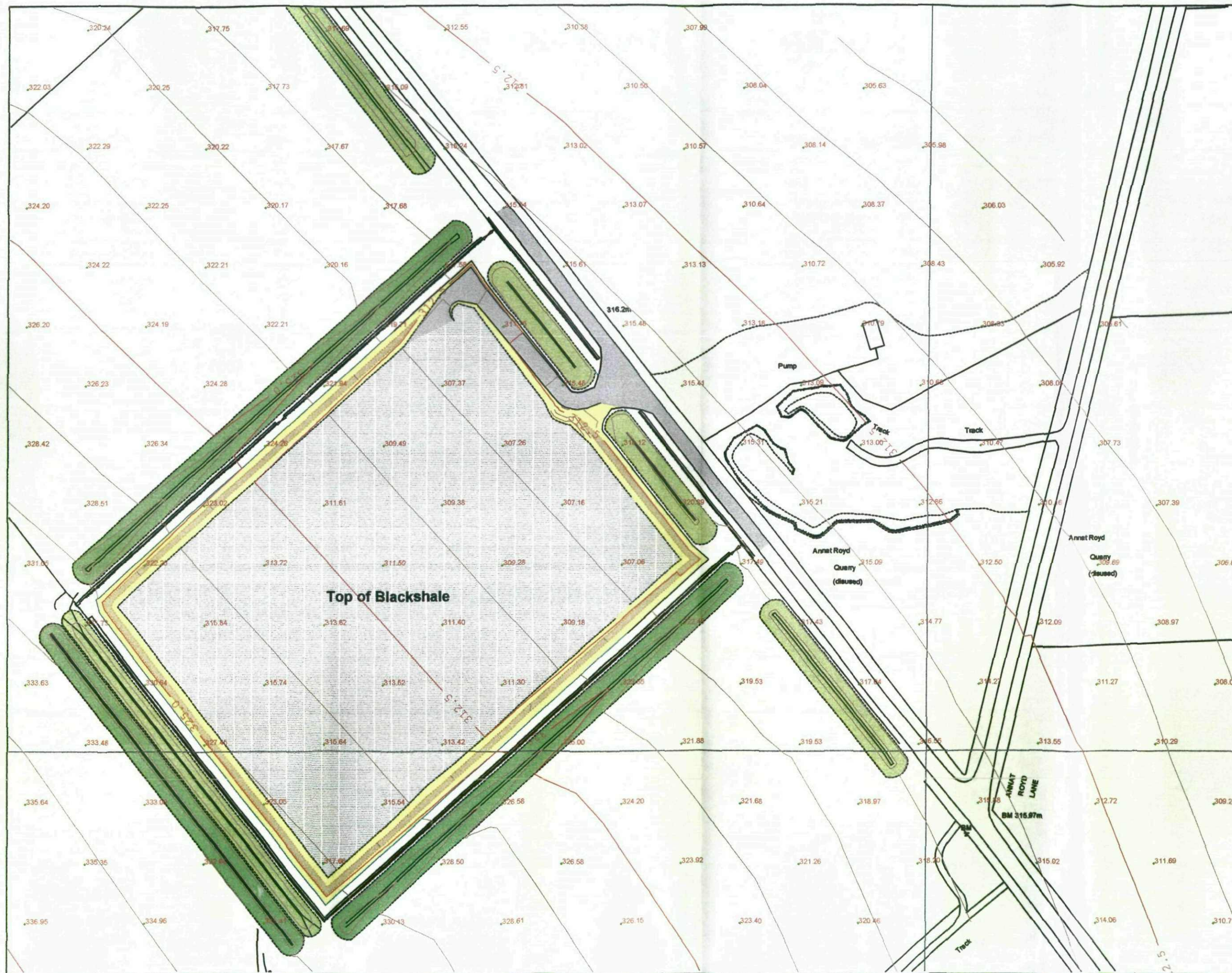
Job Title
SPICER HOUSE

Project Title
Working Scheme

Scale
 1:1250
 Date
 Dec 08
 Drawing
 SW
 Sheet
 00

Drawn by
 JGP/SH/WS
 Job No.
 02
 Date
 00

Plot Size A3 Plot Board 3 TYPE SCALE HERE



REVISIONS			
	Date	Description	By
11	e	e	
11	"	"	
11	"	"	
11	"	"	
11	"	"	

Legend:

	Planning Foundation Area		Land Under Current Approval
	Top of Bank		Boundary/Top PC
	Top of Quarry face		Ordinance Survey Bench Mark
	Bottom of Bank		Survey Control Station
	Road		Electricity Pylon
	Trench		Telegraph Pole
	Verge		Lamp-post
	Face Type 1		Man Hole
	Face Type 2		Step Top (grass/stone/stone)
	Face Type 3		Water Level
	Gully		Tree (unrooted)
	Reinforced/Concrete/Paved		
	Overhead Electricity Cable		
	Building		
	Ice Cellar Inland		
	Ordinance Survey Bench Mark		

DRAFT



FENNELL, GREEN & BATES
25 Smyth Street
Wakefield
West Yorkshire
WF1 1ED

Tel - 01924 372197
Fax - 01924 385559

e-mail - fgb@fgb-surveyors.co.uk

Client
J.G. PEARS

Job Title
SPICER HOUSE

Project Title
Working Scheme

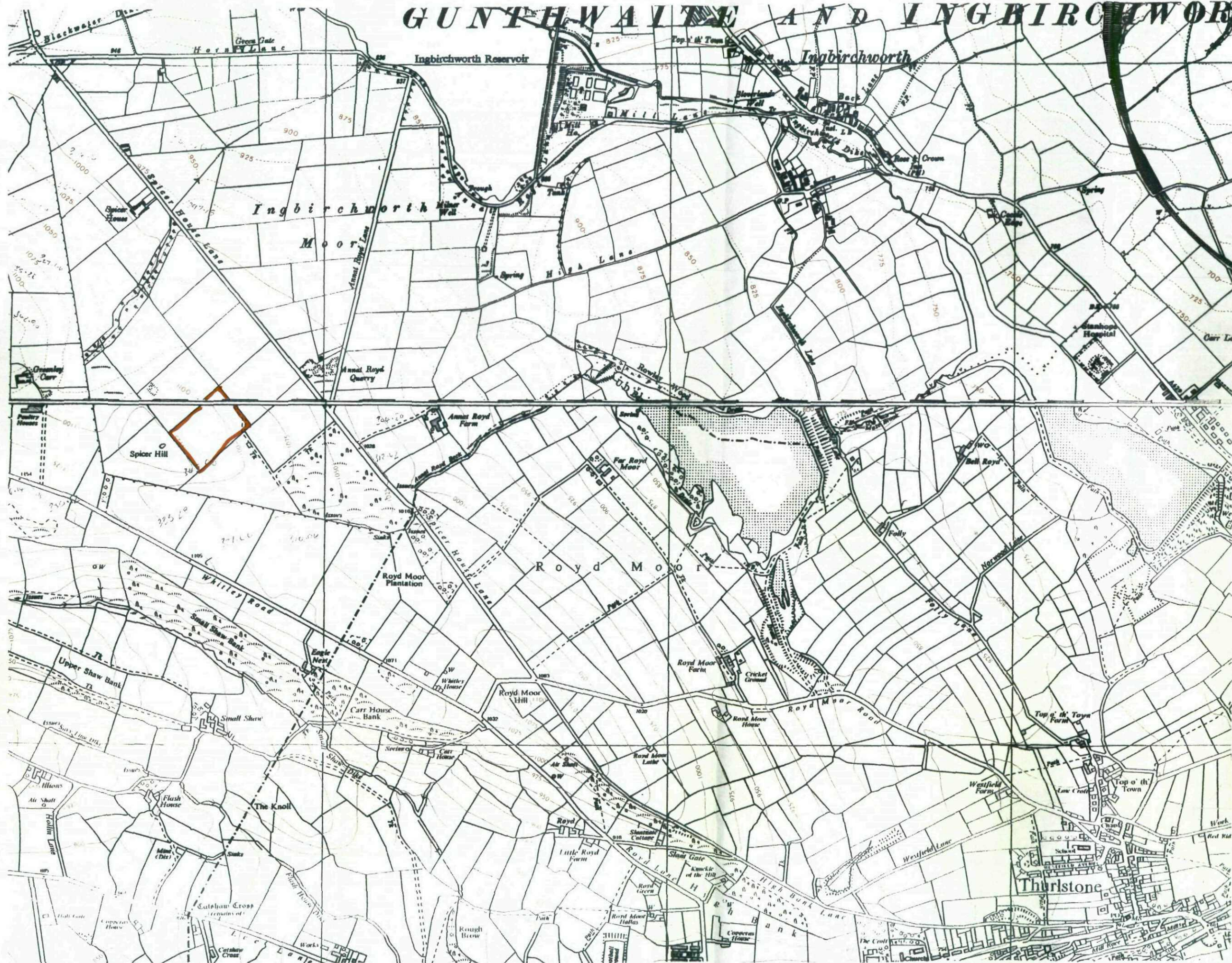
Scale 1:1250	Date Dec 06	Drawn by SW	Checked
-----------------	----------------	----------------	---------

**Dev. the
Phase 4**

DWG No	Job no	Rev
JGP/SH/WS	05	00

PLATE 27: A3 PLATE 28: A4 PLATE 29: A5

GUNTHWALTE AND ING BIRCHWORTH



REVISIONS		
Date	Description	By

Legend:

Planning Permission Area	Land Under Control of Advertiser	Top of Bank	Top of Quarry	Bottom of Bank	Road	Tank	Village	Fence Type 1	Fence Type 2	Fence Type 3	Grass	Overhead Electricity Cable	Building	1m Contour Interval	Ordnance Survey Backsight	Ordnance Survey Foresight	Ordnance Survey Bench Mark	Survey Control Station	Electricity Pole	Telephone Pole	Lamp Post	Man Hole	Stop Top (3m contour interval)	Water Line	Tree (indicated)
--------------------------	----------------------------------	-------------	---------------	----------------	------	------	---------	--------------	--------------	--------------	-------	----------------------------	----------	---------------------	---------------------------	---------------------------	----------------------------	------------------------	------------------	----------------	-----------	----------	--------------------------------	------------	------------------

FGB Fennell Green & Bates
MEMBER OF THE SURVEYORS' INSTITUTION

FENNELL, GREEN & BATES
 25 Smyth Street
 Wakefield
 West Yorkshire
 WF1 1ED
 Tel - 01924 372197
 Fax - 01924 385559
 e-mail - fgb@fgb-surveyors.co.uk

Client
 J G Pears
 Bella Vista Farm
 Hartcliffe
 Penistone
 S36 9FN

Site Name
 Spicer House

Project Title
 Dust Report

Scale
 1:10560

Date
 15.02.07

Drawn by
 JGP

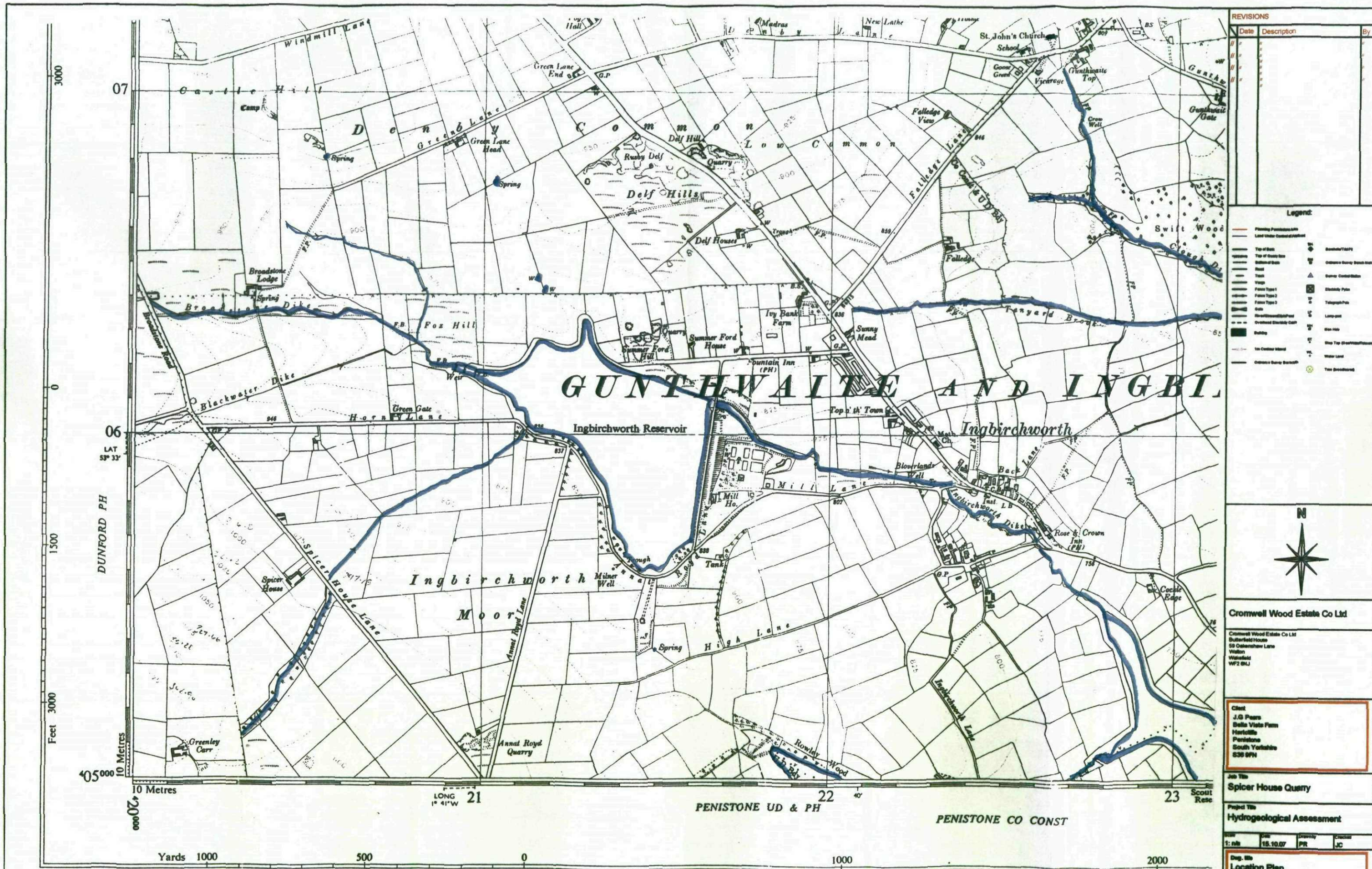
Checked
 JGP

Dwg. Title
 Hydrogeology

DWG No
 JGP/SH/PA1

Plot
 00

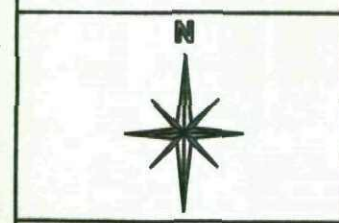
PLOT SIZE: A3, PLOT SCALE: 1:10560



REVISIONS		
Date	Description	By
11/11/07	Initial Issue	JGP
15/10/07	Revised	JGP
15/10/07	Revised	JGP
15/10/07	Revised	JGP

Legend	
	Planning Permission
	Land Under Construction
	Top of Bank
	Top of Road
	Bottom of Bank
	Road
	Trench
	Fences Type 1
	Fences Type 2
	Fences Type 3
	Gull
	River/Stream/Drainage
	Overhead Electricity Cable
	Building
	1st Contour Island
	Ordnance Survey Boundary
	Boundary/Track
	Ordnance Survey Bench Mark
	Survey Control Point
	Electricity Pole
	Telegraph Pole
	Lamp Post
	Sign Post
	Stop Top (Shrub/Tree/Flower)
	Water Level
	Tree (Broadleaf)

GUNTHWAITE AND INGBIRCHWORTH



Cromwell Wood Estate Co Ltd
Cromwell Wood Estate Co Ltd
Butterfield House
59 Oakenhow Lane
Wilton
Wetherfield
WF2 8HJ

Client
J.G. Peers
Bella Vista Farm
Harcliffe
Penistone
South Yorkshire
S36 8PN

Job Title
Spicer House Quarry

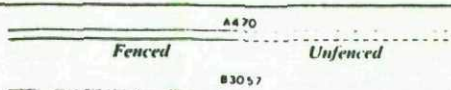
Project Title
Hydrogeological Assessment

Date
15.10.07
Drawn by
JGP
Checked by
JC

Drawn by
JGP/SJH/151007
Date
01
Rev
00
PLOT SHEET AS PLOT SCALE: 1:10000

Crown Copyright Reserved

Roads, Ministry of Transport Class 1



INDEX TO ADJOINING SHEETS

SE 11 SE	SE 21 SW	SE 21 SE
-------------	-------------	-------------

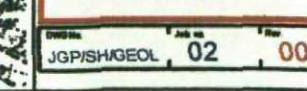
THE NATIONAL GRID
TO GIVE A GRID REFERENCE CORRECT TO 100 METRES

EXAMPLE	
Faldedge	
The Grid Letters on this sheet are SE	
EAST Take west edge of kilometre square	NORTH Take south edge of kilometre square

APPENDIX HRA2

Geological Plans

YORKSHIRE





FENNELL GREEN & BATES

25 Smyth Street
Wakefield
West Yorkshire
WF1 1ED
Tel - 01924 372197 Fax - 01924 385559
email - fgb@clial.pipex.com

LEGEND

Marshall's plc
SPICER HOUSE

Desktop Study
1871 Geological Sheet No. 273

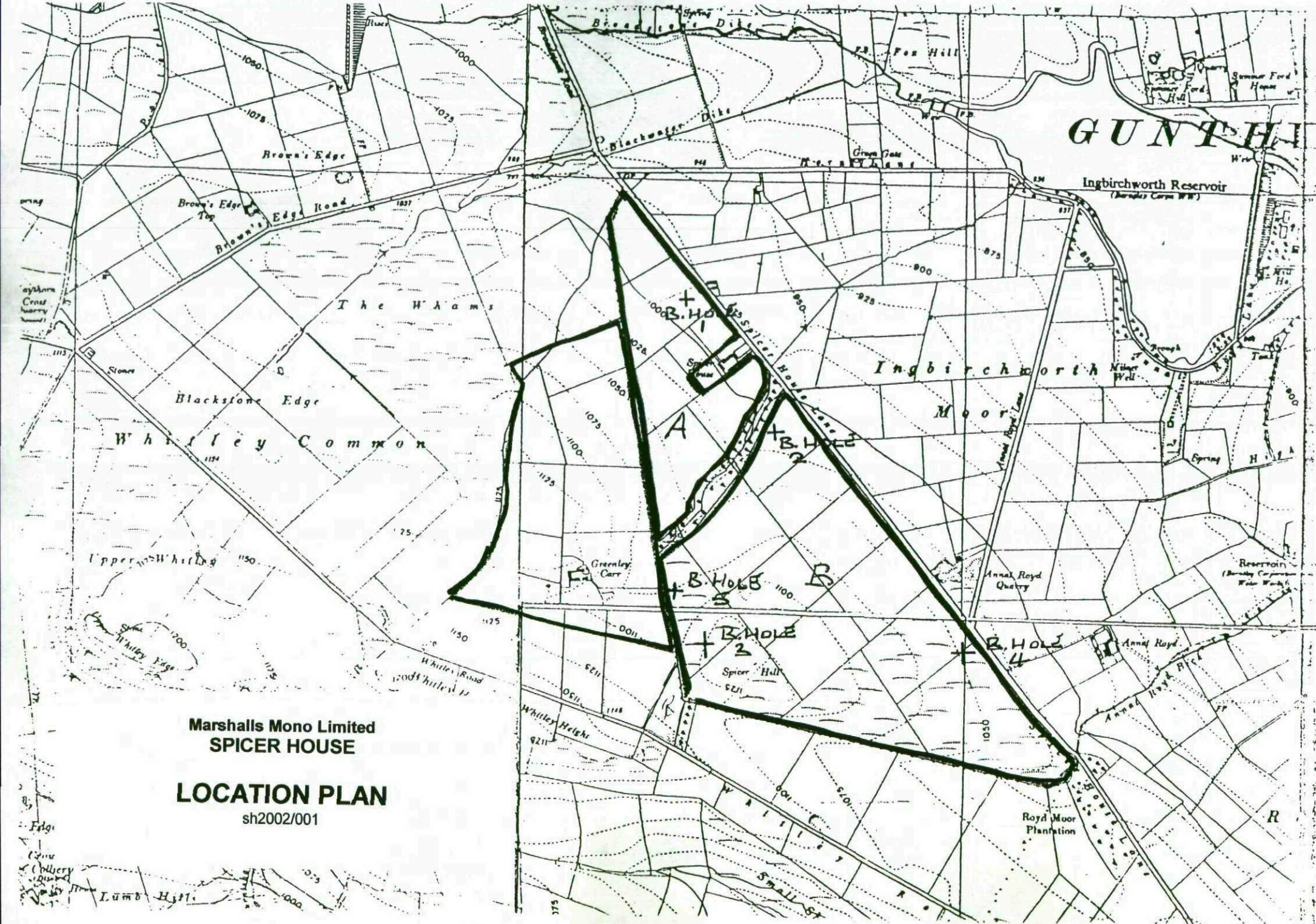
sh2002/273

Scale 1:10000

16 May 2002

APPENDIX HRA3

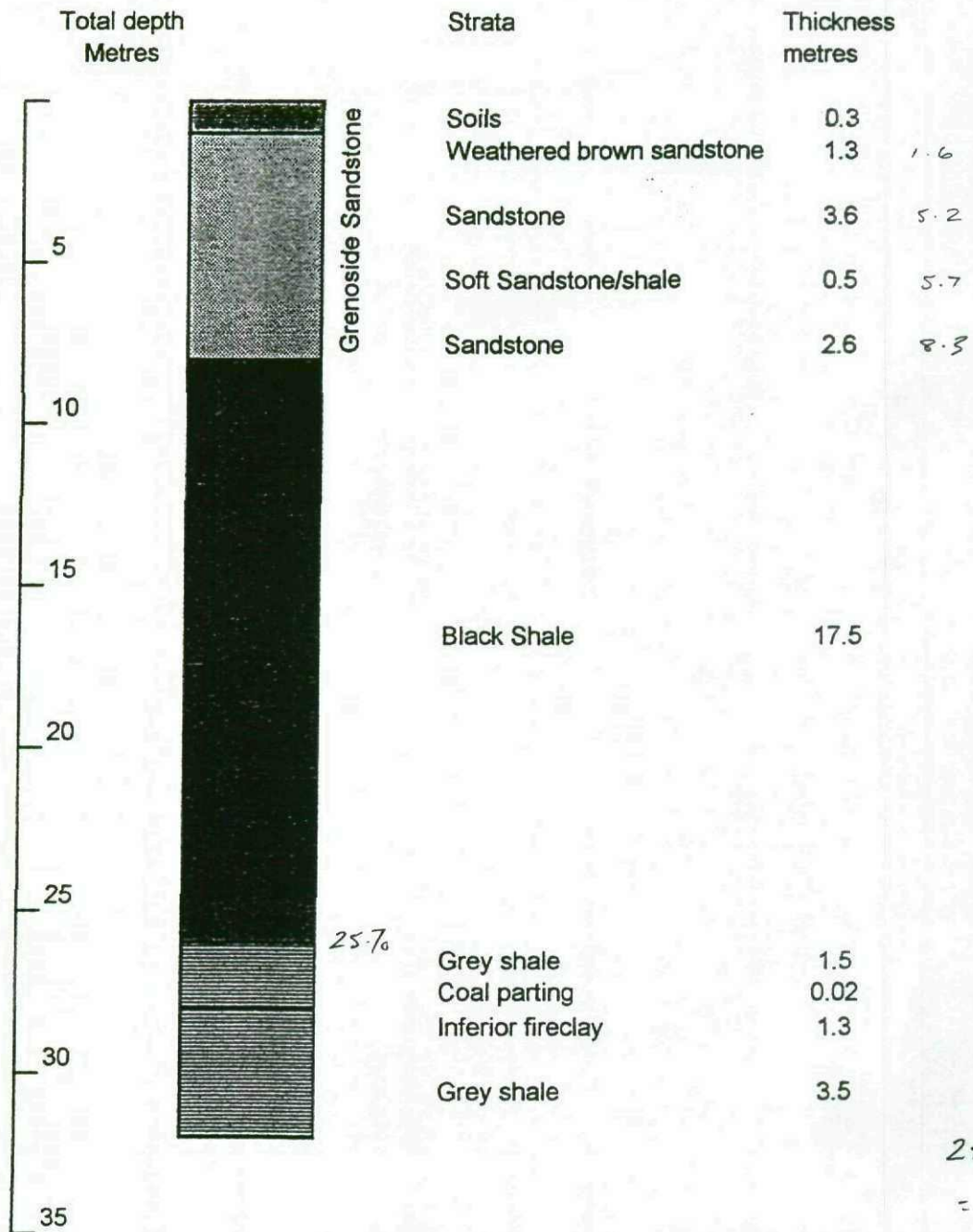
Borehole Survey and Logs



SPICER HOUSE

BOREHOLE No.1

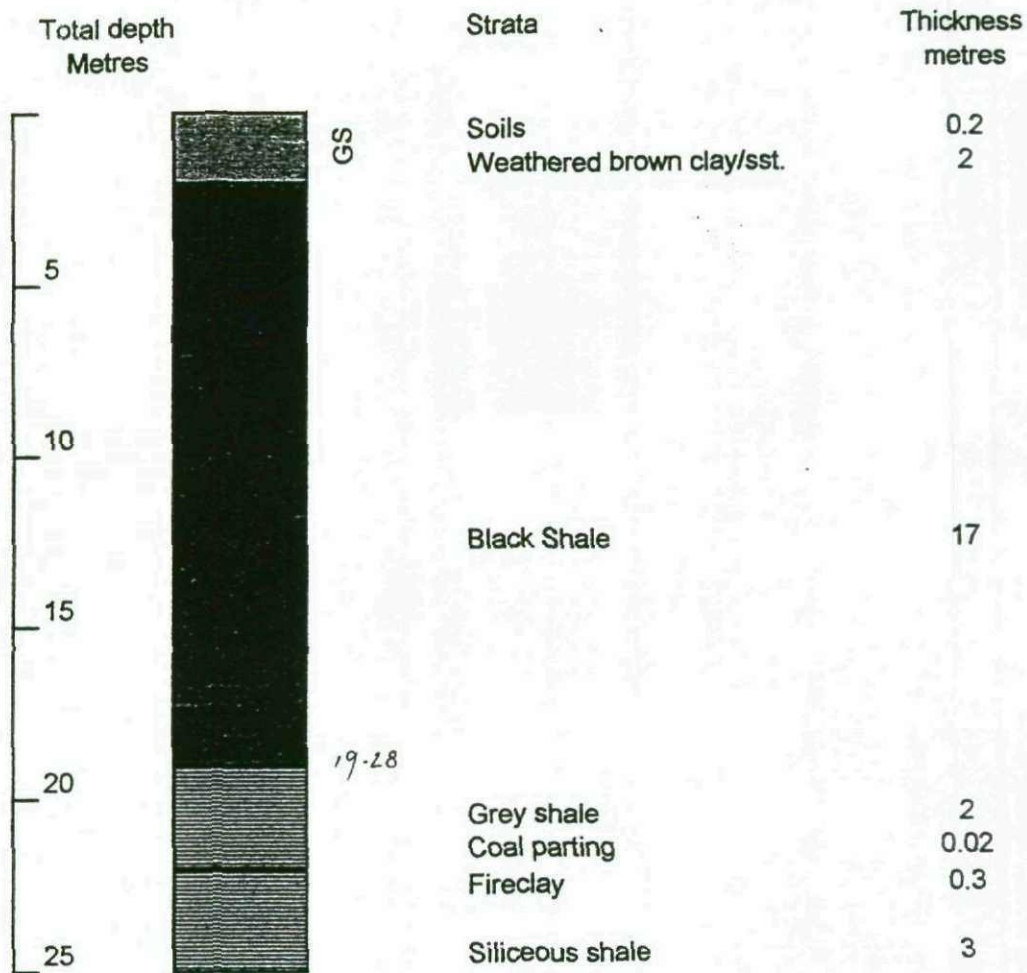
Surface Level 299 m AOD



SPICER HOUSE

BOREHOLE No.2

Surface Level 309 m AOD



19.28 + 7

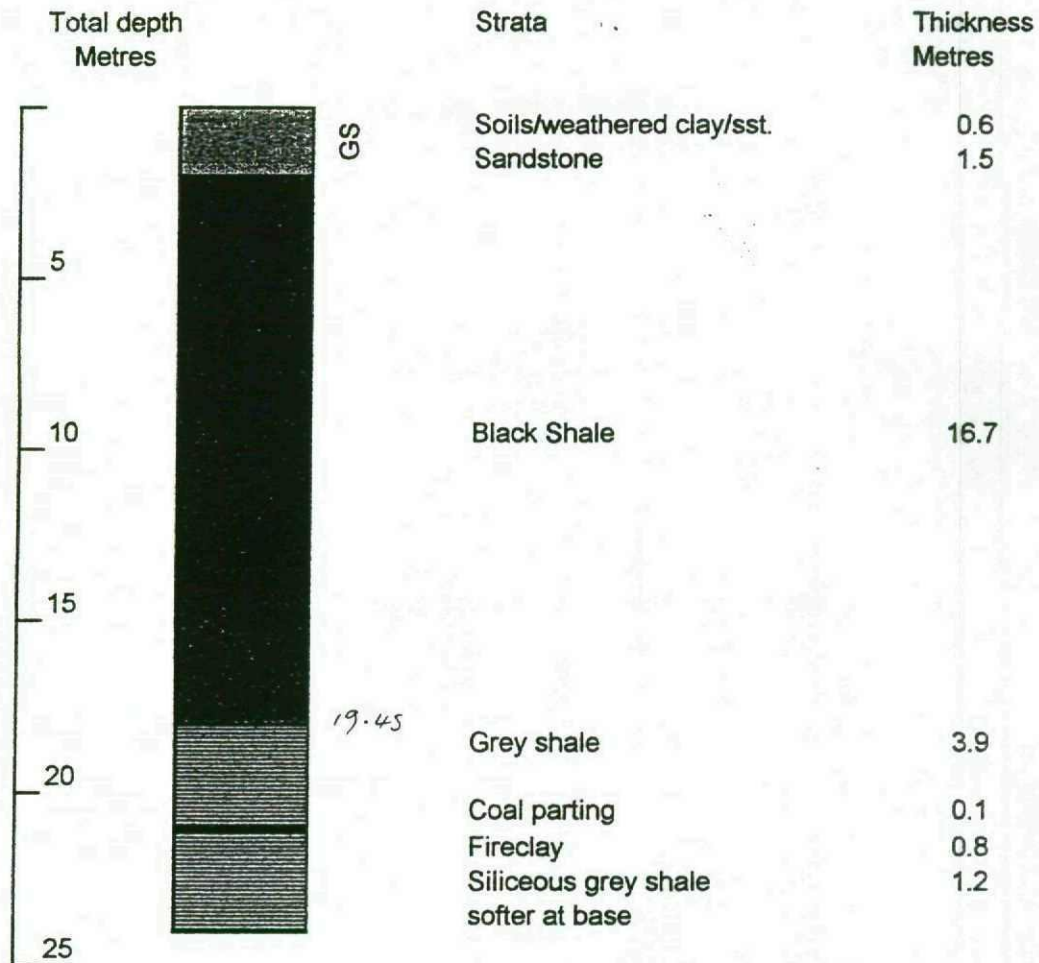
= 26.28

Top of Gm

SPICER HOUSE

BOREHOLE No.3

Surface Level 341 m AOD



$$19.45 + 7$$

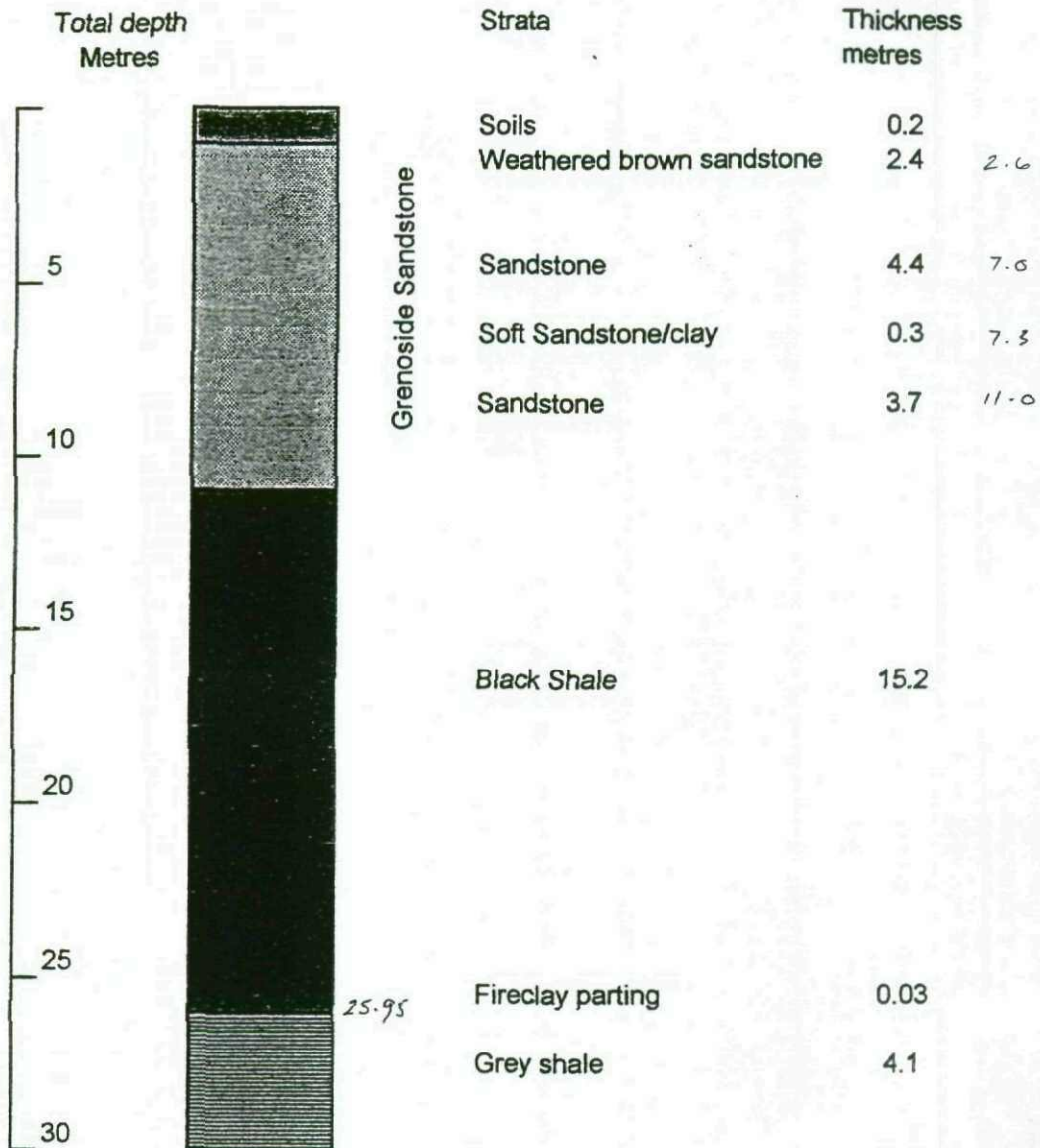
$$= 26.45$$

Top of Gm

SPICER HOUSE

BOREHOLE No.4

Surface level 319 m AOD ✓

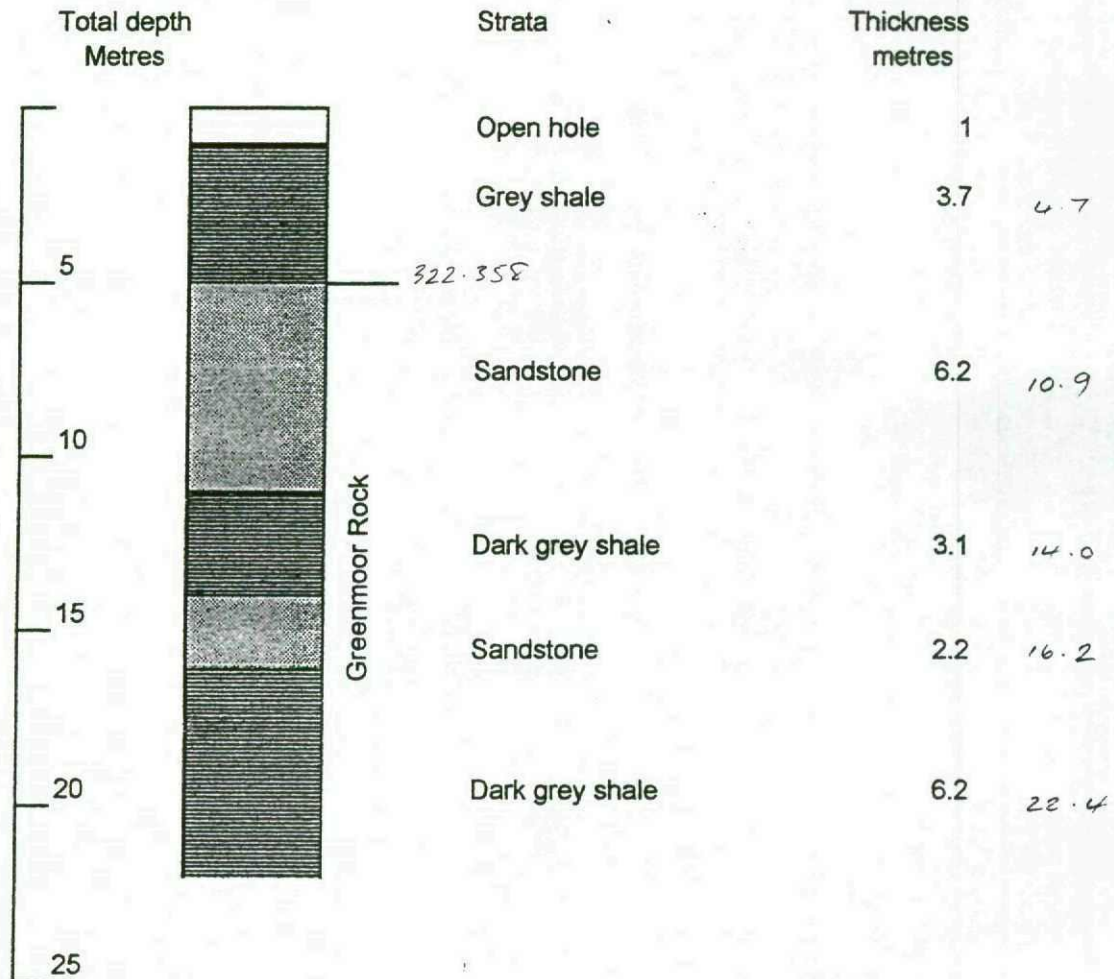


25.95 + 7
= 32.95
Top of Gm

SPICER HOUSE

BOREHOLE No.5

Surface level 327 m AOD



Assume Avg thickness of :-

Grey shale = 7m

Black shale = 16.6 m

= 322.358

= 329.358 B shale

= 345.958 base of Greenmoor

SPICER HOUSE

Spicer Hill Average Section

