CUDWORTH BY-PASS
SITE INVESTIGATION

APPENDIX EA

ENVIRONMENTAL ASSESSMENT

Report No 2319/cud/ea
11/4/2005

Client:

G J Birkett, B Tech (Hons) CEng MICE
Assistant Director
Highways, Engineering & Waste
Barnsley Metropolitan Borough Council
Central Offices
Kendray Street
Barnsley
S70 2TN

Geotechnical Services (Northern) Limited
Ground Investigation Consultants
4 Meadway Drive, Dore, Sheffield S17 3ED Tel/fax 0114 236 8622

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1 Introduction

In accordance with the instructions of the Highways and Engineering Department of Barnsley Metropolitan Borough Council (BMBC), under their Environment & Development Directorate Order Number ENV 014667, a site investigation was carried out in order to provide information for the proposed Cudworth By-Pass. As part of the investigation contamination testing on the soils and groundwater was carried out.

An earlier Site Investigation was carried out by Geotechnical Services (Northern) Limited (GSNL) in November 1996 for the route proposed at that time. There have since been minor adjustments to the proposed route.

The reports presenting the findings of the desk studies, ground investigation and laboratory testing are given as separate volumes (I to IV). Reference will be made to the borehole logs, trial pit logs, laboratory test results, plans, cross sections, and historical, geological, and mining information provided in those Reports.

This appendix evaluates the environmental impact of the scheme in terms of the ground and groundwater conditions found.

2 The site and proposed works

The site and the proposed highway works are shown on the Borehole and Trial Pit Locations Plan, Fig 1 (Volume I, Factual Report).

The route commences at Ordnance Survey grid reference SE 3790 0860 at a proposed roundabout which will replace the junction of Burton Road with the A628 Cudworth to Lundwood road. The proposed West Green By Pass will also terminate at this roundabout.

Chainages referred to in this report are measured from the exit from this roundabout.

The highway passes north eastwards across the Cudworth Dyke and in cutting through the existing railway embankment 80m north of the A628 road bridge.

The route then passes to the south east of the Bleach Works and climbs northwards along the west side of a steep escarpment adjacent to Cudworth Welfare Park. It then crosses mainly agricultural fields. The route then swings to the east across former playing fields adjacent to Weet Shaw Lane to join the Shafton By Pass at about Ordnance Survey grid reference SE 3930 1040, just north west of the newly completed roundabout on Pontefract Road, Shafton Two Gates.

The route requires possible access roundabouts at chainages 250 and 550m. An underpass is required for a bridleway at 950m, and bridges over Sidcop Road at 1500m and under Royston Road at 1700m. A roundabout at 2000m will provide access to the west section of Weet Shaw Lane and eastwards to Three Nooks Lane. The remainder of the route will replace part of Weet Shaw Lane, the east end of the latter becoming a cul-de-sac.

3. Environmental Information Provided

As part of the investigation works various desk studies were undertaken to evaluate the potential sources and pathways of contamination that may affect the proposed scheme and the surrounding area. (Phase I of the Environmental Assessment)

For initial design considerations and classification of the various materials in relation to the scheme, a series of environmental tests have been carried out. An EA Screen on 14 soil samples was carried out (plus 4 in 1996) providing contamination levels for 17 determinands.

To assess the groundwater 5 samples were collected from previously drilled and installed monitoring holes and at one location in the Cudworth Dyke.

As part of the investigation works, between March 2004 and June 2004 the borehole monitoring holes were tested for methane, carbon dioxide, oxygen and groundwater level in 6 holes, on 11 separate dates.

4 Material properties

This section considers the possible environmental impact of the *materials in the ground* along the route of the proposed by pass.

The majority of the materials to be encountered in the works comprise natural mudstones, shales, sandstones, and superficial clays and do not present any environmental hazard to the works.

Materials which may have an environmental impact exist where there have been former industrial uses of the land as identified by the various Desk Studies (Phase I of the Assessment), and include the existing railway embankment, the backfilled opencast site near Sidcop Road, and the backfilled quarry north of Weet Shaw Lane.

5 Environmental assessment

The chemical analysis results have been assessed in relation to accepted UK guideline values. Soil Guideline Values[1] (SGVs) have been introduced for seven pollutants which are the most toxic to human health in relation to land use, in order to determine levels at which there is "minimum risk" for the intended end-users of the site.

Several other contaminants were included in the older ICRCL[2] 59/83 Guidance which was derived mainly for coal processing wastes (such as coke and gas works). However, the type and age of the made ground listed above will contain wastes (such as ash, clinker, colliery spoil) which are likely to contain similar pollutants, and this Guidance is therefore considered to be valid. The Guidance contains "trigger" and "action" levels for various end uses.

For consistency the same Chainage references have been followed as in the Interpretative Report, Volume IV.

5.1 Chainage 0 to Chainage 200m including rail embankment

Boreholes 451 to 454, and previous boreholes 103 to 106 refer.

The works include a rail overbridge through the existing 6 metre high mineral railway embankment. The Cudworth Dyke will be crossed on the west side of the embankment. Foundation parameters for the bridge are discussed in Volume IV Section 5, Structures, and the Dyke culverts are discussed in the West Green By Pass reports.

Finished road levels will have a low point of 38m AOD at the railway embankment, (about a metre lower than existing ground level either side of the embankment), rising to 39m AOD at Chainage 200m.

5.1.1 Conceptual model

The proposed road crosses the infilled valley of the Cudworth Dyke comprising made ground overlying alluvial clays and occasional gravels, or lying directly on weathered bedrock. The dyke's original course meandered along the west side of the railway embankment, and has now been straightened.

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[1]Contaminated Land Exposure Assessment Model. *Assessment of Risks to Human Health from Land Contamination.* DEFRA & Environment Agency 2002

[2]Interdepartmental Committee on the Redevelopment of Contaminated Land: *Guidance on the assessment and redevelopment of contaminated land* .Guidance Note 59/83. July 1987

Drains associated with a former bleach works and a sewage works formerly existed some 40 metres to the east of the railway embankment; these have been infilled and now appear as rough arable land.

The made ground at the highway level is variable in composition, comprising brick, sandstone rubble, limestone, silty clay, gravelly clay, burnt shale, and ash. Its depth varies from 1.90m to 3.70m.

On the railway embankment the two boreholes 453 and 454 encountered 7.9 and 8.5m of made ground comprising medium dense clayey sand or sandy clay with gravel.

The water table was encountered at a maximum elevation of 37.4m AOD (in 1996) and can be assumed to be at the level of Cudworth Dyke.

5.1.2. Potential hazards

Made ground will be excavated during formation of the works. It is proposed (Volume IV) that this material be incorporated into the general fill of the highway works.

Made ground will also remain in situ within the highway land take, particularly in the remaining parts of the railway embankment.

Chemical analyses were carried out on samples of made ground from BH103 (1996) and 451 to 454 for the presence of heavy metals, phenols, cyanates, coal tars and PAHs. The Laboratory Certificates are given in Volume III.

Railway embankments are constructed of excavated clays and rocks. However, they become covered in ash and coal wastes during use, with elevated arsenic and PAH levels being common.

The results of the chemical analyses are summarised in **Table A** and compared with the SGVs for an industrial end use and also the ICRCL values for open spaces or landscaped areas.

The results are also listed in **Table C** which compares them with the Tier 1 SGVs for a more sensitive garden end-use situation.

As anticipated, there is slightly elevated arsenic present, one value exceeding the Tier 1 level but all being less than the SGV for industrial uses. PAHs are present, but not in significant quantity, only one exceeding the Tier 1 SGV.

One boron value exceeded the ICRCL trigger level. This pollutant is phytotoxic (to plants).

5.1.3 Potential pathways

Potential pathways these chemicals could take are:

- direct contact with humans on the site, either dermal or through inhalation.
- off site via surface water or ground water.
- direct contact with construction materials or vegetation.

5.1.4. Potential receptors

Users of the highway are potential receptors, however people using a bypass are likely to be only over the site for short periods, and separated from the ground by a vehicle and the road surface construction. They are therefore unlikely to come into contact with any of the contaminants.

Construction workers involved in the primary stages of the groundworks are likely to come into direct contact with potentially contaminated ground.

The Cudworth Dyke is a potential receptor, and the risk to it will increase during earthmoving works when an increased runoff of surface water in contact with potentially contaminated soil is possible.

Construction materials, such as buried concrete may be in contact with the potentially contaminated materials.

Planting may come into contact with the materials if used in a landscaping situation.

5.1.5 Mitigation

The main exposure pathways to humans for arsenic are through inhalation and ingestion of contaminated dust and soil. As construction workers are likely to be the only receptor exposed to this pathway, precautions should be taken to minimise creation of dust. Basic Health and Safety precautions such as dust masks and gloves are recommended to be used by construction workers.

Mitigation of any affects on the groundwater and the Cudworth Dyke are not considered feasible. This area represents only a small part of a railway embankment which has been constructed within and adjacent to the Cudworth Dyke valley.

High sulphate levels may affect construction concrete. Elevated sulphate contents were recorded in groundwater samples from 452 and previously from BH103, 104, and 105. Values ranged from 0.2 to 2.7g/l.

Reference should be made to BRE Special Digest 1 which indicates that ACEC Class AC3 or AC4 concrete may be necessary where it is in contact with such groundwater.

In view of the presence of slightly elevated arsenic and boron, it is recommended that this material is not used as a landscaping fill unless isolated by a capping layer of clean soil to the full rooting depth of the planting. The material may be incorporated into the general fill elsewhere as described in Section 4.1.4 (Volume IV).

5.2 Chainage 850m to Chainage 1660m including backfilled opencast

Boreholes 463 and 464, and previous boreholes 120 and 120A and trial pits T120A and T120B refer.

The route crosses the backfilled Sidcop Road Opencast coal working between Chainage 1500m and 1570m.

5.2.1 Conceptual model

The Royston Coal former outcrop lies to the north of Sidcop Road. Opencast working to this coal lies between Chainage 1500m and 1570m with the backfill comprising a firm to stiff clayey silt, sand, and gravel, with a little carbonaceous material particularly at the base.

The abandonment drawing included in the SYMAS Mineral Report in the earlier desk studies indicates a maximum depth at the "high wall" of 11.5m to the base of the coal along the line of the road.

The proposed highway formation will be on embankment where it crosses the backfilled opencast site.

It was recommended in Volume IV that the backfill be removed to a depth of 3m, the base of excavation be rolled so that soft spots can be identified and removed, and the high wall be cut back in 3m wide, 1m high, benches as described above. Temporary drainage ditches and pumped sumps should be installed in the excavation base to maintain dry conditions. The excavation should then be backfilled in compacted layers to highway construction specifications.

Therefore backfill may be recovered from the former opencast site and may be classed as stoney cohesive Class 2C to be replaced within the opencast excavation or to be used as a general fill elsewhere.

5.2.2 Potential hazards

All made ground within the works has to be considered as a potential source of contamination.

However, this opencast site was worked and backfilled in the late 1940s. The backfill at that time was typically limited to the excavated arisings and no industrial or domestic wastes were imported into such workings.

A close inspection of the borehole and trial pit samples was carried out and confirmed that no imported wastes were present in the opencast backfill.

Where carbonaceous material is present there is a possibility of the generation of methane. This is not common within backfilled opencast sites where any carbonaceous rejects are well intermixed with, or sealed within, cohesive soils. Nevertheless, monitoring was carried out in borehole 463 on eleven occasions and no detectable methane was recorded.

It is concluded that the material in the opencast backfill will not present an environmental hazard to the development.

5.3 Chainage 1900m to Shafton By Pass (Weet Shaw Lane Quarry)

Boreholes 465A, 466, 466A, 467 to 469 and previous boreholes 134 to 136 and Trial Pits T12734A to T135B refer.

The main route passes in a northeast direction, crossing Three Nooks Lane and Weet Shaw Lane onto a playing field. It will curve eastwards to re-cross Weet Shaw Lane, to join the recently constructed Shafton By Pass 100m west of the new Pontefract Road roundabout.

Except for a short section north of Weet Shaw Lane which will require a shallow embankment up to 1.5m high, the road level will be at existing ground levels, falling gently to 74m AOD at the Shafton By Pass.

5.3.1 Conceptual model

Under the playing field north of Weet Shaw Lane the residual soils and shales are replaced with made ground where they have been formerly worked for brick making.

The backfilling was carried out prior to the licencing of landfill sites in 1974, and the site is therefore not categorised.

The made ground comprises a loose or medium dense, often clayey, sand and gravel of ash, shale and sandstone with much inert refuse The material was very loose below the water

table at 3.90m in 467. (The remaining holes were dry). The depth of made ground increases rapidly northwards from 1.45m at T134A to 12.90m at 465A.

Concrete obstructions were located within the backfill (465, 466 and 466A) at depths from 0.90 to 3.50m and may be associated with structures within the former brick works as indicated on the 1906 map (Volume I, Factual Report).

It was recommended in Volume IV that ground improvement by means of a grid of vibrated stone columns should be carried out as follows:

The made ground should be excavated to 3.5m depth over the width plus 5m of the highway footprint and the base of excavation probed to expose the buried structures and obstructions. These should be broken out. The excavation should be backfilled with suitable general fill to 500mm below formation level to provide a working platform. A grid of vibrated stone columns should be installed through the made ground to the base of the former quarry and capped with a suitable geotextile and stone starter layer beneath the formation level. The improvement works should extend 5m beyond the north limit of the highway construction.

5.3.2 Potential hazard

It is proposed to excavate only the top 3.5m of this material (to expose and remove any buried structures) and, subject to the removal of unsuitable materials, to reuse this as general fill. The remaining made ground below 3.5m depth will be left in situ, and ground improvement methods applied as recommended in Volume IV.

Eight samples of backfill from the former brick quarry were analysed for a range of chemical contaminants, in addition to one analysed in 1996. The Laboratory Certificates are given in Volume III.

The results of chemical analyses on the nine samples are summarised in **Table B** and compared with the SGVs for an industrial end use and also with the ICRCL values for open spaces or landscaped areas. The results are also listed in **Table C** which compares them with the Tier 1 SGVs for a more sensitive garden end-use situation.

Several values of boron, copper, and zinc exceeded the ICRCL trigger levels for the industrial use. These pollutants are phytotoxic (to plants).

In addition all the values for arsenic, and some values of cadmium and PAH exceeded the more stringent SGVs for a garden end use.

Monitoring for landfill gases was carried out in borehole 465A on eleven occasions. Traces of methane were recorded on five occasions, the highest value being 1.4% methane-in-air or 29.5% of the Lower Explosive Level. Carbon dioxide levels of up to 13% were recorded.

5.3.3 Potential pathways

Potential pathways these chemicals could take are:

- direct contact with humans on the site, either dermal or through inhalation.
- off site via surface water or ground water.
- direct contact with construction materials or vegetation.
- the movement of gases through the ground.

5.3.4. Potential receptors

Users of the highway are potential receptors, however people using a bypass are likely to be only over the site for short periods, and separated from the ground by a vehicle and the road surface construction. They are therefore unlikely to come into contact with any of the contaminants.

Construction workers involved in the primary stages of the groundworks are likely to come into direct contact with potentially contaminated ground and gases.

There are no significant surface watercourses affected by this part of the proposed works. A field drain runs along the north side of the playing field area, with a fall towards the west.

Groundwater was struck in only one borehole within the backfill (467 at 3.90m). The monitoring borehole 465A only recorded a little water near the base of the backfill (below 11.7m) on eleven occasions. Previously groundwater had been struck below the backfill in BH134 and BH135 at 3.60 and 2.80m respectively.

Construction materials, such as buried concrete may be in contact with the potentially contaminated materials.

Planting may come into contact with the materials if used in a landscaping situation.

5.3.5 Mitigation

The main exposure pathways to humans for arsenic and cadmium are through inhalation and ingestion of contaminated dust and soil. As construction workers are likely to be the only receptor exposed to this pathway, precautions should be taken to minimise creation of dust. Basic Health and Safety precautions such as dust masks and gloves are recommended to be used by construction workers.

The values of methane recorded are not considered to be significant for the highway end-use. However, the values of **carbon dioxide** may present a hazard to operatives working in deep

drainage works if the gas is allowed to accumulate. Monitoring of carbon dioxide in all confined excavations should be carried out over this section of the highway works, and forced ventilation be carried out if necessary.

During the earthworks comprising the stripping of the top 3.5m of soils, it is unlikely that major aquifers will be intersected. However some pumping of the excavation may be required to remove rainwater. Such water should be collected in temporary lagoons within the highway works and be returned to the ground within the backfilled area on completion to avoid contamination of the local field drainage to the north of the works.

Elevated sulphate levels may affect construction concrete. The sulphate concentrations recorded for the made ground samples and for the groundwater (1996) ranged from 0.2 to 1.4g/l and indicate that ACEC Class AC2 concrete is required for drainage works in the area of the playing field.

In view of the presence of the elevated values of phytotoxic contaminants, it is recommended that the excavated material is not used as a landscaping fill unless isolated by a capping layer of clean soil to the full rooting depth of the planting. The material may be incorporated into the general fill as described in Section 4.6.6. of Volume IV and should ideally be returned to within the excavated area to avoid contamination of otherwise clean areas of the works..

5.4 Other possible hazards

5.4.1 Midland Bleach Works

The remains of the Midland Bleach Works lie to the north of the route and drainage may pass under the route around Chainage 150m.

It is inferred from the contour plan of the site that local drainage was likely to have flowed *northwards* towards the Bleach Works, and entered the Cudworth Dyke on the west side of the works.

The Desk Studies indicated that the Bleach Works operated between approximately 1842 and 1897 and was disused by 1906.

Bleach was generally calcium oxychloride, produced by the action of chlorine (a gas) on slaked lime. There are therefore no significantly hazardous waste products from the process which might affect the proposed highway works where it crosses the former drains.

5.4.2 Sewage works

A small sewage works was identified in the Desk Studies at approximate Chainage 200m. It is shown on the 1906 Ordnance Survey and had been demolished by the 1980s.

The site now forms a low lying wet area of grassland used for grazing. Again it is probable that this area would have drained northwards towards the Bleach Works.

Previous borehole BH106 was located at this site and did not record any made ground.

It was not possible to carry out further intrusive investigation by means of trial pits at this position because of the flooded nature of the ground during the 2004 site works.

Sewage works may result in ground contaminated with elevated levels of heavy metals. Such contamination is unlikely to be a hazard to the proposed highway works.

Organisms such as e-coli and faecal streptococci may be present during the operation of the plant. These however disappear over time and will not now present a hazard. (Sampling and analysis of these organisms is conplicated by the presence of similar organisms from animal defecation which will now be present.)

5.4.2.1 Recommendations for further work

It is recommended that a watching brief be maintained during soil stripping of the former sewage works area and any unusual pockets of faecal matter or structures be isolated for further analysis.

11/4/2005	
J P McCormick BSc CEng MIMM Director	
Geotechnical Services (Northern) Limited	

MADE GROUND AT RAILWAY EMBANKMENT

Samples from boreholes 451 to 454, and 103

Determinand	CLEA 2002	ICRCL 59/83		Analysis results (6 samples)		
	Soil Guideline Values	Trigger levels	Action levels	min	max	number exceeding SGV
	INDUSTRIAL	OPEN SPACES	OPEN SPACES			
Toxic - hazard to health						
Arsenic	500	40	ns	<5	81.7	0
Cadmium	1,400	15	ns	0.18	0.43	0
Chromium total	5,000	1,000	ns	14.3	26.3	0
Lead	750	2,000	ns	11.2	40.9	0
Mercury	480	20	ns	bd	bd	0
Selenium	8,000	6	ns	bd	1.46	0
Phytotoxic- hazard to plants						
Boron		3	ns	bd	3.79	**1**
Copper		130	ns	12.4	115	0
Nickel	50	70	ns	18.6	34.5	0
Zinc		300	ns	51.3	95	0
Other contaminants						
PAH (total)		1,000	10,000	bd	216	0
Phenols		5	1,000	bd	bd	0
Cyanide(complex)		250	5,000	bd	bd	0
Thiocyanate		50	nl	bd	bd	0
Sulphate %		0.2	1	0.10	(1 sample)	0
Sulphate 2:1 extract g/l	(BRE)	1.2		0.02	1.69	
Sulphide		250	1,000	bd	10.5	0
pH (units)		<5	<3	6.3	8.7	0

Notes: Levels expressed as mg/kg unless stated

ns not specified in ICRCL

nl no limit set in ICRCL

bd below detection limits

BRE BRE Special Digest 1 *Concrete in aggressive ground*. 2001

BOLD values exceeding trigger levels discussed in text

TABLE A
ASSESSMENT OF CHEMICAL ANALYSES

MADE GROUND AT BRICK QUARRY, WEET SHAW LANE

Samples from boreholes 465A to 467, and TP134A

Determinand	CLEA 2002	ICRCL 59/83		Analysis results (9 samples)		
	Soil Guideline Values	Trigger levels	Action levels	min	max	number exceeding SGV
	INDUSTRIAL	OPEN SPACES	OPEN SPACES			
Toxic - hazard to health						
Arsenic	500	40	ns	bd	64.7	0
Cadmium	1,400	15	ns	0.56	67.3	0
Chromium total	5,000	1,000	ns	19.9	109	0
Lead	750	2,000	ns	93.6	367.0	0
Mercury	480	20	ns	bd	0.22	0
Selenium	8,000	6		0.75	1.82	0
Phytotoxic- hazard to plants						
Boron		3	ns	1.54	10.8	7
Copper		130	ns	76.9	280	4
Nickel	50	70	ns	30.8	45	0
Zinc		300	ns	196	520	4
Other contaminants						
PAH (total)		1,000	10,000	7	247	0
Phenols		5	1,000	bd	1.31	0
Cyanide(complex)		250	5,000	bd	4.78	0
Thiocyanate		50	nl	bd	1.59	0
Sulphate %		0.2	1	0.55	1 sample	1
Sulphate 2:1 extract g/l	(BRE)	1.2		0.22	1.10	
Sulphide		250	1,000	bd	272	1
pH (units)		<5	<3	7.0	8.5	0.0

Notes: Levels expressed as mg/kg unless stated
ns not specified in ICRCL
nl no limit set in ICRCL
bd below detection limits
BRE BRE Special Digest 1 *Concrete in aggressive ground*. 2001

Key: **BOLD** values exceeding trigger levels discussed in text

TABLE B
ASSESSMENT OF CHEMICAL ANALYSES

Borehole Trial Pit	Depth (m)	Date	Stratum	Arsenic As	Cadmium Cd	Chromium (total) Cr	Lead Pb	Mercury Hg	Selenium Se	Boron B	Copper Cu	Nickel Ni	Zinc Zn	PAH	Phenols	Cyanide (total) Cn	Thio-cyanate	Sulphate g/l	Sulphide	pH (units)
451	1.00	09/06/2004		81.7	-	-	-	-	-	-	-	-	-	-	-	-	-	1.33	-	7.2
452	0.50	09/06/2004		-	-	-	-	-	-	-	-	-	-	216.0	-	-	-	-	-	7.8
453	2.00	09/06/2004		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2
453	6.00	09/06/2004		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.6
454	6.00	09/06/2004		-	-	-	-	-	-	3.79	-	-	-	-	-	-	-	-	-	6.3
464	1.00	09/06/2004		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.5
465A	1.00	09/06/2004		41.4	-	-	-	-	-	4.23	-	-	-	125.0	-	-	-	-	-	7.8
465A	2.00	09/06/2004		30.6	-	-	-	-	-	4.02	-	-	-	247.0	-	-	-	-	-	8.1
465A	9.00	09/06/2004		53.8	67.30	-	-	-	-	6.03	141	-	513	93.7	-	-	-	-	-	7.4
465A	12.00	09/06/2004		41.1	14.80	-	-	-	-	5.06	-	-	357	-	-	-	-	-	-	8.5
466	1.00	09/06/2004		49.3	-	-	-	-	-	5.50	-	-	447	-	-	-	-	-	-	7.4
467	2.00	09/06/2004		34.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8
467	5.00	09/06/2004		64.7	-	-	-	-	-	9.81	138	-	-	-	-	-	-	-	-	7.7
467	7.00	09/06/2004		58.5	-	-	-	-	-	10.80	172	-	-	-	-	-	-	-	272	7.6
TC2		1996		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.8
TC3		1996		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.7
TP13+A		1996		-	-	-	-	-	-	-	-	-	520	-	-	-	-	-	-	7.9
TP13B9		1996		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0
Number				14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	13	14
Average				35.7	6.37	31.7	101.1	0.13	0.90	4.00	78.8	32.7	206.9	58.9	1.1	0.9	1.3	0.59	42.4	7.6
Minimum				5.9	0.18	14.3	11.2	0.10	0.40	0.35	12.4	18.6	51.3	2.8	1.0	0.3	1.1	0.02	0.2	6.3
Maximum				81.7	67.30	109.0	367.0	0.22	1.82	10.80	172.0	43.5	513.0	247.0	1.3	4.8	1.6	1.33	272.0	8.5
Standard Dev																				
SGV Tier 1				20	3	130	450	8	35	3	130	50	300	50	5	250	50	1.2	250	5 to 9

Abbeydale BEC
4 Neville Street
WAKEFIELD, WF1 5EF
Telephone: 01924 376622
Fax: 01924 376661

Notes:

1. Levels expressed as mg/kg (ppm) unless stated.
2. Tested levels below SGV are shown as -
   For actual result see certificate sheet.

CHEMICAL RESULTS ASSESSMENT

Client: Barnsley MBC

Project: Cudworth By-Pass Site Investigation

Number: 374116

TABLE C

Borehole	Date	Methane Peak CH4 %	Methane Residual CH4 %	Methane LEL % CH4	Charbon Dioxide CO2 %	Nitrogen N2 %	Oxygen O2 %	Pressure m bars	Pressure Rise/Fall	Remarks
463	23/03/2004	-	0.0	0.0	0.0	78.8	21.1	1004	R	Incomplete
463	30/03/2004	-	0.0	0.0	3.9	82.1	13.9	1007	R	
463	06/04/2004	-	0.0	0.0	4.7	83.4	11.8	991	R	
463	13/04/2004	-	0.0	0.0	4.7	83.2	12.0	1013	R	
463	19/04/2004	-	0.0	0.0	3.4	82.7	13.8	974	R	
463	28/04/2004	-	0.0	0.0	4.7	84.2	11.0	1000	R	
463	07/05/2004	-	0.0	0.0	2.1	81.3	16.5	989	R	
463	13/05/2004	-	0.0	0.0	4.1	84.3	11.5	1009	R	
463	18/05/2004	-	0.0	0.0	5.3	85.4	9.2	1013	R	
463	25/05/2004	-	0.0	0.0	6.3	84.2	9.4	1011	R	
463	09/06/2004	-	0.0	0.0	5.6	82.1	12.2	1004	R	
607	23/03/2004	-	0.0	0.0	0.0	78.9	21.0	1007	R	Incomplete
607	30/03/2004	-	0.0	0.0	1.5	86.8	11.6	1011	F	
607	06/04/2004	-	0.0	0.0	1.1	84.7	14.1	991	R	
607	13/04/2004	-	0.0	0.0	0.2	81.1	18.6	1017	F	
607	19/04/2004	-	0.0	0.0	0.5	81.6	17.8	978	R	
607	28/04/2004	-	0.4	7.9	2.6	92.9	4.1	1002	R	
607	07/05/2004	-	0.0	0.0	0.0	79.7	20.2	993	-	
607	13/05/2004	-	0.0	0.0	0.5	82.0	17.4	1013	-	
607	18/05/2004	-	0.0	0.0	0.1	80.7	19.0	1018	-	
607	25/05/2004	-	0.0	0.0	3.4	92.1	4.4	1013	-	
607	09/06/2004	-	0.0	0.0	0.8	82.8	16.3	1005	R	
451R	06/04/2004	-	0.0	0.0	1.9	79.0	19.0	992	R	
451R	13/04/2004	-	0.0	0.0	2.5	80.5	16.9	1016	-	
451R	19/04/2004	-	0.0	0.0	0.4	79.7	19.8	980	-	
451R	28/04/2004							1002	-	Vandalised
451R	07/05/2004									Vandalised
451R	13/05/2004									Vandalised
451R	18/05/2004									Vandalised
451R	09/06/2004							1006	R	Vandalised
452R	30/03/2004	-	0.0	0.0	1.8	81.0	17.1	1009	F	
452R	06/04/2004	-	0.0	0.0	2.4	82.6	14.9	992	R	
452R	13/04/2004	-	0.0	0.0	2.5	81.9	15.5	1016	-	
452R	19/04/2004	-	0.0	0.0	3.3	83.6	13.0	979	R	
452R	28/04/2004	-	0.0	0.0	0.2	81.3	15.2	1002	-	
452R	07/05/2004	-	0.0	0.0	3.9	82.8	13.2	993	R	
452R	13/05/2004	-	0.0	0.0	3.5	81.6	14.8	1014	F	
452R	18/05/2004	-	0.0	0.0	4.4	84.1	11.4	1018	-	
452R	25/05/2004	-	0.0	0.0	5.2	82.8	11.9	1013	-	
452R	09/06/2004	NT	NT	NT	NT	NT	NT	1005	R	
462R	30/03/2004	-	0.0	0.0	0.7	82.3	16.9	1007	R	
462R	06/04/2004	-	0.0	0.0	0.9	84.4	14.6	991	R	
462R	13/04/2004	-	0.0	0.0	0.9	85.1	13.9	1013	R	
462R	19/04/2004	-	0.0	0.0	0.7	85.9	13.3	975	F	

Abbeydale BEC
4 Neville Street
WAKEFIELD WF1 5EF
Telephone: 01924 376622
Fax: 01924 376661

GAS MONITORING RESULTS

Client: Barnsley MBC

Project: Cudworth By-Pass Site Investigation

Number: 374116

TABLE 3

Borehole	Date	Methane Peak CH4 %	Methane Residual CH4 %	Methane LEL % CH4	Charbon Dioxide CO2 %	Nitrogen N2 %	Oxygen O2 %	Pressure m bars	Pressure Rise/Fall	Remarks
462R	28/04/2004	-	0.0	0.0	0.8	87.4	11.7	1000	-	
462R	07/05/2004	-	0.0	0.0	0.8	87.7	11.4	989	R	
462R	13/05/2004	-	0.0	0.0	1.1	88.0	10.8	1009	-	
462R	18/05/2004	-	0.0	0.0	1.8	87.5	10.6	1013	R	
462R	25/05/2004	-	0.0	0.0	2.3	85.7	11.9	1011	R	
462R	09/06/2004	-	0.0	0.0	2.8	83.5	13.6	1005	R	
465A	23/03/2004	-	0.3	6.9	3.4	82.2	14.0	1002	R	
465A	30/03/2004	-	0.3	7.4	4.5	83.3	11.8	1007	F	
465A	06/04/2004	-	1.0	20.3	11.0	84.5	3.4	990	R	
465A	13/04/2004	-	0.0	0.0	4.4	83.3	12.2	1012	R	
465A	19/04/2004	-	0.0	0.0	0.0	79.5	20.5	973	R	
465A	28/04/2004	-	1.4	29.5	13.0	85.0	0.5	999	R	
465A	07/05/2004	-	0.0	0.0	0.3	80.1	19.5	988	R	
465A	13/05/2004	-	0.0	1.6	3.9	81.9	14.1	1009	-	
465A	18/05/2004	-	0.0	0.0	1.9	81.2	16.8	1012	R	
465A	25/05/2004	-	0.2	3.9	4.3	82.5	12.9	1010	R	
465A	09/06/2004	-	0.0	0.0	0.1	80.2	19.6	1004	R	
603R	30/03/2004	-	0.0	0.0	1.3	79.1	19.5	1009	-	
603R	06/04/2004	-	0.0	0.0	0.9	82.5	16.5	991	R	
603R	13/04/2004	-	0.0	0.0	0.1	80.0	19.8	1016	F	
603R	19/04/2004	-	0.0	0.0	2.2	92.5	5.2	978	R	
603R	28/04/2004	-	0.0	0.0	0.0	79.9	20.0	1002	-	
603R	07/05/2004	-	0.0	0.0	2.6	89.7	7.6	993	-	
603R	13/05/2004	-	0.0	0.0	3.2	83.5	13.2	1013	-	
603R	18/05/2004	-	0.0	0.0	3.5	81.2	115.2	1017	R	
603R	25/05/2004	-	0.0	0.0	3.2	79.3	17.3	1013	-	
603R	09/06/2004	-	0.0	0.0	2.3	81.7	15.9	1005	R	

Abbeydale BEC
4 Neville Street
WAKEFIELD WF1 5EF
Telephone: 01924 376622
Fax: 01924 376661

GAS MONITORING RESULTS

Client: Barnsley MBC

Project: Cudworth By-Pass Site Investigation

Number: 374116

TABLE 3

Abbeydale

Building Environment Consultants

Water Monitoring Sheet

Sheet 1 of 1

Site	Cudworth By-Pass, Barnsley	Job No.	374116

BH No.	Water Depth (m) bgl											
	23-Mar-04	30-Mar-04	6-Apr-04	13-Apr-04	19-Apr-04	28-Apr-04	7-May-04	13-May-04	18-May-04	25-May-04	9-Jun-04	
451R	-	NT	2.26	2.41	2.70	2.29	2.32	2.42	2.46	NT	2.52	
452R	NT	2.46	2.14	2.22	2.26	2.19	2.22	2.28	2.40	NT	NT	
462R	NT	15.87	15.55	15.81	15.63	15.69	14.69	15.10	15.25	NT	16.07	
463	4.95	Dry	Dry	4.87	4.87	Dry	Dry	Dry	Dry	NT	Dry	
465A	11.71	11.74	11.78	11.82	11.84	11.81	11.86	11.88	11.88	11.89	11.95	
603R	NT	2.51	10.12	10.22	10.15	10.07	9.96	10.92	9.97	NT	10.00	
607	1.61	1.90	1.69	1.73	1.77	1.61	1.59	1.63	1.71	NT	1.82	

Notes

NR	Not Recorded
V	Vandalised
-	Not installed

TABLE 4