Hanson Aggregates

Machen Quarry

Hydrological/ Hydrogeological Assessment

15 November 2004

Entec UK Limited

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Report for

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Contents

1. Introduction

Hanson Aggregates propose to submit a planning application to extend their Machen Quarry in a northeasterly direction to release additional limestone reserves of approximately 10 million tonnes.

The existing quarry has been worked since the 1940's with the most recent planning permission having been granted in 1990.

Conditions attaching to existing mineral planning permissions at the site are due for review under the Environment Act, 1995, (ROMP) process by 22nd August 2005. A consolidating planning application is therefore proposed which incorporates all land currently consented for mineral extraction as well as the proposed quarry extension.

A desk study has been undertaken to assess the potential impact on the water environment of:

- the existing quarry; and
- the proposed extension.

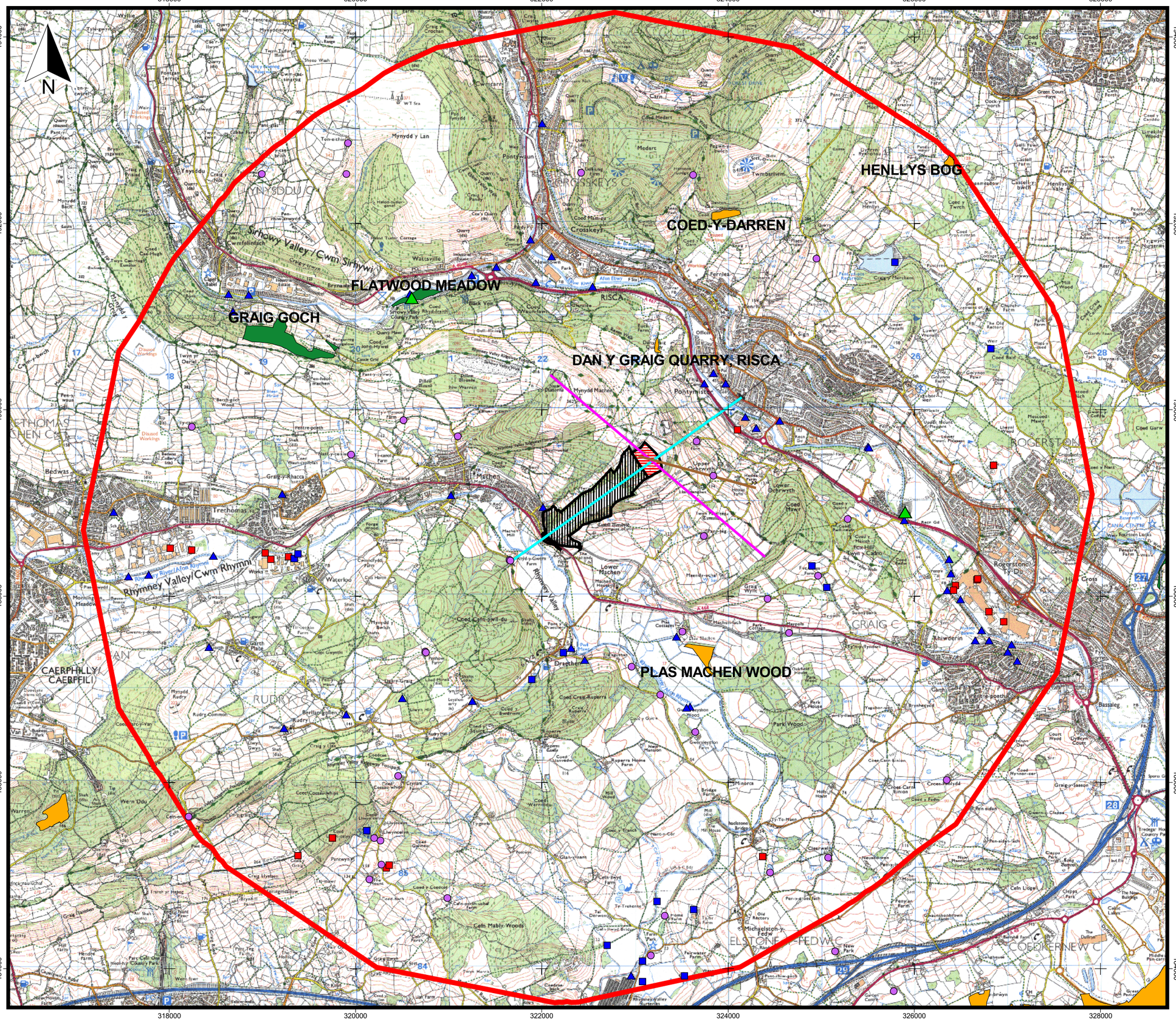
The location of Machen Quarry is shown in Figure 1.1. Reference is made in this report to areas to the north, south and east of the quarry, indicated as Areas A, B and C respectively; the locations of these three areas are shown in Figure 2.3.

1.1 Methodology

A detailed desk study has been undertaken to collate relevant information on the water environment around the quarry. In addition details have been obtained on potential receptors:

- licensed groundwater abstractions;
- private water supplies;
- sensitive river environments;
- SSSIs;
- local water features.

A walkover survey was undertaken in April 2004 to examine the local environment and obtain site specific information.



Key:

- NW-SE Cross section A
- NE-SW Cross section B
- W-E Cross section C
- Quarry extension
- Quarry
- River Flow Gauges
- Surfacewater abstractions
- Groundwater abstractions
- Consented Discharges
- Private Water Supplies
- Local Nature Reserves (LNR)
- SSSI
- 5 km Radius

Path: h:\projects\hm-250\13430 machen quarry\drawings\13430_site.apr

Hanson

Machen Quarry
Hydrological/Hydrogeological Assessment
Hanson Aggregates

Figure 1.1
Location Map
Machen Quarry

September 2004
13430-S01b barkr

Entec

2. Baseline Description

2.1 General

The current quarry excavates Carboniferous limestone down to a depth of approximately 110 m AOD at the south-western end and rises in a series of benches to an elevation of about 260 m AOD at the northeastern end, Figure 2.1.

The current permission allows excavation at the northeastern end down to approximately 150 m AOD.

There are no recorded groundwater levels in the vicinity of the quarry but from the distribution of springs, streams and the proximity of the River Rhymney it is very likely that groundwater flow was generally in a south - southwest direction from high ground around Mynydd Machen and directed towards the River Rhymney by the dip and strike of the geological strata. Flow in the limestone southwards beyond the quarry is likely to be restricted by the presence of the low permeability Lower Limestone Shale.

To the northeast of the quarry groundwater flow in the limestone is likely to be along strike with flow towards the northeast with discharge in the vicinity of the River Ebbw.

To the south and east of the quarry are Devonian Sandstones, which contain groundwater. Although locally important it is thought that groundwater in these sandstones is isolated from the limestone due to the presence of the Lower Limestone Shale.

With the development of the quarry it is likely that groundwater in the limestone has been intercepted and is drained from the site by the surface water drainage system. This would have very little effect on the amount of water ultimately reaching the River Rhymney but local to the quarry would draw groundwater more directly into the quarry and would therefore have some effect on nearby springs and streams. Indeed from field observations there is some suggestion that flow in the stream immediately to the north of the quarry has been reduced. Effects on the groundwater system to the south and east of the quarry would be restricted by the Lower Limestone Shale.

The proposed extension would also intercept groundwater and the overall effect is expected to be similar to the existing quarry but because the extension moves across the surface water, and likely groundwater divide, this aspect needs to be taken into consideration.

2.1.1 Topography

An extract from the 1:25 000 scale Ordnance Survey Map for the area (Explorer 152, 151 and 166) and a site plan are presented in Figure 1.1 and Figure 2.1 respectively with the site boundaries clearly marked. Machen Quarry is located between two river valleys, namely the River Rhymney to the southwest and the River Ebbw to the northeast on a moderately steep hillside, extending from the Rhymney river valley at 65 m AOD and rising to 270 m AOD near the surface water divide.

The proposed extension covers an area of approximately 0.055 km^2 (5.5 ha) at the northeastern end of the existing quarry, crossing over the surface water divide which peaks at 280 m AOD, and over into the adjacent River Ebbw catchment. The peak marks the surface water divide for the rivers Rhymney and Ebbw running from the prominent high point of Mynydd Machen (362 m AOD) in a northwest-southeast orientation as coincides with the northwest - southeast section line in Figure 1.1.

The existing quarry floor lies at an elevation of 110-120 m in the southwest and currently rises to 260 m AOD in the northeast (Figure 2.2).

2.2 Hydrology

Hydrometeorology

The long-term average annual rainfall (1961-90) for the Rhymney catchment measured at the Llanedeyrn flow gauge station (057008) is 1405 mm and for the Ebbw catchment measured at the Rhiwderyn flow gauging station (056002) it is 1456 mm per annum.

Annual rainfall and runoff statistics are available for Llanedeyrn flow gauge station for the years 1973-2001 from the Centre for Hydrology and Ecology (CEH) and are presented in Table 2.1. Runoff measured at the gauge represents both runoff and groundwater recharge arriving at the gauge as baseflow.

Table 2.1 Average Monthly Rainfall and Runoff at the Llanedeyrn Flow Gauge (057008), and Calculated Actual Evapotranspiration[1] for the River Rhymney 1973-2001

Month	Mean Rainfall (mm)	Mean Runoff (mm)	Mean Actual Grassland Evapotranspiration (mm)
January	174	160	14
February	128	119	9
March	123	106	17
April	83	65	18
May	78	43	36
June	72	30	42
July	72	24	48
August	95	29	66
September	135	47	87
October	168	100	69
November	161	128	33
December	171	149	22
Total	**1461**	**1000**	**461**

[1] Calculated as Actual Evapotranspiration = Rainfall - Runoff

Surface Hydrology

The surface hydrology of the area is dominated by the River Rhymney, which flows past the quarry 200 m away from the southern boundary in a south-easterly direction. Mean flow and Q95 are 5.67m^3/s and 0.732m^3/s respectively from the CEH records for the Llanedeyrn flow gauge (NGR: ST 225 821) located approximately 10.7 km downstream from the quarry. The River Ebbw flows in a south-easterly direction in the adjacent valley beyond the proposed quarry extension to the northeast. Mean flow and Q95 are 7.53m^3/s and 1.462m^3/s respectively (IoH) at Rhiwderyn flow gauge (NGR ST 259 889) approximately 2.7 km downstream of the quarry. Mean river levels at Waterloo Bridge, Machen (ST 195 884) on the Rhymney are 0.45 m between 1990 and 2002, reaching an average 0.60 m during January and 0.31 m during July and August.

In the immediate vicinity of the quarry there are a number of springs, issues and small streams arising on the hillside carrying both surface water runoff and groundwater discharge. These drain in a south-westerly direction in the Rhymney catchment and north-easterly direction in the Ebbw catchment. Surface water features were identified from a 1:10,000 basemap and verified during a site walkover in April 2004. These are shown in Figure 2.3 and visual flow estimations are included in Appendix A.

2.3 Geology and Hydrogeology

Geology

Geological interpretations have been made from the IGS Geology Sheet 249 and extracts from the HMSO Memoir 249[2]. The simplified geology around the quarry is shown in Figure 2.4.

The Carboniferous limestone being worked by the quarry outcrops along a narrow strip, never more than 500 m wide, extending north-eastwards from the Rhymney Valley towards the Ebbw Valley before turning north-north-eastwards and narrowing to less than 250 m wide beyond the high point on the water divide northeast of the quarry. The Main Limestone is reasonably steeply dipping at an angle of approximately 25º to the northwest (Figure 2.4), is approximately 120 m thick and thins towards the northeast.

The upper division of the Main Limestone consists of mainly massively bedded, poorly stratified, pale grey, coarse to fine-grained sometimes current-bedded oolitic limestone and the lower division comprises thickly bedded, dolomite or dolomitic limestones The oolitic limestones are most common in the middle and upper parts of the sequence, particularly in the western area of the outcrop. This is evident in the quarry along the northern face where the quarry workings are working around outcrops of gully oolite.

The top of the Main Limestone forms an unconformable junction with the overlying sandstones, conglomerates and mudstones of the Millstone Grit series, noticeable along the northern boundary of the quarry site. Locally a conglomeratic sandstone occurs between the Millstone Grits and Main Limestone and this is exposed in a stream section to the northeast of Ffwrwm (ST 22380 89220), shown as site 4 in Figure 2.3.

The base of the Main Limestone lies conformably on the Lower Limestone Shale. The junction follows the base of the scarp formed by the Main Limestone along much of its outcrop (see

[2] Institute of Geological Sciences (1969). Geology of the country around Newport. HMSO.

Figures 2.5 and 2.6). The Lower Limestone Shale forms a narrow outcrop extending north-eastwards between the Rhymney and the Ebbw valleys and thickens gradually to approximately 65 m, comprising +/- 30 m of mudstone overlying +/- 35 m of limestone. The mudstones consists dominantly of grey, sometimes micaceous, shaley mudstones, and some buff, fine grained, current bedded, silty sandstones. The Lower Limestone Shale bounds the quarry to the south and east and marks the upthrow side of a fault extending roughly from Ochrwyth to Lower Machen (ST 241894 to ST 232881) see Figure 2.7.

The Lower Limestone Shale lies conformably on the Upper Old Red Sandstone strata to the east. These include Upper Old Red Sandstone and Lower Red Sandstones of the Brownstone group which outcrops orientated southwest/north-eastwards towards the Rhymney Valley. Towards the Ebbw Valley they swing round to the south-southwest/north-north-eastwards caused by the Machen Anticline and Machen Syncline. They are approximately 120 m thick near Machen and the two strata vary considerably from soft, fine-grained sandstones, to hard, coarse-grained conglomeratic sandstones to silty mudstones of fluvatile origin.

Hydrogeology

The Main Limestone is the main hydrogeological unit at the quarry. No hydrogeological data or groundwater level data for either the quarry or the local area are available for the limestone. (The Environment Agency does not have any groundwater observations boreholes in the area.) However a reasonable assessment can be produced at this site in the absence of such information from the known geology, observations made during the walkover survey and from information obtained from the quarry operators.

On a regional scale the dip of the limestone is towards the northwest and it is underlain by the Lower Limestone Shale such that any groundwater flow will be directed towards the Rhymney Valley. Although no specific hydraulic properties are available for the Lower Limestone Shale at this location, they are generally regarded as having a low permeability.

Groundwater recharge occurring beyond the groundwater divide to the northeast of the quarry is inferred to flow north-eastwards towards the River Ebbw, down strike in the limestone. Groundwater flowing locally from the limestone along the eastern boundary of the quarry may emerge as a spring line at the contact with the Lower Limestone Shale. The limestone itself is heavily jointed and faulted, with a large fault running along the central axis of the quarry, therefore groundwater flow within the limestone is likely to be through fissure and fracture flow rather than through a uniformly porous media. The River Rhymney is in contact/underlain with the limestone and is assumed to be in a degree of hydraulic continuity with it, receiving some baseflow from groundwater.

It is not known if groundwater recharge into the Coal Measures on the southern slopes of Mynydd Machen to the north and northwest of the quarry is relatively continuous or discontinuous with the limestone. However, it is possible that given the numerous springs and issues arising in this area at similar elevations, that there is a degree of aquifer continuity despite the densely interbedded strata.

To the east the Devonian sandstones are the main hydrogeological unit but it is thought unlikely that they are in continuity with the limestone owing to the 50-60 m thickness of Lower Limestone Shale. There are no groundwater level data for the sandstones in this area and flow is likely to be complex owing to the Machen Syncline and Anticline to the south and east of the quarry.

Groundwater Levels

An understanding of groundwater levels and flow has to be established from existing topography and field observations (presented in Appendix A).

The following general comments can be made:

- Surface water arising off the slopes around the existing quarry drains to the River Rhymney;
- Surface water arising off the slopes in the extension area follows the surface water divide, with some flow draining into the River Rhymney and some into the River Ebbw;
- Groundwater recharge to the limestone beneath the quarry occurs from rain falling onto the catchment north of the quarry and from rain falling directly onto exposed quarry surfaces, after runoff and evaporation losses have occurred;
- Groundwater at the base of the limestone strata is bound by the low permeability Lower Limestone Shale.

To the north of the quarry the following observations can be made:

- The springline to the north of the quarry is shown on Figure 2.3 (Area A; stream survey points 1 to 8), occurring at elevations of 200-235 m AOD. However, field observations gave electrical conductivity readings <100µS/cm and flow rates generally equal to or less than 1 l/s suggesting a predominantly surface water source at these elevations. A groundwater component was observed at point 7 (see Figure 2.3) in the stream arising from springs and issues on Mynydd Machen at an elevation of 145 m AOD;
- A groundwater component is detected in a stream section between the 100-130 m elevations in the stream passing Ffwrwm (ST 22380 89220) closest to the quarry at survey point 8 (Figure 2.3). There is evidence to suggest some derogation of stream flow along this reach as follows:
  - the presence of derelict water works;
  - dry stream bed;
- The derelict water works comprise a large water tank with approximately 50 m^3 capacity, a brickwork structure with an off-take pipe to the water tank and a 4 inch water pipe line running down to the houses below at Chatham. The water tank is now completely silted up and overgrown with shrubs. The tank does not appear on OS Sheet 152 published 1999, but was shown on the BGS geology sheet ST 28 NW surveyed between 1959-1961;
- The stream bed is completely dry in the vicinity of the waterworks. Upstream of the tank (at an approximate elevation of 150 m AOD), the flow appears to be twice that at stream survey point 4 (Figure 2.3). Below this point the flow reduces and disappears at approximately 130 m AOD. It does not re-emerge until a point 5 m upstream from the brickwork structure where the piped off-take to the tank is located. 5 m downstream the stream flow resumes again at approximately 5 l/s. The stream continues past the tank and then completely dries up. It re-emerges

from a gravel pool in the dry bed 10 m upstream from the fenceline shown as stream survey point 8 on Figure 2.3, at an elevation of 100 m AOD.

- The geology along this reach changes from Millstone Grit to Sandstone to Limestone over a short distance (Figure 2.4). The point where flow disappears is at 130 m AOD and is near the boundary of the limestone suggesting the water table may have been drawn down in the limestone.
- The quarry floor in this area is between 110-115 m AOD.
- These observations could be interpreted as evidence of some reduction in flow from the stream. When the water tank was operational there was sufficient flow from the spring to sustain a private water supply requiring a tank with 50 m^3 capacity. The current small flow rate of 5 l/s and stretches of dry stream bed imply that the flow from the spring in the past may have been greater than it is today.

The water features to the south (Area B) and northeast (Area C) of the quarry are shown on Figure 2.3 as follows:

- A very small spring (No.9 ~140 m AOD) arises on the boundary of the quarry site, possibly where the limestone comes into contact with Lower Limestone Shale.
- Springs occurring to the south (Area B) of the quarry occur at elevations between 50 - 135 m AOD. EC measurements range between 200-500 μS/cm suggesting a strong groundwater component. Estimated flow rates of the spring (No.10) behind the church in Lower Machen (ST 228 881) are 15 l/s (EC 500 μS/cm) suggesting that groundwater from the sandstones issues near the contact with the Lower Limestone Shale that outcrops here in an approximately north-easterly - south-westerly strike.
- Fewer springs arise on the Ebbw valley hillside (Area C) at approximate elevations of 150 - 210 m AOD. EC readings suggest a component of flow is derived from groundwater. Estimated flow rates are approximately 0.5 l/s (April 2004).

It can be surmised that the historical springline occurred approximately between 130-150 m AOD to the north and south of the quarry (Areas A and B) and the current springline is slightly lower than this at approximately 100-130 m AOD to the north (Area A) and in the immediate vicinity of the quarry.

This would suggest that the current workings have intercepted the water table at about 130 m AOD which is consistent with experience at the quarry.

The indication is therefore that the current workings have intercepted the water table and over the life of the quarry (50 years) have reduced the water table at the quarry by approximately 10 - 20 m.

The quarry does not have to actively dewater the workings as drainage is by gravity. The amount of groundwater drained is relatively small.

Extrapolation of the water table across the extension area (Figure 2.8) suggests the current water table slopes to the southeast from around 200 to 170 m AOD. The proposed extension will extract rock down to a maximum of 150 m AOD. This indicates that the water table in the

limestone will be lowered and to a similar magnitude as experienced in the current workings. The potential impacts of this are considered in Section 3 below.

2.4 Water Resources

Licensed abstractions

There are 17 surface water abstraction licences within 5 km of Machen Quarry as shown in Table 2.2, of which the two nearest (21/57/12/*s/0075) are at Nant-y-Draethen on the opposite side of the River Rhymney valley.

Table 2.2 Surface Water Abstractions within 5 km of the Site

Location	Licence Number	Licensed Abstraction (TCMA)	Distance from Machen Quarry (km)
Nant-y-Draethen ST23088408	21/57/12/*s/0075*	**272.8**	1.2
Nant-y-Draethen ST19348840	21/57/12/*s/0075*	**272.8**	1.6
Five Lanes ST25799158	20/56/61/*s/0019	**0.3**	2.1
Sunnybank Farm ST25068809	20/56/61/*s/0014	**3.9**	2.4
River Rhymney ST26829065	21/57/12/*s/0022	**109.1**	2.7
Nant Tir-Jenkins ST19348840	21/57/12/*s/0054	**1363.8**	2.8
Llanfedw ST23088386	21/57/12/*s/0094*	**1.0**	3.7
Llanfedw ST20128548	21/57/12/*s/0094*	**1.0**	3.7
Pant-Yr-Eos Reservoir ST20128548	20/56/11/*s/0007	**1659.3**	3.8
River Rhymney ST23236847	21/57/12/*s/0086	**113.7**	4.0
Pant-Yr-Eos ST21898710	20/56/11/*s/0005	**1659.3**	4.2
Ty-Hir Farm ST23538392	21/57/12/*s/0028*	**2.3**	4.2
Nant Fawr ST23638463	21/57/12/*s/0028*	**2.3**	4.4
River Rhymney ST19388845	21/57/12/*s/0087	**64.5**	4.6
Fairwater Farm ST24908832	21/57/12/*s/0088	**64.5**	4.9
Fairwater Farm Reservoir ST22708425	21/57/12/*s/0030	**6.8**	4.9

* Aggregate licence from multiple point sources. Annual quantity for licence given. Distribution between individual boreholes is unknown.

There are 20 groundwater abstraction licences within a 5 km radius of Machen Quarry according to records held by the Environment Agency, the locations of which are shown on Figure 1.1 and are summarised in Table 2.3. The closest groundwater abstraction is at a borehole at Pontymister steelworks (20/56/61/*g/0015) for 68,200 m^3/a (68.2 TCMA) 1.4 km to the northeast near the River Ebbw (ST 241 897).

Table 2.3 Groundwater Abstractions within 5 km of the Site

Location	Licence Number	Licensed abstraction (TCMA)	Distance from Machen Quarry (km)
ST24108978	20/56/61/*g/0015	**68.2**	1.4
ST19288842	21/57/12/*g/0058	**90.9**	2.8
ST19098839	21/57/12/*g/0060	**54.6**	3.0
ST19038846	21/57/12/*g/0053	**45.5**	3.1
ST26448811	20/56/61/*g/0004*	**409.1**	3.7
ST26428806	20/56/61/*g/0004*	**409.1**	3.7
ST18248849	21/57/12/*g/0090	**2.3**	3.8
ST26678817	20/56/61/*g/0004*	**409.1**	3.9
ST26688818	20/56/61/*g/0004*	**409.1**	3.9
ST20368511	21/57/12/*g/0048	**0.2**	3.9
ST20338508	21/57/12/*g/0081	**2.0**	4.0
ST19758540	21/57/12/*g/0045	**1.7**	4.0
ST19758540	21/57/12/*g/0044	**0.3**	4.0
ST19758540	21/57/12/*g/0046	**1.6**	4.0
ST26858940	20/56/61/*g/0024	**44.0**	4.0
ST18018851	21/57/12/*g/0073	**101.7**	4.1
ST26808783	20/56/61/*g/0004*	**409.1**	4.1
ST24378520	21/57/12/*g/0100	**2.3**	4.1
ST26968772	20/56/61/*g/0004*	**409.1**	4.3
ST19388521	21/57/12/*g/0061	**3.3**	4.4

* Aggregate licence from multiple point sources. Annual quantity for licence given. Distribution between individual boreholes is unknown.

Private Water Supplies

There are thirty seven private water supplies according to records held by Newport Borough Council, Caerphilly Borough Council and two further have been identified as a part of this work. These are shown in Figure 1.1 and summarised in Table 2.4. Within the immediate vicinity of the quarry there are twelve private water supplies, the nearest five being located 0.4 km away at Llan-danglws and 0.5 km away at Castle Farm, to the northeast and east of the quarry extension respectively and 0.5 km away on the opposite side of the River Rhymney at Rhyswg Farm (ST 216883), Rhydgwern (ST 216883) and Rhyswg Ganol Farm (ST 213883). A well is located at Panteg Farm (ST237886) 0.9 km away from the quarry to the east.

Table 2.4 Private Water Supplies within 5 km of the site

Location	Source	No. properties	Distance from Machen Quarry (km)
Llan-danglws ST236892	Spring	1	0.4
Castle Farm ST237896	Spring	1	0.5
Abercarn ST216883	Well		0.5
Lower Machen ST216883	Well		0.5
Cwmcarn ST216883			0.5
Lower Machen ST237886	Well	1	0.9
Machen ST210897	Spring		1.4
Lower Machen ST325876	Spring	1	1.6
Draethan ST229872	Spring		1.6
Lower Machen ST244879	Spring	1	1.8
Machen ST207874			1.9
Rudry ST207873	Spring		1.9
Michaelstone y Fedw ST232869			2.0
Bedwas ST205898			2.0
Machen ST205898			2.0
Rhiwderin ST249882	Spring	few	2.1
Rhiwderin ST252888	Well	1	2.2
Rhiwderin ST246876	Spring	1	2.2
Machen ST199895			2.3
Michaelstone y Fedw ST236865			2.5
Risca ST249916	Spring		2.8
Crosskeys ST224925	Spring		3.0
Risca ST236925	Spring		3.0
Rudry ST204860	Spring		3.1
Lisvane ST201854	Spring		3.8
Trinant ST202853	Rainwater		3.8
Cardiff ST209847	well		4.0
Lisvane ST202851	spring		4.0
Trethomas ST182898	Spring		4.0
Cefn-Mably ST233845	Well	1	4.2
Cefn-Mably ST244850	Spring	1	4.2
Lisvane ST201849	Well		4.2
Mynyddislwyn ST198925	Spring		4.2
Michaelstone ST250851	Spring	1	4.4

Table 2.4 (continued) Private Water Supplies within 5 km of the site

Location	Source	No. properties	Distance from Machen Quarry (km)
Myndislwyn ST199928	Spring		4.4
Bassaleg ST263860	Well	1	4.5
Cefn-Mably ST231841	Well	2	4.6
Rudry ST182856	Spring		4.9
Machen ST189925	Spring		4.9

Discharges

There are two licensed discharges within the immediate vicinity of the quarry, according to records held by the Environment Agency, including the discharge from the final effluent lagoon from the quarry (Consent No: AF4028802) and one from the sewage treatment at Machen, approximately 1 km upstream (AN0096001) as shown in Figure 1.1. Within a 5 km radius of Machen Quarry there are 50 consented discharges, of which 30 are sewerage with the majority discharging into the River Ebbw.

Water Quality

The chemical and biological quality of the Rivers Rhymney and Ebbw are monitored by the Environment Agency. The most recent (2001) General Quality Assessment (GQA) data available from the Environment Agency for the Rhymney along a 4.6 km stretch from the Nant Tir-Jenkin confluence (ST195884) to the Nant-y-Draethen confluence (ST223873), indicate that the river is generally of good chemical quality[3]. However, it declined to fairly good status during 2001 and the river was assessed under the GQA scheme as having a significant failure for dissolved oxygen during the 2001 assessment. It has fairly good biological quality[4] and nitrates and phosphates are low to very low.

For the River Ebbw along an 8.4 km stretch from the Sirhowy confluence (ST222191) to Bassaleg (ST278187), the GQA indicates the river is of very good to good chemical status, good to fairly good biological status and has very low nitrates and phosphates.

Current Water Management Operations

Surface water runoff from the quarry is collected via a drainage system comprising a succession of lateral drains at the base of every bench and fed into a settlement pond at the south-western end of the quarry. It discharges through a culvert into an existing watercourse flowing in a south

[3] Water of very good chemical quality is 'suitable for all abstractions, very good salmonid fisheries, cyprinid fisheries and is indicative of natural ecosystems'. Water of good chemical quality is 'suitable for all abstractions, salmonid and cyprinid fisheries and is indicative of ecosystem at or close to natural condition'. Water of fairly good chemical status is 'suitable for potable supply after advanced treatment, other abstractions, good cyprinid fisheries and is indicative of natural ecosystems or those corresponding to good cyprinid fisheries'. (Environment Agency GQA Assessment Standards).

[4] Water of good biological quality is 'a little short of an unpolluted river'. Water of fairly good biological quality is 'worse than expected for unpolluted river'. (Environment Agency GQA Assessment Standards)

westerly direction towards the River Rhymney 300m away. Rendel Palmer and Tritton (1989)[5] designed the existing drainage system and settlement structures to cater for surface water runoff from the current quarry area of 37.3 ha. Their hydrological analysis indicates surface water runoff from the quarry (including the proposed extension) with return periods of 2 and 100 years will be 0.57 m^3/s and 1.35 m^3/s. The consideration of the existing water treatment and discharge facilities at the site and their ability to deal with additional surface and groundwater drainage from the extension area will be the subject of separate pre-application consultations with the Environment Agency.

2.5 Sites of Interest

The quarry is surrounded by a woodland fringe with a Forestry Commission plantation located immediately to the north. Four SSSIs and two Local Nature Reserves (LNR), are located within the 5 km radius and their locations are summarised in Table 2.5 below and shown on Figure 1.1. The two nearest features are Dan y Graig Quarry designated for its limestone exposures, 1 km away at Risca (ST 232 907) and Plas Machen Wood SSSI located 2 km to the southeast (ST 237 873) in the Rhymney valley downstream. Plas Machen Wood is designated for its wet woodland community.

Table 2.5 Locations of SSSIs and Local Nature Reserves

Name	Location	Designation	Area (ha)	Distance from Machen Quarry
Dan y Graig Quarry SSSI	ST 232 907	Geological Exposures of Carboniferous Limestone (of the Oolite Group and Llanelly Formation)	0.55	0.9
Plas Machen Wood SSSI	ST 237 873	Ecological Wet woodland including alder (*Alnus glutinosa*) tussock sedge (*Carex paniculata*) and yellow flag (*Iris pseudacorus*)	3.8	2.0
Coed-y-Darren SSSI	ST 239 192	Geological Exposures of middle Westphalian (Carboniferous) Strata	2.2	2.5

[5] Outline Design, Machen Quarry Drainage (1989). Rendel Palmer and Tritton (Wales). Report No. 1252

Table 2.5 (continued) Locations of SSSIs and Local Nature Reserves

Name	Location	Designation	Area (ha)	Distance from Machen Quarry
Flatwood Meadow LNR	ST 206 913	Ecological Wet meadow wetland, & heath vegetation	3.6	2.8
Graig Goch LNR	ST 195 908	Ecological Ancient broadleaf woodland (pre-industrial remnant)	14.8	3.7
Henllys Bog SSSI	ST 263 926	Ecological Only site in county for marsh helleborine (*Epipactis palustris*)	0.8	4.4

N

B

A

GULLY OOLITE

CAERPHILLY CBC

NEWPORT CBC

CAERI

NEWPOR

0 m 150 m

Scale 1:2,500 @ A3

Key

- Freehold ownership at Machen
- Freehold ownership at Pontyminster Quarry
- Boundary between Unitary Authorities of Caerphilly and Newport
- Boundary of planning permission at Machen
- Boundary of planning permission at Pontyminister
- Soil storage mounds
- Public footpaths in vicinity of quarry
- Mineral safeguarding area
- Line of section (See Figure 1.9 for quarry cross section)

Hanson

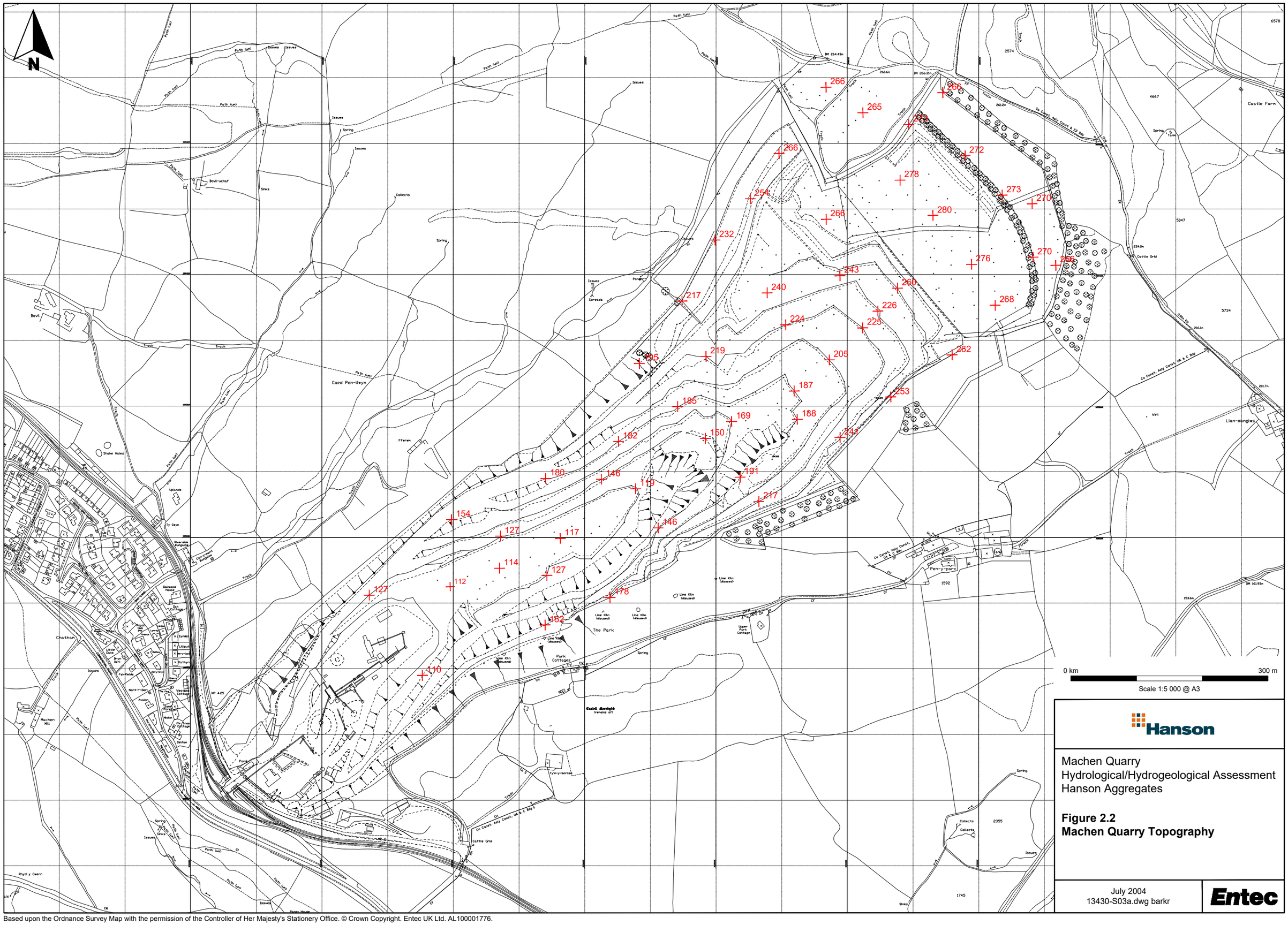
Machen Quarry
Hydrological/Hydrogeological Assessment
Hanson Aggregates

Figure 2.1

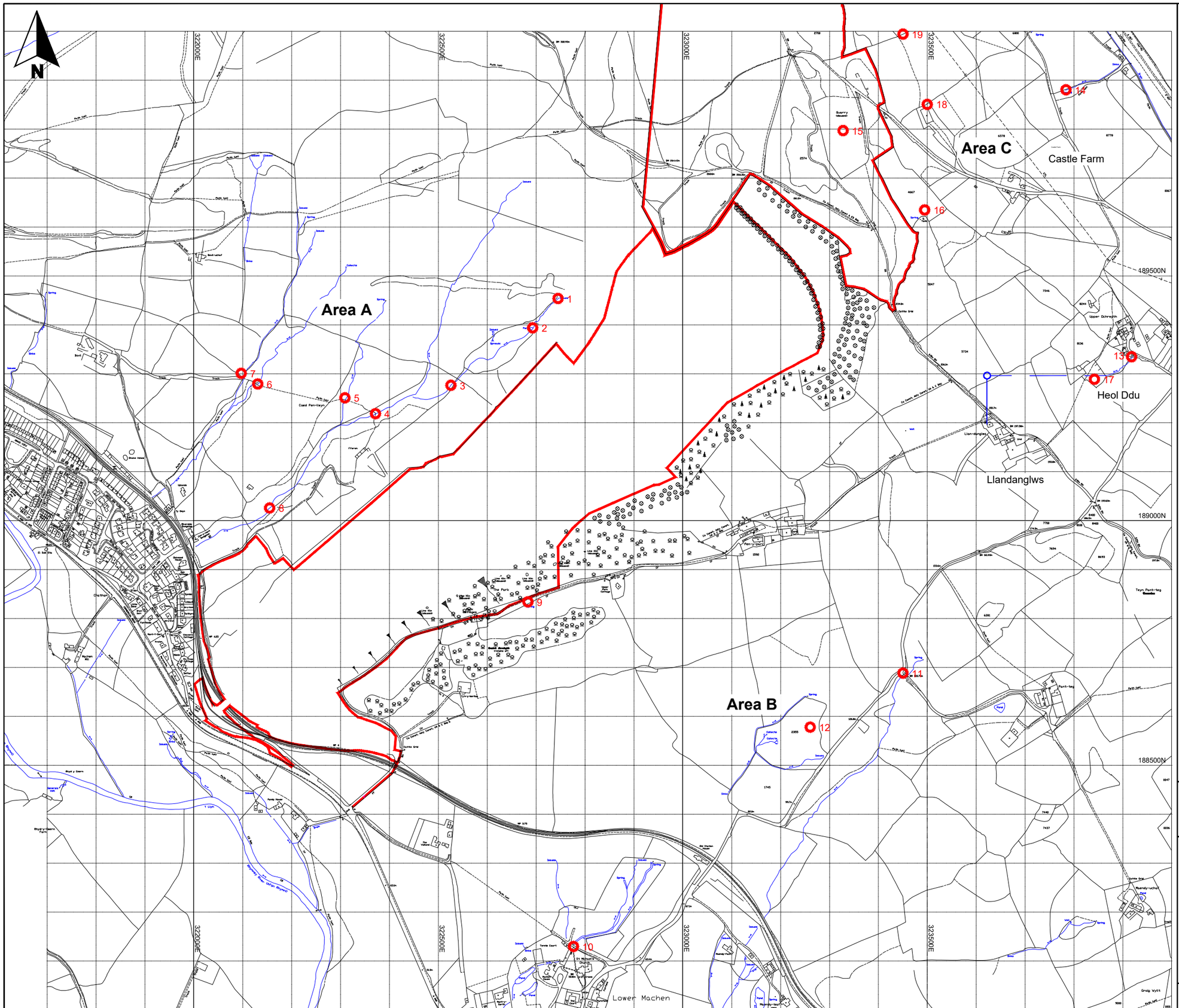
Site Plan

September 2004
13430-S02b.cdr barkr

Entec



Based upon the Ordnance Survey Map with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright. Entec UK Ltd. AL100001776.



Key

13 Survey point

Note
See Appendix A for details.

Survey point
16 Llandanglws (old water supply)
17 Llandanglws (present water supply)
18 Castle Farm (Main water source for cattle)
19 Castle Farm (main water source for cattle)

0 m 400 m
Scale 1:7500 @ A3

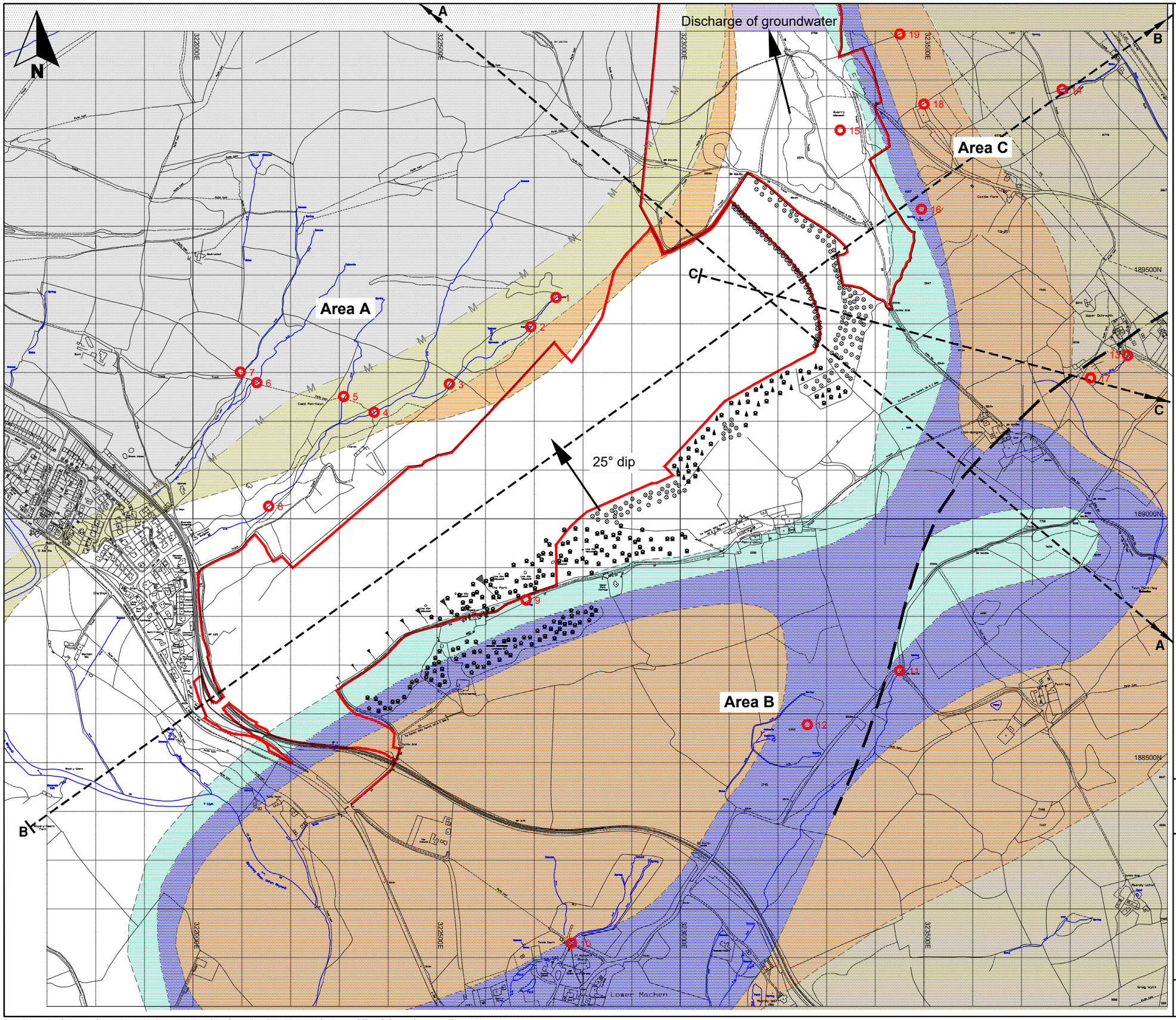
Hanson

Machen Quarry
Hydrological/Hydrogeological Assessment
Hanson Aggregates

Figure 2.3
Surface Water Features Around Machen Quarrry

Sepember 2004
13430-S04b.dwg barkr

Entec



Key

- 13 — Stream survey point
- Lower Coal Measures
- M — Marine Transition
- Millstone Grit Series
- Sandstone (MSG)
- Main Limestone (Dolomite)
- Lower Limestone Shale
  - Mudstone
  - Limestone
- Upper Old Red Sandstone
- Lower Old Red Sandstone
- Fault
- Approximate line of cross section

0 m — 400 m

Scale 1:7500 @ A3

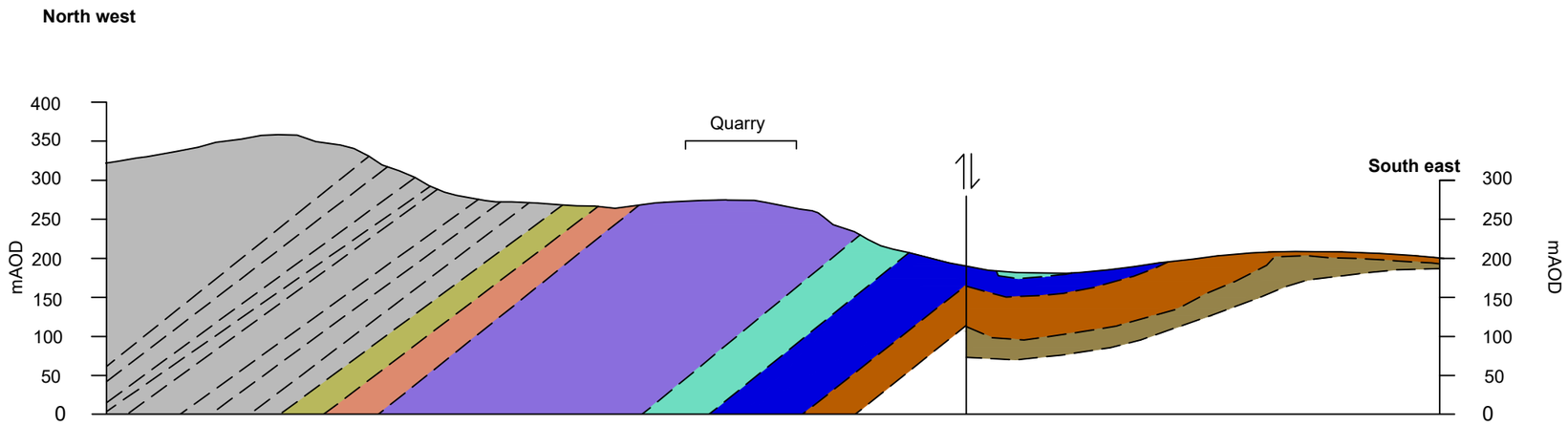
Hanson

Machen Quarry
Hydrological/Hydrogeological Assessment
Hanson Aggregates

Figure 2.4
Simplified Geology at Machen Quarry

September 2004
13430-S08a.dwg barkr

Entec



Key

- Coal Measures
- Millstone Grit Series
- Sandstone (MSG)
- Main Limestone
- Mudstone
- Lower Limestone Shale
- Upper Old Red Sandstone
- Lower Old Red sandstone

0 m — 750 m

Horizontal scale 1:15 000 @ A3
2x Vertical exaggeration

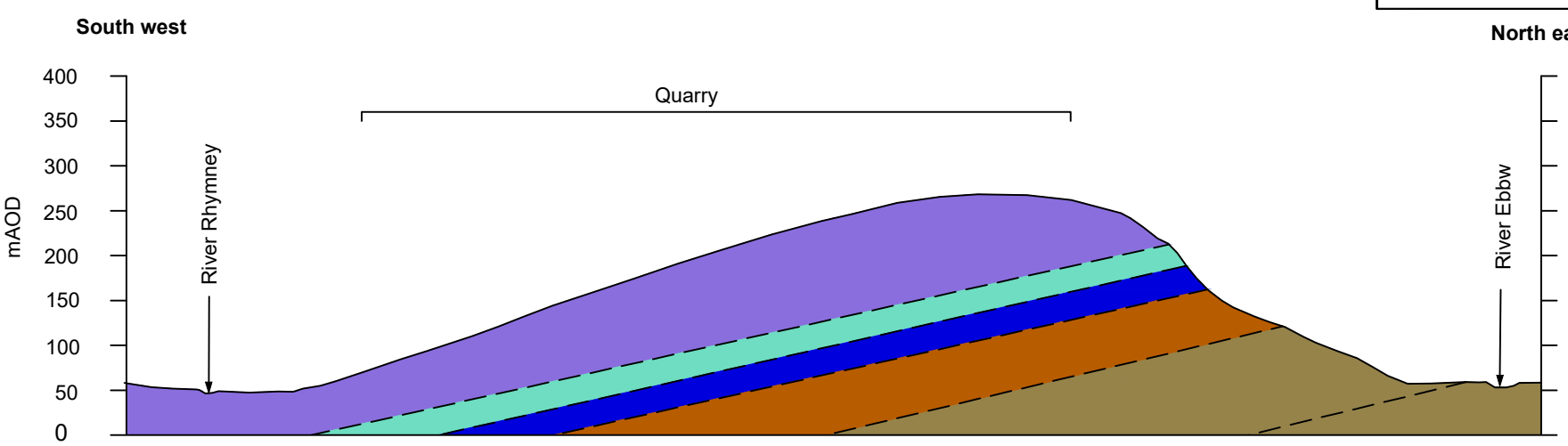
Hanson

Machen Quarry
Hydrological/Hydrogeological Assessment
Hanson Aggregates

Figure 2.5
Geological Cross Section North West-South East Through Machen Quarry

September 2004
13430-S05b.cdr barkr

Entec



Key

- Main Limestone
- Mudstone
- Limestone
- Lower Limestone Shale
- Upper Old Red Sandstone
- Lower Old Red Sandstone

0 m — 750 m

Horizontal scale 1:15 000 @ A4
2x Vertical exaggeration

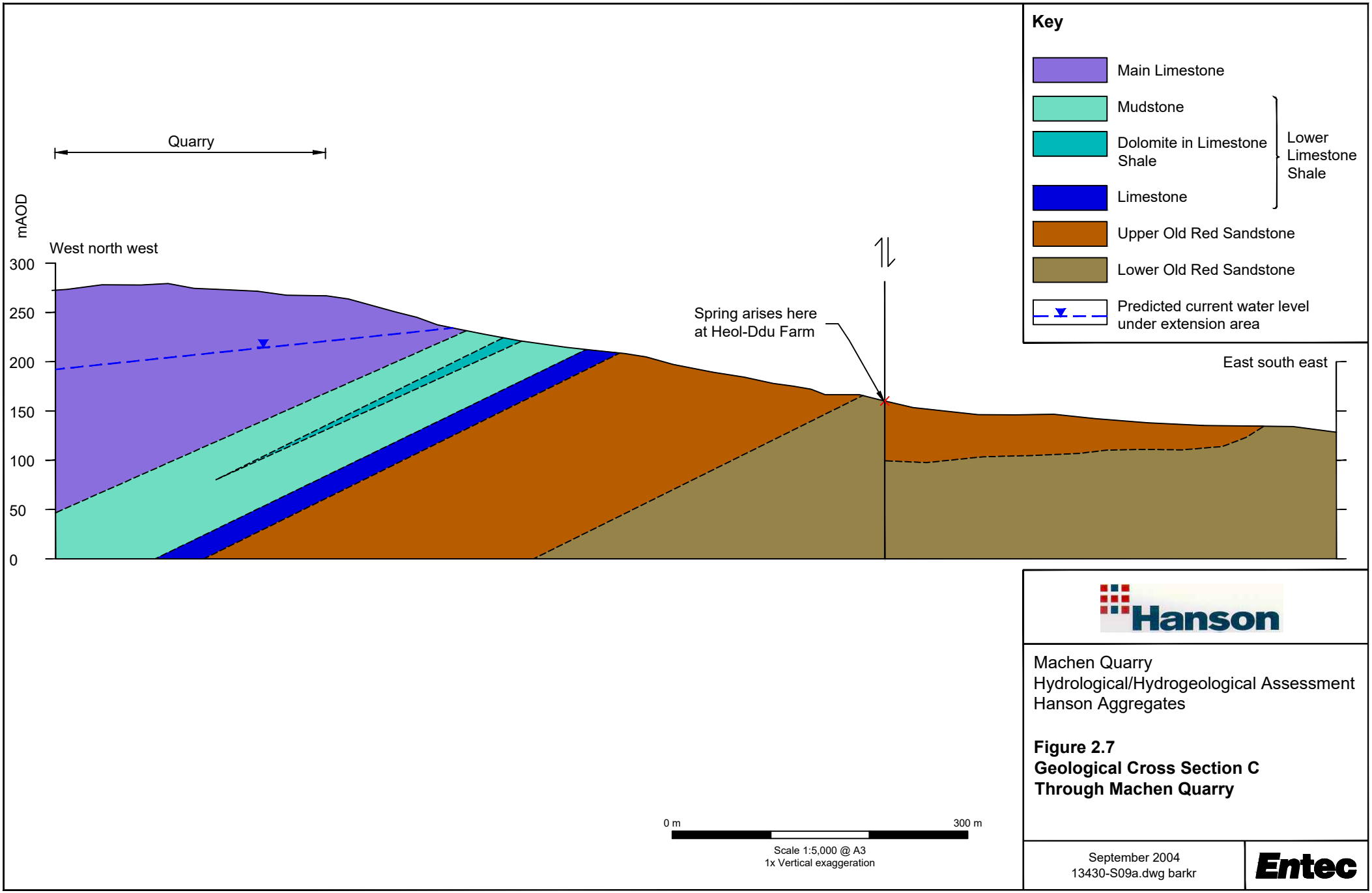
Hanson

Machen Quarry
Hydrological/Hydrogeological Assessment
Hanson Aggregates

Figure 2.6
Geological Cross Section B Through Machen Quarry

September 2004
13430-S06b.cdr barkr

Entec



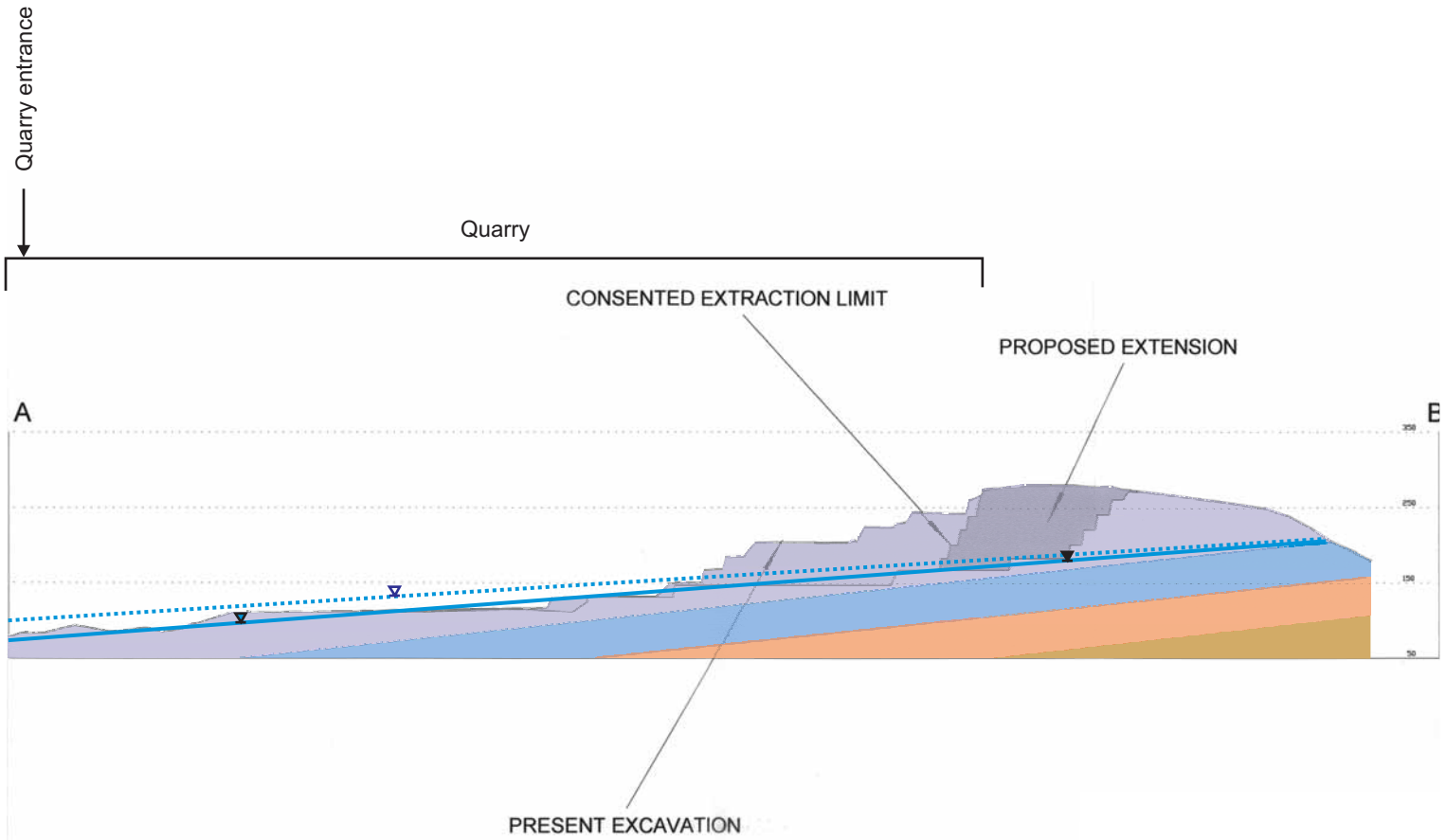
Hanson

Machen Quarry
Hydrological/Hydrogeological Assessment
Hanson Aggregates

Figure 2.7
Geological Cross Section C
Through Machen Quarry

September 2004
13430-S09a.dwg barkr

Entec



Key

- Current observed water level
- Estimated historic water level
- Predicted current water level under extension area
- Current water level
- Estimated historic water level
- Main Limestone
- Lower Limestone Shale
- Upper Old Red Sandstone
- Lower Old Red Sandstone

Note
Section A-B, see Figure 1.2 for line of section.

0 m 500 m

Scale 1:10,000 @ A4

Hanson

Machen Quarry
Hydrological/Hydrogeological Assessment
Hanson Aggregates

Figure 2.8
Section Showing Present, Consented and Proposed Extraction Areas

September 2004
13430-S07b.cdr barkr

Entec

3. Potential Impacts

There are a number of potential impacts associated with minerals development of this type. Extending the quarry over the surface water divide will locally affect flow quantities and directions. Groundwater drainage in the quarry for example, may result in drawdown of groundwater levels in the surrounding area. This in turn has the potential to effect nearby abstractions, private water supplies, river flows and surface water levels. The discharges resulting from quarry drainage could increase water levels in receptors potentially affecting land drainage, flooding and water quality.

3.1 Relevant Water Features

Figure 1.1 shows relevant water features within a 5 km radius, including licensed abstractions, private water supplies, river flows and discharges, SSSIs and Local Nature Reserves and local water features. The majority of these will not be affected by either the existing quarry operations or the proposed extension to the quarry, as they lie on opposite sides of the Rivers Rhymney and Ebbw which will act to constrain any impact from the quarry. In the immediate vicinity of the quarry the following features have been considered.

Licensed Groundwater Abstractions

The groundwater abstraction at Pontymister steelworks (Licence no :20/56/61/*g/0015, ST241898) is from the Old Red Sandstone aquifer and is unlikely to be affected by either the existing quarry or proposed extension. There are no other licensed groundwater abstractions likely to be affected by either the existing quarry or the proposed extension.

River Flows and Discharges

There are a number of consented discharges on the Rivers Rhymney and Ebbw, shown on Figure 1.1. These are only of concern if there are significant effects to the river flows resulting in a lower dilution ratio. It is not thought that there will be any changes to the flow entering the River Rhymney from the existing quarry, as there will not be any change to the area of the excavations within the existing planning consent.

Changes to surface water drainage will result from the proposed quarry extension, causing a very minor increase in runoff to the River Rhymney and a minor reduction of flow to the River Ebbw. Table 3.1 shows the percentage change in river flows, based on the assumption that the surface water catchment is concurrent with the boundary of the quarry (as delineated from the OS 1:25 000 topographic map) and that in the worst case scenario all of the rainfall[6] goes directly into runoff or groundwater recharge to emerge as runoff at the base of the quarry.

[6] Rainfall taken as long term average from Rhymney flow gauge (057008) over years 1973-2001 as 1461mm per annum. This represents the worst case scenario and is higher than that for the Ebbw flow gauge or 1961-1990 average.

Table 3.1 Changes to Surface Water Runoff (Including Recharge) Due to Proposed Quarry Extension

	Calculated Runoff per annum (m^3/a)	Calculated Runoff (m^3/s)	% of mean Rhymney Gauged Flow	% of mean Ebbw Gauged Flow	% of Q95 Rhymney Gauged Flow	% of Q95 Ebbw Gauged Flow
Total extension area	81015	0.002567	0.05		0.18	
Existing area within Rhymney catchment	48826	0.001547	0.03		0.10	
Loss from Ebbw catchment	32189	0.00102		0.01		0.07
Gain to Rhymney catchment (from Ebbw catchment)	32189	0.00102	0.02		0.14	

The increase in flow to the River Rhymney from the entire extension area represents less than 0.1% of the mean flow rate and less than 1% of the Q95. It is unlikely to have a significant affect on consented discharges, water quality or ecology.

The decrease in flow to the River Ebbw from the entire extension area represents less than 0.1% of the mean flow rate and less than 0.1% of the Q95. It is unlikely to have a significant affect on consented discharges, water quality or ecology.

SSSIs and Local Nature Reserves (LNR)

Dan y Graig Quarry SSSI in Risca (ST 232 907) is 0.9 km to the north of the Machen Quarry. Its feature of interest and designation as a SSSI is for geological exposures of Carboniferous Limestone of the Oolite Group and Llanelly Formation, so it is unlikely to be affected by either the existing quarry or proposed extension.

Plas Machen Wood SSSI (ST 237 873) is 2 km to the southeast and is located in a different surface water catchment. The site is underlain by the Old Red Sandstone aquifer, so it is unlikely to be affected by either the existing quarry or proposed extension.

Local Water Features

There is evidence that the current quarry workings have intercepted the water table and may have locally reduced the water table by up to 10 - 20 m. This is supported by observations of the stream near FFwrwm (stream survey point 8) that suggest flow derogation. The quarry has been operational since the 1940s so much of this impact is likely to be historical. Current and future quarry operations may continue to cause a small reduction in groundwater levels in this area.

The impact of this would be to reduce groundwater levels away from the quarry. However, given the steeply dipping nature of the geology and presence of lower permeability rock, any effects are likely to be limited across dip to the northwest or southeast and therefore the effect will be greatest along strike, to the northeast.

The extension area will also intercept groundwater and result in a similar level of local lowering of the water table. The effects on local springs and streams will therefore be similar and it is possible that:

- springs and stream flow immediately to the north and west (Area A) could reduce
- springs to the northeast (Area C) could reduce or possibly cease flowing
- the spring immediately to the south of the quarry (Location 9) could reduce or cease flowing

If the Lower Limestone Shales were not impermeable then the quarry extension would cause groundwater to drain into the quarry, in which case, nearby springs on the Ebbw catchment side could reduce or possibly cease flowing. However, as the Lower Limestone Shales are believed to have a low permeability their presence will probably constrain the effects on water levels to the north and east.

Private Water Supplies

The private water supply at Llan-danglws Farm (ST236892) is 0.4 km away from the proposed quarry extension. Water is taken from a spring at Heol Ddu (ST238893), shown as no. 17 on Figure 2.3, and pumped to a storage tank in an adjacent field where it drains to the farm under gravity. Figure 2.4 shows the geology in this area and Figure 2.7 shows a geological cross section through Heol Ddu. The spring arises on a major fault and between the contact between the Upper Old Red Sandstone and Lower Old Red Sandstone. The Lower Limestone Shale occurs between the quarry and the sandstones at Heol Ddu. The Lower Limestone Shale is thought to have low permeability and therefore the risk to this spring is believed to be small.

The private water supply at Castle Farm (ST237896) is 0.5 km away from the proposed quarry extension. The household water supply is provided from the mains supply, however, there is one managed main source of groundwater and several other minor sources that are utilised to feed livestock. The main source consists of a spring, shown as no. 18 on Figure 2.3, that feeds water around the side of a barn where it is manually distributed to livestock. There are also a number of other minor springs in adjacent fields which create natural ponds which provide sources of drinking water for the livestock, shown as no. 19 on Figure 2.3. It would appear these springs originate from the Old Red Sandstone. Again the presence of The Lower Limestone Shale, which is thought to be of low permeability, reduces the risk to these springs. In the case of Castle Farm then an alternative mains supply does exist.

The three private water supplies located near Rhyswg Farm at (ST 216883) 0.5 km to the southwest are in the same limestone aquifer. Caerphilly Borough Council have records showing there are two wells, but no information is held on the third. As the River Rhymney separates the quarry from these supplies it is very unlikely that either the existing quarry or extension will have any effect on water levels at this location.

The private water supply at Panteg Farm (ST 237 886) 0.9 km to the east of the quarry is from a well in the Lower Old Red Sandstone aquifer. The presence of the Lower Limestone Shale between the quarry and Panteg Farm suggests that groundwater between the two aquifers may be discontinuous, so the existing quarry and proposed quarry extension are unlikely to have any effect on water levels at Panteg Farm.

There are two water supplies to the northwest of the quarry. These are a spring at Hyland, Penrhiwe Lane, Machen (ST 210897) 1.4 km away and a spring at Tyr y Ffynon Farm, Machen

(ST 205898) 2 km from the quarry. These are unlikely to be of concern as they are situated on the Coal Measures some distance from the quarry where any impact is not expected.

3.2 Evaluation of Effects

From the details presented in Section 3.1 it is considered that the relevant water features potentially affected by the quarry are:

- Modification to the surface drainage system;
- The private water supplies to the northeast (Area C);
- Local water features in Areas A and C.

The significance of these potential effects are discussed below.

Existing Quarry

It is not thought that the effect of the existing quarry on local water features is significant.

Historical quarrying operations appear to have drawndown water levels to the north of the quarry (Area A) especially in the vicinity of the stream passing Ffwrwm (ST 22380 89220). Future impacts are likely to be a continuation of the observed reduction in stream flow. It is considered that the level of significance of this effect is minor as there are no receptors of importance, but there may be some loss of the aesthetic value from reduced stream flows.

Proposed Quarry Extension

The proposed extension is not expected to have any significant effect on water features in the area although locally some effects may occur.

The proposed quarry extension will alter the surface hydrology by changing the drainage of surface water runoff from the River Ebbw (a loss) to the River Rhymney (a gain). However, the quantities are so small that they are insignificant with changes less than 0.1% of both the mean flow and Q95 in either the River Ebbw or River Rhymney.

Springs to the east of the quarry originate from the Old Red Sandstone which is separated from the Main Limestone by the Lower Limestone Shale. This formation is considered to be of low permeability and therefore the likelihood that the proposed quarry extension could affect spring discharge is considered small. Even though the risk is considered low it should be noted that if there were to be any affect it would be a major concern for the private water supply at Llan-danglws Farm (ST236892) as the spring is their sole water supply, but a lesser concern for Castle Farm (ST237896) which has an alternative mains supply.

The proposed quarry extension is also likely to slightly increase the reduction in stream flows to the northwest of the quarry (Area A), especially the stream passing Ffwrwm (ST 22380 89220). There are no receptors of importance, but, as noted above there may be some loss of aesthetic value from reduced stream flows.

4. Conclusions

This report has assessed the significance of the possible effects on the water environment of the existing quarry and proposed extension at Machen Quarry.

The existing quarry extracts limestone down to a level of approximately 110-120 m AOD at the southwest end, rising to 260 m AOD at the northeastern end. Groundwater is drained, from the quarry by gravity to the River Rhymney.

Field observations suggest that groundwater levels in the vicinity of the quarry were historically around 130-150 m AOD at the southwest end of the quarry rising to approximately 170-200 m AOD at the northeastern end.

Groundwater levels around the south-western end of the quarry have therefore been lowered. This is unlikely to have any significant effect on those important water features identified in the area around the quarry, although locally it has reduced stream flows in the area just to the north of the quarry. The potential impact on water levels to the south and east is thought to be restricted by the presence of the low permeability Lower Limestone Shale.

The proposed quarry extension covers 5.5 ha to the northeastern end of the quarry. The overall impact of the proposed work is expected to be similar to that of the current workings with the following exceptions:

- The proposed extension will change the surface water drainage from the River Ebbw to the River Rhymney, however the quantities are insignificant (<0.1% of flows);
- The extension area is closer to the private water supplies at Llan-danglws and Castle Farm. There is a risk that the water levels may be reduced in the vicinity of the springs, this risk is considered to be small due to the presence of the low permeability Lower Limestone Shale.

5. Recommendations

The recommendation is made that this report is used as the basis of pre-application consultations with regards to the proposed query extension.

Appendix A
Walkover Survey

2 Pages

Walkover survey conducted by Entec on 29 April 2004 (stream survey points 1-14) and 15 June 2004 (points 15-16). Flow rates are estimated visually by eye and are intended as qualitative indications to flow rates rather than absolute values. The Electrical Conductivity (EC) meter had a 100 - 19,000 μS/cm range.

Location of stream survey points are indicated on Figure 2.3. Areas A-C indicate geographical zones to the north, south and northeast of the quarry respectively.

Points 16 - 19 relate to the private water supplies for Llan-danglws Farm and Castle Farm.

Site no.	Estimated Flow rate (l/s)	EC (μs)	Notes
Area A			**Following stream down from saddle from Mynydd Machen along Northwest edge of quarry:**
1		<100	A topographic depression ~20m below the saddle. A small trickle starts here. There are some Millstone Grit boulders along the bund / quarry boundary here. EC not registered (i.e < 100 μS/cm) implying rainwater derived runoff.
2	<0.1		The trickle flows to the bottom of the sheep field and gains a little. It flows into a pond / manmade scrape for the sheep.
3	0.1	<100	Flowing. EC not registered indicating rainwater runoff. Downstream looks like it could take more water as gully quite deep for a small stream. There appears to be a dry valley at the opposite side of this field along the boundary of the quarry parallel with the bund. There are no signs of it taking flow. Beech trees with dry leaf litter.
4	1		Geology has changed to sandstone. There are large sandstone blocks in the stream channel from the Millstone Grit
5	0.5-1	<100	
6	0.5-1	<100	
7	2.5	100	Much more flow from this stream 2- 3 l/s. Has a longer flow path and collects from 3 springs/issues. EC = 100 μS/cm and a sandier bed. There is probably a small groundwater component to flow. The stream passes through a culvert under the track. There is no evidence to indicate any changes to flow rates through this culvert.
8	5	200	EC = 200 μS/cm suggesting a groundwater component to flow. There is evidence to suggest derogation of stream flow along this reach as follows: • The presence of derelict water works • Dry stream bed Derelict water works were observed along this stream comprising a large water tank with approximately 50m^3 capacity, a brickwork structure with an off-take pipe to the water tank and a 4 inch water pipe line running down to the houses below at Chatham. The water tank is now completely silted up and overgrown with shrubs. The tank does not appear on OS Sheet 152 published 1999, but is shown on the BGS geology sheet ST 28 NW surveyed between 1959 – 1961. The streambed is completely dry in the vicinity of the waterworks. Upstream of the tank (at an approximate elevation of 150m), the flow appears to be twice that at stream survey point 4 (Figure 2.3). Below this point the flow reduces and disappears. It does not re-emerge until a point 5m upstream from the brickwork structure where the piped off-take to the tank is located. 5m downstream actually at the brickworks the spring starts in earnest again at 5 l/s. The stream continues past the tank and then completely dries up. It re-emerges from a gravel pool in the dry bed 10m upstream from the fence-line shown as stream survey point 8 on Figure 2.3, at an elevation of 100m.

			These observations could be interpreted as evidence of a reduction of flow from the spring. When the water tank was operational there was sufficient flow from the spring to sustain a private water supply requiring a tank with 50m3 capacity. The small flow rate of 5 l/s today and stretches of dry stream bed imply that the flow from the spring in the past was greater than it is today.

Area B			**Following streams along the eastern boundary of the quarry and to the south east to Lower Machen village. Fewer springs arise in this area compared with Area A. The EC readings are higher suggesting springs are groundwater fed.**
9		500	The spring emerges from the road and runs down over a 50m stretch. Looks like it's wet all year. 500μS/cm suggests a groundwater source. 140m elevation. Sandstones outcrop near point 9 but there is no evidence of any groundwater seeping out from the base of this unit.
10	15	500	Behind the church in Lower Machen. The main stream takes flow from 3 tributary springs and has flow rate over the weir of 15 l/s. EC500μS/cm = Groundwater. A second much smaller stream joins the main stream at this point with EC=300 μS/cm.
11	2	200	Flow emerging from a spring in the field marked by a large *Juncus* area and a willow. It also emerges directly onto the road and from the road itself, which has obviously been repaired many times.
12		500	In the wood, there a number of small trickles and boggy seeps arising.

Area C			**Following the spring line to the northeast of the quarry in the River Ebbw catchment**. **There are far fewer springs arising on this side compared with Areas A and B. The EC readings suggest springs are groundwater fed.**
13	1		Spring with small flow. Directed into culvert.
14	2	300	Spring emerging from sandstone. EC indicates groundwater.
15	dry		Old quarry at Pontymister. The quarry was dry. Some staining of rocks orange-brown, but cannot say if this is groundwater.
16	Seep		A spring and tank is marked on the OS map. The lower corner of this field has a boggy seep with lots of common rush (*Juncus subuliflorus*) and woody nightshade (*Solanum dulcamara*). There is no surface water flow. No evidence of stream head below this point either. Bob Jones, Hansons: Mr Jenkins at Castle Farm, notes this was the original source of groundwater supply to Llan-danglws Farm. It is no longer in use.
17			Bob Jones, Hansons: Sole source of groundwater for Llan-danglws Farm is a spring now covered by a brick-built collection chamber. A pump house is situated alongside. Water is pumped to a highpoint and then gravity fed to the farm.
18			Spring. Source utilised to feed livestock.
19			Minor springs which create natural ponds to provide water for livestock.