A REMEDIATION STRATEGY AND GAS PROTECTION VERIFICATION PLAN FOR THE PROPOSED HOTEL DEVELOPMENT AT THE IRISH WORLD HERITAGE CENTRE CHEETHAM HILL

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1. INTRODUCTION

1.1. Background

Tier Environmental was commissioned by Truman Design and Build Ltd to produce a Remediation Strategy and Ground Gas Verification Plan based on a review of 2No. third party Ground Investigation Reports produced by Leyden Kirby Associates (LKA) for the Irish World Heritage centre, Cheetham Hill, Manchester, specifically for the northern sector referred to as Area A – 'The Site' and its proposed development as the IWHC Hotel.:

- Land at Irish World Heritage Centre Ground Investigation and Risk Assessment Report, dated 21st July 2008 ref. CL1294-02.
- Land at Irish World Heritage Centre Further Work & Groundwater Risk Assessment Report, dated 22nd May 2009. Ref.CL1294-03.

It is understood that the current development proposals comprise redeveloping the north of the wider IWHC site, (known as Area A within LKA reports) which is intended for the design of a 135 bedroom budget hotel, and associated facilities including car parking and landscaping.

The results of the Generic Quantitative Risk Assessment within the GIR demonstrated that measured concentrations of lead and PAHs in the Made Ground as whole present a potentially significant risk to human health. In addition, LKA logs noted visual and olfactory evidence of hydrocarbon in contamination in soils in the vicinity of the former petrol station in the east of the site. It is understood that interceptors also associated with the former petrol station in the east remain in situ which are considered to present a potentially significant risk to human health for the proposed land use.

Heavy metal, petroleum hydrocarbon and PAH contamination was encountered in the groundwater and leachate samples taken from the Made Ground however, it was considered that controlled water receptors were not at risk due to Till deposits encountered and the lack of water abstractions within influencing distance from the site and due to the distance of the River Irk from the study site. It is also considered that contamination of the perched groundwater within the drift deposits is likely to be occurring from the adjacent site and as such any remedial works undertaken is unlikely to improve the general groundwater quality due to recontamination from the adjacent site.

The results of ground gas assessment determined (in accordance with CIRIA C665), a GSV may be calculated from the maximum values encountered across the whole survey as a conservative measure. For 'Queens Road' (the wider IWHC site) this maximum GSV for methane is 0.2158 l/hr and for carbon dioxide is 0.1716 l/hr which places the site within Characteristic Situation 2 where protection measures are required within new buildings. No gas protection measures will be required within areas of landscaping and car parking.

An outline remediation strategy was included within the GIR, on the basis of the risk assessment findings and comprised:

- Elevated levels of B(a)P, Lead and D(a,h)A have been identified across the former petrol station area (Area A). The primary route of entry is from direct contact (ingestion, dermal and inhalation of dust). Therefore, LKA considers Pollutant Linkage 1 is complete with regards to all of Area A. Therefore, the remedial measures are necessary in the landscaped areas and health and safety precautions are necessary for future construction workers to protect against direct contact,

- Removal of any below ground relict structures which includes the removal of the interceptor tanks associated with the former petrol station on the east of the site will need to be removed prior to construction of the hotel. Any impacted material associated with the interceptor tank should be removed off-site and validation sampling should be undertaken to ensure that all contamination has been removed. ;

- In order to break the direct contact, dust inhalation and ingestion pathways associated with lead and PAHs, and ingestion pathways associated with any residual hydrocarbons areas in areas of soft landscaping and planting, a clean cover system will be installed. A minimum of 300mm 'clean cover' derived from imported topsoil and subsoil laid over a geotextile membrane to prevent mixing of potentially contaminated material with the capping layer. It will also guard against ecological disturbance (e.g. moles, plant roots etc);

- Implementation of water pipework (which is likely to comprise barrier pipework) appropriate based on the results of the assessment within the Ground Investigation Report.

- Installation of ground gas and vapour protection measures in line with a ground gas protection verification plan. The results of the gas monitoring to date places the site within Characteristic Situation 2 which requires the following protection measures:

    - Ventilation of confined spaces within the building.

    - Well-constructed floor slab.

    - Sub floor void vented to the atmosphere.

    - Low permeable membrane such as 2000g, fitted by a professional contactor and validated by a third party.

    - Minimum penetration of ground slab by services, with sufficient lapped and taped joints.

The installation of the gas and vapour membrane should be undertaken by a suitably competent contractor and quality assurance and control information should be collected. For example photographic evidence of ground joints, welds and service entry seals.

LKA considers that the most appropriate piling option would be via a non-displacement technique. This technique involved the coring and removal of the material from that area to be occupied by the pile. The material is brought to the surface as arisings. The excavated hole is then cased and replaced with the pile. This technique minimises the displacement of contaminated material and prevent such material being "dragged" downwards into the underlying aquifer. Method Statements and Risk Assessments for the chosen piling option should be forwarded to the Environment Agency once an appropriate technique has been chosen by the contractor, and prior to works commencing on site.

In addition, upon the Tier Environmental review the following is recommended:

- Whilst no asbestos was identified during investigations and through laboratory testing on soil samples; site staff should be vigilant and in the event that any bulk asbestos should be identified this should be removed and off-site disposal of localised asbestos should be carried out (same area as hydrocarbon impacted soils)

1.2. Remediation Strategy

Taking into account the planned future use of the Site, the objectives of this report were:

- To summarise the potential risks posed by any ground contamination within the site and present the revised conceptual site model with regard to the redevelopment of the site;
- To provide a detailed remediation statement to manage the risks;
- Propose remedial targets which will be used to assess the suitability of any material to remain *in situ*;
- Describe locations where impacted soil will likely require removal;
- Provide the specification for the proposed capping layer proposed around the soft landscaped areas (including verification sampling);
- Provide detailed specifications for the ground gas mitigation installations required on site;
- To provide details of what documentation will be required as part of a final verification report.

This report, which was designed to meet the requirements of all relevant current guidance including CLR 11, presents the factual information available during this appraisal, interpretation of the data obtained and recommendations relevant to the defined objectives.

It has been assumed in the production of this report that the Site is to be hotel/public accommodation. In addition, it is assumed that ground levels will not change significantly from those described in this report. If this is not the case, then amendments to the recommendations made in this report may be required.

The comments and opinions presented in this report are based on the findings of the ground conditions encountered during intrusive investigation works performed by LKA and the results of tests carried out within one or more laboratories. There may be other conditions prevailing on the Site which have not been revealed by this investigation and which have not been taken into account by this report. Responsibility cannot be accepted for any conditions not revealed by this investigation. Any diagram or opinion on the possible configuration of the findings is conjectural and given for guidance only. Confirmation of intermediate ground conditions should be undertaken if deemed necessary.

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This report does not include for assessment of risks to construction workers as any redevelopment and construction work should be conducted in accordance with HS(G)66. Similarly, nuisance health effects are not considered within this report. The Statutory Nuisance Act considers olfactory impacts from odours and allows comparison of enclosed space air concentrations with odour threshold concentrations.

2. SITE DETAILS AND DESCRIPTION

Table 2.1 Current Site Overview

Site name	**IWHC Hotel**
Site address	1 Irish Town Way, Cheetham Hill, M8 0RY. A site location plan/cut and fill plan is included as Drawing No. 170502 Site plan for cut and fill Rev P01within Appendix A.
National Grid Reference	384830 400380.
Location description	The IWHC site is located immediately south of Queens Road (A6010), in the Cheetham Hill area of Manchester. The wider site consists of the recent development of a two storey IWHC with associated open space. The land to the north is the 'Site' which is the proposed Hotel, and car parking with areas of landscaping
Approximate Site area	~ 0.76 Ha
Site shape	The Site is broadly rectangular in shape.
General topography	The Site comprises an area of land lying at around 60.00m AOD. The site is generally flat lying with little variance.
Site ground surfaces and general description	The majority of the Site is covered by grass over Made Ground. The north west of the site has relatively dense vegetation and areas of hard standing are noted in the area of the former petrol station and to the north of the Site.
Sub-surface structures	The Site is underlain by a variety of shallow services; in particular those associated with the former petrol station, interceptor tanks. Additional unrecorded services should be anticipated. A Petroleum Officer search was commissioned by LKA from the Greater Manchester Fire and Rescue Service. The results of this search indicate that three petrol tanks and one diesel tank and all associated pipe work and contaminated soil were removed off-site on the 16th April 1991. However, it should be presumed, and contingencies made that unknown / unrecorded USTs and associated infrastructure (pipework etc) may be present beneath the Site
Invasive plant species	Japanese Knotweed has been identified on the study site within the LKA 2008 report; particularly to the north (Area A – 'The Site'). Confirmation of treatment or presence should be sought by a suitably qualified specialist.

3. PROPOSED DEVELOPMENT

It is understood that the current development proposals include the removal and subsequent grubbing up of all below ground structures currently occupying the Site and redeveloping the area into hotel accommodation with associated outdoor landscaping space and car park as presented in Appendix A.

GIR REVISED CONCEPTUAL SITE MODEL SUMMARY This Remediation Strategy has been prepared with reference to the Ground Investigation Reports produced by LKA (report 21st July 2008 ref. CL1294-02.and 22nd May 2009. Ref.CL1294-02.

Whilst it is not the intention of this report to repeat the information contained within the GIR in full, the salient points which have informed this Remediation Strategy are covered below along with background context to the Site.

Justification

- Made Ground was encountered in each of the sampling locations and was found to extend between 2.7 and 10.2 metres below ground level (mbgl). The depth is likely associated with a former landfill use on the site and can be applied to the wider IWHC area.
- The Made Ground across the site generally comprised sand or reworked clay with ash, clinker, bricks, gravel, cobbles, metal, glass, pottery and coal fragments.
- Large quantities of putrescible material were not encountered however some cardboard, wood and paper was identified in some sampling locations.
- Olfactory evidence of hydrocarbon contamination was encountered within the made ground in CP1, WS1 and WS3 in the area formally occupied by the petrol station, WS4 and TP5 in the north-eastern part of the site; and, WS6, WS7 and WS10.These soils are located within the area of the former fuel tanks and, as such, the soils in this area are considered to pose a risk to end users. In addition, the Made Ground as whole is considered to present a potentially significant risk to human health from elevated lead and PAHs.
- Generally the natural ground comprised a soft becoming very stiff to hard clay/ sandy clay with inclusions of sand, rare fine gravel and coal fragments. This was underlain in some locations by dense coarse sand. The natural ground in limited locations comprised of clayey sand and visual and olfactory evidence of hydrocarbon contamination was present. Weathered red / brown sandstone was encountered within a single location.
- Groundwater strikes encountered during the 2009 Site investigation works and groundwater levels observed during monitoring have indicated the presence of groundwater below the Site at depths between 2.20m bgl (WS5) and 13m bgl (CP4 and CP6). Groundwater monitoring was undertaken on twelve occasions and therefore some inconsistencies according to seasonal variability were observed. In addition several locations were dry on occasions.
- The GQRA for controlled waters identified a potential risk from the former petrol station (Area A) to the River Irk from petroleum hydrocarbons, xylene, naphthalene and ammonium. However Based on the DQRA within the 2009 report LKA does not consider there is a significant risk to the identified receptors from the site (Area A and 'Landfill Area') and therefore Pollutant Linkage is considered incomplete and no further remediation is required in respect to this linkage.
- With regard to controlled waters, no significant impact was identified to the Secondary (undifferentiated) (superficial) and Secondary A (bedrock) Aquifers or River Irk receptors from contaminated soils and perched waters encountered on the study site.

- 6 No. combined ground gas monitoring visits were completed by LKA .In accordance with CIRIA C66510, a GSV may be calculated from the maximum values encountered across the whole survey as a conservative measure. For Queens Road this maximum GSV for methane is 0.2158 l/hr and for carbon dioxide is 0.1716 l/hr which places the site within Characteristic Situation 2 where protection measures are required within new buildings.

Potential Sources

- Elevated levels of B(a)P, D(a,h)A, and lead were encountered within the near surface soils across the former petrol station area (Area A).
- Hazardous ground gas generation.

Potential Pathways

- Inhalation of contaminants on Site.
- Migration of contaminated dusts during redevelopment works.
- Migration of hazardous soil gases through pore spaces in to buildings and services.
- Migration of mobile contaminants through services and water pipes.

Potential Receptors

- Future, current and adjacent users of the Site.
- Site investigation, demolition and construction staff and future underground service maintenance
- Buildings, hardstanding and services.

Table 4.1. Assessment of Pollutant Linkages.

Pollutant linkage				Qualitative risk assessment
	Source	**Pathway(s)**	**Receptor(s)**	
1	Potential hazardous gas generation from on and off site Made Ground associated with hydrocarbon contamination within Made Ground soils of the former petrol station to the east.	Inhalation (indoor and outdoor).	Current site users (Residential)	Medium x Likely = Moderate Risk
		Explosion	Buildings and services	Severe x Unlikely = Moderate/Low Risk
2	Elevated Lead and PAHs contamination in the Made Ground soils of shallow surface soils	Dermal contact, ingestion and inhalation of contaminants including contaminated dust migration. Migration via water pipes	Future site users (Commercial)	Medium x Likely = Moderate Risk
			Adjacent site users (Commercial)	Medium x Low Likelihood = Low Risk
			Ground workers/Future maintenance workers	Medium x Likely = Moderate Risk

For definition of the terms used in the qualitative risk assessment, please see Appendix C.

4. REMEDIATION STRATEGY

4.1. Anticipated Remedial Works

Based upon the findings of the site investigation, an MMP is anticipated to be produced for the Site in due course. Any any such document will be produced in accordance with DoWCoP. The following remediation strategy has been devised in order to make the Site safe and suitable for redevelopment, as proposed:

- Removal of any below ground relict structures associated with former petrol station (including any unknown tanks);
- Removal of below ground interceptors and associated infrastructure and any residual previously unidentified gross hydrocarbon impacts;
- In order to break the direct contact, dust inhalation and ingestion pathways associated with lead and PAHs, inhalation pathways associated with any residual asbestos and direct contact dust inhalation and ingestion pathways associated with any residual hydrocarbons areas in areas of soft landscaping and planting, a clean cover system will be installed. A minimum of 300mm 'clean cover' (as determined by LKA 2008 report) derived from imported topsoil laid over a geotextile membrane to prevent mixing of potentially contaminated material with the capping layer. It will also guard against ecological disturbance (e.g. moles, plant roots etc);
- Implementation of water pipework (which is likely to comprise barrier pipework) appropriate based on the results of the assessment within the Ground Investigation Report.
- Installation of ground gas protection measures in line with a ground gas protection verification plan

4.2. Tank / Interceptor Removal

Uplift and Disposal of Underground Storage Tanks

Before soil removal can take place, it will be necessary to remove the existing and potentially previously unidentified USTs/interceptors on the site.

The procedures detailed in the Institute of Petroleum publication "Guidelines for the Uplift of Product from Petrol Filling Stations and Customer Tanks" should be followed. Prior to the commencement of works, the PLO will need to be notified with two weeks' notice.

Notwithstanding the above comments, before any work is commenced on the rendering permanently safe of an underground petroleum storage tank, any residual product within the tank shall be removed as far as is practically possible, this is known as "bottoming". In addition, it may also be then necessary to treat the base of the tank with a proprietary emulsifier or hydrocarbon adsorbent to ensure, so far as is practicable, that all residual hydrocarbons are removed. Observations made by Tier Environmental

suggests that the tanks are likely to be concrete filled; however, this is based on observations at the surface and so the potential for residual explosive atmospheres within the tank are considered to potentially remain.

Methods of Inerting Tanks

Before commencing the excavation and exhumation or the rendering safe in situ of any underground fuel storage tanks, the following methods are suitable to inert the tanks to remove the risk of explosion. The actual method which is used will be determined closer to the time of remediation and will be agreed with the PLO and based on the extent or otherwise of the concrete fill in the tanks. In the case of nitrogen gas, dry ice, nitrogen foam and combustion gas, it is necessary to reduce the oxygen content to below 5%.

Nitrogen Gas

The condition of redundant fuel/oil tanks is uncertain, and therefore the atmospheric pressure method can be used. This involves the nitrogen being passed continuously into the tank at one point, while the air and petroleum vapour being purged leaves from another opening, usually the flame trap outlet.

It is recommended that the nitrogen gas be introduced directly from an industrial gas supplier's road tank vehicle, fitted with the necessary reducing valves and measuring equipment.

The tank, and in the case of multi-compartment tanks all compartments, shall be bottomed, and all openings sealed except for those required for the inlet of 'nitrogen and for the exhaust outlet to atmosphere. The exhaust outlet shall be of sufficient size so as to prevent the build-up of pressure in the tank. The nitrogen shall then be introduced and the mixture leaving the tank shall be vented to atmosphere so that tank remains at atmospheric pressure throughout the entire operation. If approximately five tank volumes of nitrogen are used, the final oxygen level will be approximately 1%. Following completion of the purging, the openings shall be sealed and the tank may then be excavated.

During the excavation and removal all holes found in the tank shall then be securely plugged with wooden pegs.

If excavation takes place immediately after purging the tank, a small vent shall be left in the tank to allow excess pressures to escape.

Dry Ice

Following the bottoming of the tank, and in the case of multi-compartment tanks of each compartment, the ventilation pipes shall be removed and all openings sealed except that required for the insertion of 'dry ice' (solid Carbon Dioxide). 4Kg shall be allowed for each 2000 litres of capacity. The dry ice shall be broken into pieces not larger than the size of a walnut.

Operatives shall wear gloves when handling dry ice which shall be kept covered while being broken to contain any flying fragments.

The tank shall be left for 12 hours after the addition of the dry ice. After this the opening used for the insertion of the dry ice shall be sealed and the excavation can commence, if oxygen levels of below 5% have been achieved.

During the excavation and removal all holes found in the tank shall be securely plugged with wooden plugs. If excavation takes place immediately after purging the tank, a small vent shall be left in the tank to allow excess pressure to escape.

It should be noted that with this method of inerting, difficulties can be encountered due to stratification, inadequate quantity of dry ice or incomplete transformation of the dry ice to gas. It is therefore, important when using this method to test the atmosphere in the tank with an oxygen meter at intermediate levels. Particular care shall be taken to test the VOC atmosphere at the top of the tank. If the atmosphere exceeds 2000ppm VOC, there is a potential explosion risk and the inerting procedure must be repeated.

Water Fill

Following the bottoming of the tank (which has already been undertaken), the suction pipe(s) shall be disconnected and the tank connecting points be excessively sealed. The tank shall then be filled completely with water with care being taken to ensure that any water or residual product does not overflow from the fill point.

Surplus water or residual product shall, if necessary, be removed from the pipe to avoid an outflow when the vent pipe is disconnected from the tank. Any surplus water or residual product shall be disposed of safely.

Finally, the vent pipe shall be disconnected and the tank connection point and fill point effectively sealed.

It should be remembered that when filling the tank with water, flammable vapours will be displaced through the vent pipe outlet.

When the tank is ready for lifting from the excavation the water shall be uplifted and conveyed to a site authorised for the handling and disposal of contaminated waste. Contaminated water from the petroleum tanks is subject to the regulations made under the Environmental Protection Act 1990 and the Duty of Care Regulations 1991.

Complications may occur with method when the tank is badly holed or when the excavation is delayed causing flooding of the excavation. When this occurs the excavation work shall stop, the water pumped out of the tank and an alternative method used instead.

Hydrophobic Foam Fill

With this method the foam having designed compressive strength (when set) of 8 tonnes per square metre is generated on site and pumped directly into the tank(s). This procedure shall be carried out in accordance with the manufacturers/supplier's instructions.

Nitrogen Foam Fill and Combustion Gas

These two alternative methods of inerting tank(s) are detailed in HSE Guidance Note CS15.

a. Removal of all existing Underground Storage Tanks / Interceptor

Where a tank / interceptor is being excavated and there is a danger that the surrounding earth may have been contaminated either by leakage from the tank or by spillage, the following precautions shall be taken:

ii. Danger notices shall be displayed.

iii. No smoking or naked lights shall be allowed near the vicinity.

In all the above operations, care shall be taken to ensure that no hydrocarbon or hydrocarbon contaminated water is allowed to enter any drainage system or water course. In order to prevent the potential for cross contamination with existing soils on site, it is recommended that some form of protective membrane is emplaced across any areas where the tanks, or any associated materials are to be placed, prior to their removal from site.

Due to the presence of loose Made Ground and natural soils, excavations are likely to be unstable, especially during the removal of the existing USTs. Man entry into unshored excavations should not be permitted and reference to CIRIA 97 Trenching Practice should be made to establish suitable means of support or battering of excavation sides during their removal.

If a tank is to be lifted by chains or wire ropes, they shall be protected from direct contact with the tank to prevent risk from spark generation. Natural fibre ropes may be preferable for small tanks. A tank shall not be lifted by placing chains or ropes around the manhole neck, as it is possible to rip the neck from the tank.

In preparation for transportation, the following precautionary work shall be carried out

1. All pipework connected to the tank shall, as far as is reasonably practicable, be removed.
2. All openings to the tank shall be sealed.
3. Any holes in the tank caused by corrosion or damage during exhumation shall, so far as is reasonably practicable, be sealed.
4. The appropriate orange coloured (warning) panels as required by Schedule 10 to The Carriage of Dangerous Goods by Road Regulations 1996 shall be displayed.
5. The tank shall be securely attached to the carrying vehicle, following the precautions noted for chains or wire ropes as above.
6. Where there are holes or obvious areas of weakness in the tank, the tank shall be positioned on the carrying vehicle in such a way that the hole/areas of weakness are positioned above the level of any liquid or sludge remaining in the tank.
7. The transportation of a disused petroleum tank from the site by road is covered by the Carriage of Dangerous Goods by Road Regulations 1996, (Schedule 2 (4)).
8. The Contractor shall ensure that the recipient of the tank is made aware of the tank's previous use, the toxic hazard within the tank and the need to take adequate precautions against fires and explosions when handling and disposing of it.

a. Excavation and Removal of Tank Containment

Any USTs on Site may be contained within a concrete surround. This concrete surround should be broken out and removed from site if shown to be impacted by hydrocarbons.

Within the immediate vicinity of the known USTs, samples of the Made Ground and / or natural strata shall be taken to determine the extent, if any, of potential speciated petroleum hydrocarbons (TPH). The results obtained shall be compared against the remedial target levels which have been derived in the following sections of this report.

Areas of highly/grossly contaminated material shall be determined by visual / olfactory observations. If any areas of odorous, 'oily' or brightly coloured materials or liquids are encountered, the Supervising Engineer (SE) if not in attendance, shall be notified immediately.

Any disposal of grossly contaminated materials shall take place by the direct placement onto a bunded Visqueen layer whilst chemical analysis is undertaken. This soil will also be covered in a layer of Visqueen to prevent leaching to the surrounding soils. Following WAC and soils analysis, the soil will be placed into a road haulage truck and subsequent disposal at a suitable landfill site. On site precautions will be required to prevent the spreading of contaminated soils around the site or to adjacent land.

The removal of sufficient soil will be validated by ensuring that remedial targets have been met for the contaminants. Once validation of the all excavations in relation to removal of the tanks, interceptor and associated pipework has been achieved, suitable material should be used (which will be identified by a separate Materials Management Plan) to backfill the excavations.

4.3. Remediation Criteria

The results of the Generic Quantitative Risk Assessment in the GIR have demonstrated reported soil concentrations of Lead and PAHs in the vicinity of the former petrol station which present a potentially significant risk to human health. The risk assessment demonstrated that the Site does not present a risk to controlled waters.

On this basis, it is proposed that LQM/CIEH (2015) S4ULs for speciated TPH CWG, speciated PAHs and BTEX are implemented as remediation criteria for comparison with soil samples obtained on a 5 m grid basis from the sides and base of any resultant interceptor or UST excavation. This will ensure that residual TPH, BTEX and PAHs do not present a potentially significant risk to human health for a commercial land use.

4.4. Independent Verification and Supervision of the Works

Verification of Impacted Soil Removal

In order to ensure verification of the removal of contaminated soils, if encountered, excavations will be carried out as follows:

- A visual inspection of the soil will be undertaken. The excavation will be progressed until no visual evidence of gross contamination remains or until excavation is no longer practicable / safe due to the proximity to adjoining structures of services.

- Soil samples will be taken from the **base and sides** of the excavation, prior to infilling, on a 5m grid. Sample collection will be made by the use of the excavator bucket to 'scrape' the sample locations. The Site Engineer will not enter the excavation at any time. Base samples will be obtained in a 'W' shape pattern to provide confidence in the lateral and vertical verification of the resultant excavations;

- If, in the experience of the competent Site Engineer, it is thought that the sample is likely to be below remedial targets, the sample will be submitted for laboratory analysis;

- Should the results of laboratory analysis be greater than the remedial targets, then further assessment and/or potential remediation of the contamination will be necessary.

4.5. Clean Cover System

Installation

In order to remove the remaining pollutant linkages, it is considered that the soft landscaped areas of the Site should be covered with a minimum 300mm deep clean cover system (300mm Topsoil layer and a hi visibility Terram geotextile membrane. It is considered that as the proposed development is for hotel accommodation purposes, that a 300mm clean cover system with a geotextile membrane will provide sufficient thickness for the exposure scenarios typical for hotel accommodation use and the geotextile will provide a hi-visibility physical barrier in the unlikely event that any excavations are undertaken to this depth. It should be noted that the clean cover system should only be implemented in those areas for which shallow soils still lie at ground surface, i.e. soft landscaped areas as all other areas will be covered in hardstanding and/or buildings which will be sufficient to break the direct contact and dust inhalation pathways in these areas.

The source of any aggregates, imported subsoil and Topsoil material will be inspected and tested **prior to being brought to site** on site to ensure its chemical suitability and absence of any deleterious materials such as glass, metal, roots, invasive weed species and the like.

Verification

It will be necessary to ensure that the development of the site does not cause an increased risk to receptors. All materials imported to the site will be tested **prior to being brought to site** to determine its chemical suitability for use on the site in the soft landscaping areas. The imported material will be tested for the standard Tier Environmental soil and leachate suite listed in Appendix D of this report as part of a verification testing exercise. The purpose of the testing is to verify the quality of any materials imported to the site and to determine the contaminant concentrations of materials. Imported materials will need to be tested at a minimum rate of 1 sample per $50m^3$ for topsoil and 1 per $150m^3$ for subsoil/other backfill materials with a minimum of 3 No. samples of each.

In addition to the chemical testing, the depth of clean cover will also be verified. Verification will take the form of a suitably qualified environmental engineer undertaking hand dug pits in each soft landscape plot, with the number of holes determined based on a 1 per $25m^2$ or per soft landscaped 'plot' area.

Irrespective of the finished total area of soft landscaped areas, a minimum of 3 No. pits overall will be undertaken within soft landscaped areas to ensure that a combined thickness of 300mm Topsoil has been achieved and to prove the installation of the Terram geotextile. These hand dug pits will be photographed and photographs will be submitted as part of the verification report.

4.6. Contingency for any Unknowns

Whilst relatively uniform ground conditions have been encountered at the Site during previous investigations, a small risk exists of the presence of localised unidentified contamination of Made Ground soils.

Should any suspicious material be encountered during the redevelopment works, works shall be ceased within this part of the site and the area should then be investigated further by a suitably qualified geo-environmental engineer and sampled as necessary. The Contaminated Land Officer / Environmental Health Officer (or equivalent) at the local authority should also be notified immediately.

Samples will be forwarded to a UKAS/MCERTS accredited laboratory for a suite of analytical testing deemed appropriate based upon an appraisal of the material identified.

Once the results of the analysis are known and have been interpreted, the required remedial action (if any) will be determined and approved with the relevant regulatory authorities.

4.7. Environmental Monitoring and Mitigation

Introduction

In order to mitigate the environmental impacts of the works on nearby residents and sensitive areas, a programme of measures will be implemented during the remediation works.

Dust Mitigation

Appropriate measures shall be implemented at all times during the remediation works, to minimise dust emissions. Soils will be dampened down, as necessary, and activity will be minimised in extremely windy conditions to prevent dust nuisance. An adequate supply of water shall be maintained on site at all times to allow for dust suppression activities to be carried out at short notice.

When dusty material is being loaded onto trucks, extra care will be taken to ensure that the drop height is minimised. Trucks will be suitably covered when leaving the site with contaminated material to prevent dust migration.

The amount of disturbed surfaces left exposed for significant time periods will be minimised. Stockpiles of fine or loose materials should be tamped down or covered if necessary to reduce the production of dust. Traffic both entering and working on the site shall obey a maximum speed limit of 10 mph.

Noise

The requirements of BS 5228:1997 "Noise and Vibration Control on Construction Sites" shall be adhered to at all times. All machinery shall be fitted with effective silencers and shall be serviced at regular intervals. No plant shall be operated with engine covers raised.

Run-off into Drains

All potential drainage on site and any discharge points will be identified, including land drains, foul sewers, surface water drains and any combined drains. These will be marked, as appropriate, for easy identification.

Works will be minimised during periods of heavy rainfall to reduce the likelihood of contaminated run-off. Temporary containment and cover measures or tamping down of stockpiles to reduce run-off shall be used where necessary.

4.8. Waste Soils – Basic Characterisation and WAC

Impacted material exported from the site to landfill shall be hauled by a registered waste carrier in accordance with Duty of Care Regulations, 1991 and the Hazardous Waste Regulations, 2005.

It is anticipated that some of the waste materials will be hazardous on the basis of previous site investigation works and on-site observations.

There will be requirement for the waste producer to provide appropriate Waste Acceptance Criteria (WAC) testing of the soils for disposal to ensure that the soils are appropriately classified and that the landfill is licensed to receive such soils.

4.9. Verification Report

The SE should ensure that the requirements of the strategy are complied with. On satisfactory completion of all remedial works, a verification report should be produced. This report will comprise all relevant site records and act as certification that the remedial preparation works have been carried out in accordance with this remediation strategy.

The Verification Report shall include the following:

- A description of the works undertaken;
- Records of the works;
- Progress photographs;
- Photographs of the ground gas and precautionary vapour protection measures and details of the installed membrane;
- Waste Transfer Notes;
- Chemical verification test results;
- A statement that the works have been undertaken in accordance with the agreed strategy.

It is acknowledged that any minor exceedances of the remediation criteria from materials left in the ground may require further assessment and/or discussion with Manchester City Council. Due consideration will be given to the viable pathways and the locations of any such minor residual exceedances and qualitative assessment of the potential risks may also be provided in the Verification Report, where appropriate.

5. THE GROUND GAS REGIME AND GAS PROTECTION MEASURES

5.1. Tier Ground Gas Risk Assessment

The results of LKA ground gas assessment determined (In accordance with CIRIA C66510), a GSV may be calculated from the maximum values encountered across the whole survey as a conservative measure. For Queens Road being the wider IWHC area (Area A – 'The Site' falls within this area) this maximum GSV for methane is 0.2158 l/hr and for carbon dioxide is 0.1716 l/hr which places the site within Characteristic Situation 2 where protection measures are required within new buildings. No gas protection measures will be required within areas of landscaping and car parking.

During engineering and construction activities, the ground gas data indicate that the following aspects are to be considered during the preparation of relevant site H&S plans, method statements and related documents, and appropriate working methods adopted:

- *Carbon dioxide concentrations in ground gas*. The measured CO_2 concentrations in ground gas reported are elevated relative to background and could present an asphyxiation risk in excavations and other confined spaces. The Health & Safety Executive has published information defining safe occupational exposure levels for CO_2 and the latest guidance must be consulted to determine whether the ground gas regime necessitates specific precautions during site works.

Basic radon protection measures are not currently required for the proposed development on this site.

5.2. Remedial Objectives

The remediation objectives are to break the potentially active linkage between bulk ground gas and resistant to VOC's from residual hydrocarbons from beneath the Site and the buildings or future Site users associated with the proposed development.

5.3. Proposed Foundation and Floor Slab Design

The proposed development is considered by Tier Environmental to fall within a Type B category as defined by BS8485: 2015. Guidance document BS8485:2015 describes a Type B building as:

"private or commercial property with central building management control of any alterations to the building or its uses but limited or no central building management control of the maintenance of the building, including the gas protection measures. Multiple occupancy. Small to medium size rooms with passive ventilation of rooms and other internal spaces throughout ground floor and basement areas. May be conventional building or civil engineering construction. Examples include managed apartments, multiple occupancy offices, some retail premises and parts of some public buildings (such as schools, hospitals, leisure centres) and parts of hotels."

As a result, gas protection measures with a minimum gas protection score of 3.5 would be required for a Characteristic Situation 2 – Low Risk scenario. As such it is recommended that the proposed development includes the emplacement of a gas and vapour resistant membrane meeting all of the following criteria (2.0 points) which must be:

- Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m^2/atm (average) for sheets and joints (tested in accordance with BS ISO 15105-1 manometric method);

- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools etc);
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and
- Verified in accordance with CIRIA C735

The Client (Truman Design and Build Ltd) have procured Tier Environmental to advise upon the design and undertake the verification of the gas protection measures. The detailed design of the ground gas protection measures will ultimately be undertaken by the structural engineer. Tier Environmental have recommended that the site sits within Characteristic Situation 2. Based on the characterisation of the Site and the proposed development, it is concluded that the following gas protection measures would be appropriate:

- Cast *in situ* monolithic suspended floor slab with minimal service penetrations (1.5 points)
- A ground gas and vapour membrane (2 points)

This combination gives a gas protection guidance value of 3.5 which exceeds the required value of 3.5.

In order to achieve the 2 points score, the gas barrier will comprise a suitable VOC resistant AND satisfy Table 7 or BS8485:2015 with respect to ground gases.

- Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method);
- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc);
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas

In order to fully qualify for the 2 points, the membrane will be verified by Tier Environmental in accordance with CIRIA C735. The specification sheet for the membrane and the detailed design of the membrane are presented in the appendices. The gas and vapour membrane will be installed by PAGeotechnical who are a professional geomembrane installer with all operatives who have or are working towards the NVQ Level 2 Qualifications in Gas and vapour Membrane Installation. The membrane design will be determined by the groundworker's specialist subcontractor. The membrane is placed continually over the floor slab and it is strongly

adhered any penetrations using 300mm wide bitumen based self-adhesive which it is considered to be a suitable method of preventing ground gas ingress into the building.

6. GROUND GAS AND VAPOUR VERIFICATION PLAN

6.1. General

An informed and risk-based approach has been taken as part of the verification plan, which has been produced to determine the following:

1. decide which stakeholders are deemed suitable to undertake the necessary verification procedures;
2. how many site inspections should be undertaken;
3. the need for, and scope of, any integrity testing.

This risk-based system has taken into account the various factors that have influenced the scope of verification activities (including the possibility of integrity testing), which have included:

- site-specific gas regime;
- number of /sections of buildings to be inspected and the period over which this will take place;
- complexity of the design and installation;
- qualifications and experience of the workforce.

Figure 7.1 has been modified from CIRIA C735, with the red dots showing the relative placement of the site.

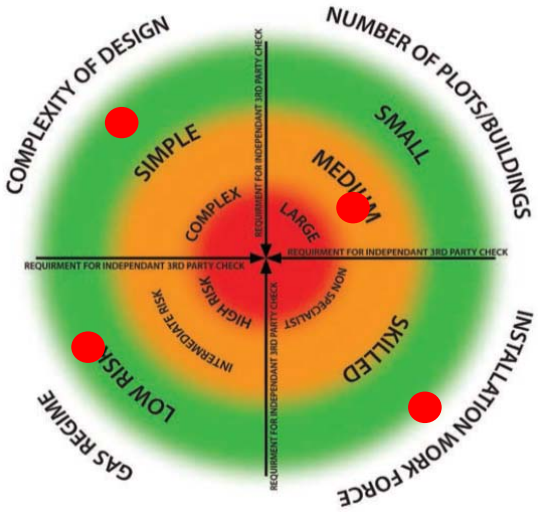

Figure 7.1 Analysis of the variables which have influenced the scope of the verification plan for this site.

6.2. Independence and Competence

In respect to the level of competence required in general ground remediation, The Environment Agency recommends that conflicts of interest in verification should be avoided. A contractor or gas and vapour membrane supplier certifying their own work or product is considered to be a conflict of interest and is therefore not good practice. If verification is carried out by the same company (or related company) that carried out the installation then the process, the results and report should be audited by an independent consultant.

In this instance the installation of the gas protection measures are being undertaken by ground worker's specialist sub-contractor.

The verification will be undertaken by Tier Environmental.

6.3. The Inspection Regime

The gas and vapour membrane installation should be subject to a visual verification inspection to establish the adequacy of the ground preparation and, subsequently, possible damage to the installed gas and vapour membrane. The inspection visits should fall generally in line with the following:

1. The verifier should determine whether an area to be covered in a ground gas and vapour membrane is ready for inspection by initiating contact with contractor;
2. The verifier would then inspect all areas of interest with the site manager or groundworks supervisor;
3. The inspection will cover:
    a. the ground prepared for the gas and vapour membrane which should be clean and free from stones etc;
    b. The installation of the membrane to an acceptable standard, and;
    c. the membrane itself.
4. The verifier should also inspect the gas and vapour membrane itself over the whole floor area, paying particular attention to laps, edges and the sealing of service entries and penetrations such as vent pipes and pile caps;
5. The visual inspection should be recorded on the Gas Protection Verification Pro Forma, as presented in Appendix E of this report;
6. Any discrepancies with the installation method recommended by the gas and vapour membrane supplier should be highlighted. These may include small or large holes and rips, tears and punctures, absence of tape (double sided or single sided tape) on the lapped areas, loose or unstuck tape, inadequate corner details, and unbounded seams such as loose edges and 'fish mouths' in the gas and vapour membrane;
7. Tapes used to join gas and vapour membranes should be inspected to make sure they are compatible with the gas and vapour membrane being joined and are as specified by the gas and vapour membrane supplier or specified; non proprietary

gas resistant tape should never be used to seal a gas and vapour membrane. Where welded joints are used, the verifier should ensure they are correctly tested;

8. Repairs should be instructed and observed on the same day as the site visit or inspected at a later date. This will be documented on the Gas Protection Verification Pro Forma for that visit. The frequency and intensity of inspections should increase to reflect any lower level of competence of the workers installing the gas protection system;

9. As this membrane is located below the reinforced slabs, inspections should take place installation of the pressure relief pathway and before installation of the membrane and also before concreting. The concrete should then be poured as soon as possible after the gas and vapour membrane has been signed off, in order to ensure that follow-on trades do not damage a gas and vapour membrane that has been signed off.

10. All follow-on trades should be made aware of the presence and purpose of the gas and vapour membrane and pressure relief pathway, and who they should contact if they believe their actions have had the potential to compromise it.

The final verification report will include photographs as supporting evidence. A pro forma should be completed for each inspection visit. All pro formas should be retained for inclusion within the final verification report in order to demonstrate the involvement of the verifier throughout the process and provide evidence of the appropriate installation of the gas protection measures. An example pro forma which highlights all aspects to inspect is provided in Appendix E of this report.

6.4. Inspection Timing and Frequency

There is currently no absolute guidance relating to the number and frequency of visits; however, for the purposes of this verification plan, reference has been made to table A1 within Annex 1 of CIRIA C735. Whilst at this stage it is not possible to give specific dates for inspection visits, the following rules should be adhered to when attending site to make the required visual inspection (relative to the site specific risks shown in Figure 7.1).

- Verifier to conduct a thorough verification (visual) inspection of the membrane and installation prior to between 25 and 750per cent of concrete pours with inspections undertaken just prior to a concrete pour event. Inspection will be predominantly visual but may include the mechanical point stress test (this involves running a blunt instrument (e.g. a screwdriver) along the edge of the seam to identify any unbounded seams).

- The installer to supply sign off sheets (verification evidence) including photographs to the verifier for all other pours.

6.5. Integrity Testing

Consideration has been made to the use of integrity testing as part of the verification of the gas protection measures. In determining the requirement for integrity testing, reference has also been made to the diagram in Figure 7.1 and Table A1 of Annex 1 of CIRIA C735, the Site is Low Risk and the membrane is being inspected by a qualified geoenvironmental engineer. As such integrity testing is not currently recommended in this verification plan. It should be noted; however, that this is dependent upon the results of the initial verification visits. If, following these initial visits, it is deemed by the verifier that the installation is of a questionable standard, the use of integrity testing may be added to this verification plan. The results of any integrity testing must therefore be included in any final verification report.

7. REGULATORY APPROVALS

The conclusions and recommendations presented above are considered reasonable based on the findings of the GIR. However, these cannot be guaranteed to gain regulatory approval and, therefore, the report should be passed to the appropriate regulatory authorities and/or other organisations for their comment and approval prior to undertaking any works on site.

It is recommended that conditions placed on any planning permission are discharged prior to commencement of site works.

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APPENDIX A – FIGURES AND DRAWING

SF-TO 1			
Code	Easting	Northing	Height
FM1	384897,041	400540,542	58,110
M1A	384873,473	400545,806	58,310
M1A1	384825,814	400530,090	59,178
23/02/2017			

landscaped mound with wildflower planting

gabion wall

gabion wall

gabion wall

gabion wall

7,590,539,000 sq mm

1,561,096,000 sq mm

NOTE ANOMOLY IN SURVEY DRAWING AND GOOGLE EARTH MAP COMPARED WITH ARCHITECTURAL DRAWING

NOTES

THIS DRAWING HAS BEEN COMPILED USING THE ARCHITECTURAL LEVELS DRAWING 341-SK-039, THE SURVEY DRAWING, sss-7348 ADN HAS BEEN SUPERIMPOSED WITH A GOOGLE EARTH MAP.

FOR SECTIONS AS NOTED REFER TO DRAWINGS SK0170502-01 & 02

REV	DATE	PURPOSE	DRN	CHK
P01	02.05.17	ISSUED FOR INFORMATION	ET	HG

renaissance
Renaissance Associates Ltd
Carvers Warehouse
77 Dale Street
Manchester
M1 2HG

PROJECT
IWHC HOTEL

TITLE
SITE PLAN FOR CUT & FILL ASSESSMENT

PROJECT NO.		
1509-06		
DRAWING	REV	SCALE
SK-170502-00	P01	NTS

STATUS
PRELIMINARY

APPENDIX B - GLOSSARY OF TERMS

ACEC	Aggressive Chemical Environment for Concrete (classification)
aOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
Designated location	Site (and the ecosystem on that site) protected under national of international legislation. A potential ecological receptor to be considered as part of the assessment of land contamination. Example designated locations include SSSIs (q.v.), SACs (q.v.), national nature reserves, Ramsar sites and bird special protection areas.
DQA	Data Quality Assessment
DQO	Data Quality Objective
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
K_{ow}	Octanol-water partition coefficient
LEL	Lower Explosive Limit
LL	Liquid Limit
LoD	Limit of Detection (analytical)
LoQ	Limit of Quantification (analytical)
Mean Value Test	Statistical test (described in the CIEH Guidance) to estimate the mean value of a normally distributed population of data at a given level of confidence. Normally for contaminated land assessment, the 95th percentile (referred to as the 95%UCL or US95) is applied as a reasonable but conservative estimate of the mean concentration for comparison with the relevant assessment criteria.
Maximum Value Test	Statistical test (described in the CIEH Guidance) to identify whether an elevated concentration within a normally distributed data set forms part of the underlying population from which it has been sampled or whether it is an outlier (such as a localised area of contamination) that merits further consideration.
MC	Moisture Content
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
PI	Plasticity Index
PID	Photoionisation Detector
PL	Plastic Limit
ppm	Parts per million
ppmv	Parts per million by volume
QA	Quality Assurance
QC	Quality Control
SAC	Special Area of Conservation
SOM	Soil Organic Matter
SPT	Standard Penetration Test
SPZ	Source Protection Zone
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest
SVOC	Semi-Volatile Organic Compound

TEF	Toxicity Equivalent Factor
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
US95	95th percentile estimate of the true mean value of a data population (also known as 95%UCL).
VOC	Volatile Organic Compound

APPENDIX C – DEFINITIONS OF TERMS USED IN QUALITATIVE AND QUANTITATIVE RISK ASSESSMENTS

For the qualitative and quantitative assessment of risks posed by potential pollutant linkages have been undertaken using the risk matrix adapted from CIRIA C552 and outlined in the table below.

	Category	Definition
Potential severity	Severe	Acute (short term) risk to human health, Major pollution of sensitive controlled waters, ecosystems or habitat. Catastrophic damage to buildings or property or crops.
	Medium	Chronic (Medium / long term) risk to human health Pollution of sensitive controlled waters, ecosystems or species, Significant damage to crops, buildings or structures
	Mild	Easily preventable permanent health effects on humans. Pollution of non-sensitive controlled waters. Minor damage to buildings or structures.
	Minor	Easily preventable non-permanent health effects on humans, or no effects. Minor, low level and localised contamination of on-site soil. Easily repairable damage to buildings or structures.
Probability of risk	High Likelihood	Pollutant linkage may be present and the risk is almost certain to occur, or there is evidence of harm already occurring.
	Likely	Pollutant linkage may be present and it is probable that the risk will occur over the long term.
	Low Likelihood	Pollutant linkages may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
	Unlikely	Pollutant linkage may be present but the circumstances under which harm would occur are improbable.

		Potential Severity			
		Severe	**Medium**	**Mild**	**Minor**
Probability of risk	**High Likelihood**	Very high	High	Moderate	Moderate/Low
	Likely	High	Moderate	Moderate/Low	Low
	Low Likelihood	Moderate	Moderate/Low	Low	Negligible
	Unlikely	Moderate/Low	Low	Negligible	Negligible

APPENDIX D – LKA REPORTS 2008 & 2009

LAND AT

IRISH WORLD HERITAGE CENTRE

QUEENS ROAD

CHEETHAM HILL

GROUND INVESTIGATION AND RISK ASSESSMENT REPORT



Prepared for:

The Trustees of the Irish World
Heritage Centre
Irish Diaspora Foundation Ltd
Irish World Heritage Centre
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By:

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Date: 21st July 2008

Leyden Kirby Associates Ltd
Document Verification

Site Address	Irish World Heritage Centre, Queens Road, Cheetham Hill, Manchester		
Job Number	CL1294		
Report Title	Ground Investigation and Risk Assessment Report		
Date Issued	21st July 2008	Document Ref.	CL1294-02
Prepared By	Michelle Pickford	Signature	
Checked By	Rebecca McKellar	Signature	

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APPENDICES

Appendix A: Borehole Logs

Appendix B: Analytical Results

Appendix C: LQM GAC Table

Appendix D: CLR7 Statistical Tests

Appendix E: Gas Monitoring Results

Appendix F: Japanese Knotweed Survey Plan

1 EXECUTIVE SUMMARY

Leyden Kirby Associates (LKA) was commissioned by the Trustees of the Irish World Heritage Centre to undertake a contamination and geotechnical investigation on land at Queens Road, Cheetham Hill, Manchester. The works were designed to investigation the properties of any potential contaminants that may be present in, on or under the site and the geotechnical properties of the underlying soils.

The study site forms part of a former landfill site which ceased operation in the 1970s. The site is generally flat with an approximate elevation of 57m AOD, but has three high man-made embankments which run along the southern and eastern boundaries and part of the northern boundary of the site. The proposed development comprises a two storey new IWHC, a 100 bed Hotel, three office units, a sports pitch and pavilion, car parking and areas of landscaping.

The drift geology on site is indicated as Till. The solid geology beneath the site is indicated to change from east to west as it becomes younger. The east and centre of the site is underlain by Carboniferous Westphalian C Coal Measures including the Worsley Delf Rock (sandstone unit). The west of the site is then underlain by the Permian aged Collyhurst Sandstone with Manchester Marls along the western edge of the site. The eastern and central part of the site to be underlain by a Minor Aquifer (variably permeable) represented by the Westphalian deposits. The western part of the site is underlain by a Major Aquifer (highly permeable) represented by the Sandstone Deposits. The western edge of the site is underlain by a non-Aquifer (negligible permeable) represented by the Marl deposits.

Potential contamination from the study site will be dependant upon the composition of the material used to infill the former clay pits, ponds and cuttings on site. Information from the previous site investigation work and the Envirocheck Report suggests that material is variable. Some of the material in is likely to be putrescible and is know to be generating carbon dioxide, methane and trace gases. Ash and clinker from hearths and boilers is also likely to be present (giving rise to contaminants such as heavy metals and Polycyclic Aromatic Hydrocarbons (PAHs) and asbestos).

In addition, the northern part of the site is likely to have been impacted by its previous use as a petrol filling station. As such, contaminants associated with petroleum hydrocarbons, Semi-volatile Organic Compounds (SVOCs) and Volatile Organic Compounds (VOCs) may be present.

The Environment Agency holds no evidence to suggest that the licensed landfill site had any Gas Control measures. Previous site investigation work has shown that hazardous landfill gases (carbon dioxide and methane) are present on the site.

Seven potential pollutant linkages were identified in the preliminary conceptual model. In addition to the sources identified above, potential receptors include future site users, construction workers, underlying aquifer, site buildings and future landscaping. Potential pathways by which the receptors could be exposed to the sources include dermal contact, ingestion, leaching, migration and uptake.

A site investigation was undertaken to investigate the potential pollutant linkages and the geotechnical conditions beneath the study site. A total of twenty four trial pits, six cable percussive boreholes and ten window sample boreholes were undertaken. In addition each of the cable percussive boreholes and eight of the window sample boreholes were instrumented with gas monitoring wells and subsequently monitored for landfill gas on six occasions.

Contamination testing had identified concentrations of heavy metals, PAHs, petroleum hydrocarbons across the site. Therefore remedial measures are required in soft landscaping areas and health and safety considerations should be employed by construction workers. Gas monitoring indicated levels of carbon dioxide up to 15.8% by volume and a maximum of 16.6%v/v methane. In accordance with CIRIA C665 this places the site within Characteristic Situation 2 were protection measures are required.

In-situ geotechnical testing was undertaken in each borehole. Standard penetration tests characterised the natural clay as very stiff to hard and the sand as very dense. Laboratory testing on the clay characterised the material as very stiff to hard at 10mbgl.

At this stage LKA recommend that a piling option using the clay as the appropriate foundation strata is adopted for the site. At this stage an End Bearing Driven pile would seem to be the most suitable foundation option. Confirmation of these considerations and an assessment of the ground conditions with respect to the proposed building load should be sought from the appointed Structural Engineer.

2 INTRODUCTION

2.1 *Background*

Leyden Kirby Associates Ltd (LKA) has been commissioned by the trustees of the Irish World Heritage Centre (IWHC) to carry out a Geoenvironmental Investigation for land at Queens Road, Cheetham Hill, Manchester. This work is being undertaken to support future redevelopment of the site into the new Irish World Heritage Centre (IWHC), a hotel and associated areas of open space playing fields. A Preliminary Risk Assessment report has already been undertaken by LKA on this site (reference CL1294-01 dated 14th March 2008) and should be read in conjunction with this report.

2.2 *Site Details*

The IWHC site is located immediately south of Queens Road (A6010), in the Cheetham Hill area of Manchester at National Grid Reference 384830 400380 (Figure 1-1). The IWHC site is bounded to the north by Queens Road, to the east by Metrolink House (offices and tram shed), to the south by undeveloped land, to the south-west by Manchester Fort (retail park) and to the north-west by a small residential development. The site has most recently been used as a landfill site which ceased operation in the 1970's.

The site is approximately 5.17ha in size (see Figure 1-2). The site is generally flat with an approximate elevation of 57m AOD, but has three high man-made embankments which run along the southern and eastern boundaries and part of the northern boundary of the site. The site proposed layout is indicated in Figure 1-3. The proposed development comprises a two storey new IWHC with associated open space, a 100 bed Hotel, a sports pitch and pavilion, car parking and areas of landscaping.

2.3 *Disclaimer*

This report has been prepared by LKA who have exercised such professional skill, care and diligence as may reasonably be expected of a properly qualified and competent consultant experienced in preparing reports of a similar scope.

However, to the extent that the report is based on or relies upon information contained in records, reports or other materials provided to LKA which have not been independently produced or verified, LKA gives no warranty, representation or assurance as to the accuracy or completeness of such information.

This report is issued on the condition that LKA will not be held liable for any loss arising from ground conditions between sampling points (i.e. boreholes/trial pits/hand augers/surface samples) which have not been shown by the sampling points or related testing carried out during the investigation, nor for any loss arising from conditions below the maximum depth of the investigation. Opinions on such conditions, where given, are for general guidance only.

This report is prepared solely for the benefit of Irish Diaspora Foundation Ltd. It may not be relied upon by any other party without the prior written consent of LKA. Those using this information in subsequent assessments or evaluations do so at their own risk.

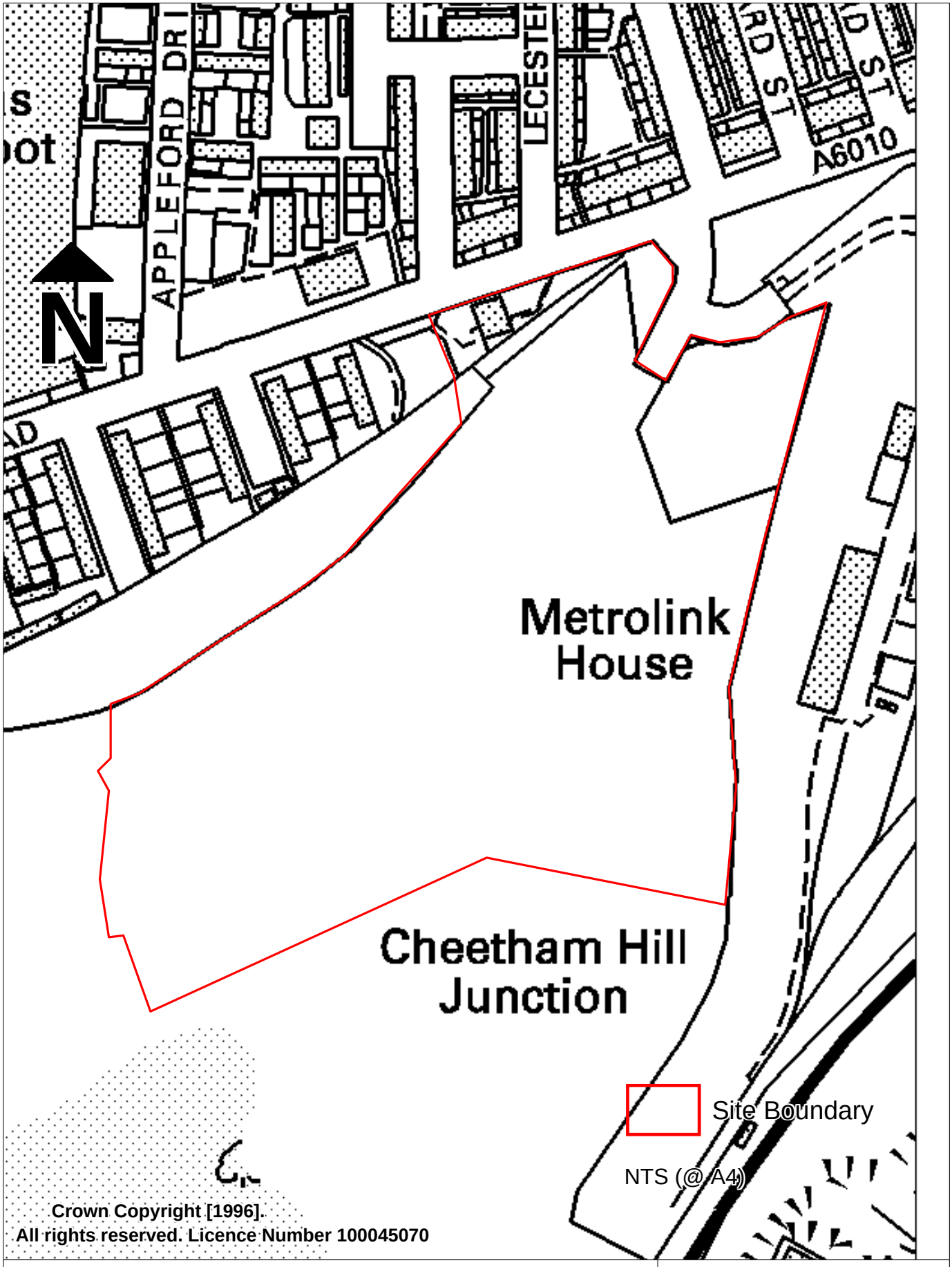

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Figure 1-2: Site Plan, IWHC, Queens Road, Manchester

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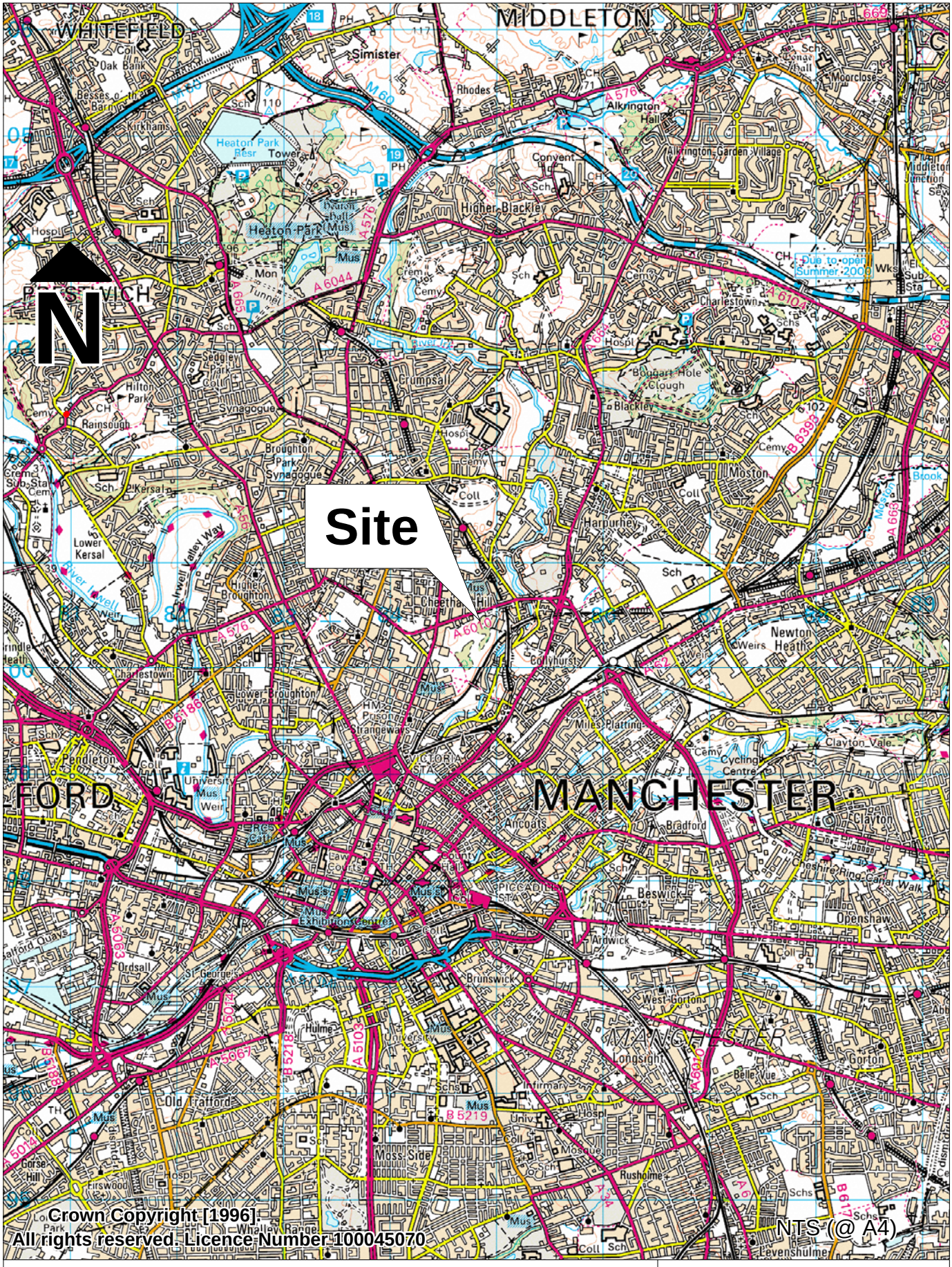

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NTS (@ A4)

Figure 1-1: Location Plan, IWHC, Queens Road, Manchester.

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NTS (@ A4)

Figure 1-3: Proposed Development Plan, IWHC, Queens Street, Manchester

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3 PREVIOUS WORK

3.1 *Summary of Existing Information*

A Phase I Desk Study and Preliminary Risk Assessment report has previously been undertaken by LKA (ref. CL1294-01, dated 14th March 2008).

The report comprised a review of factual information sources such as site history via historical mapping, geology, hydrogeology and a landfill and Coal Authority search. A conceptual model was also provided.

A summary of the available information is provided below along with an adaptation of the preliminary conceptual model.

3.2 *Site History*

The study site remained vacant until the 1891 mapping edition when two brick works encroached onto the site, with associated clay pits, cuttings and ponds. The Brick Works were no longer identified after the 1949 / 1950 mapping edition, and all the clay pits, cuttings and ponds were no longer identified after the 1951 / 1977 mapping edition. The Envirocheck Report states that the site was a tip between 1955 and 1970 and was licensed to accept wastes such as Inert, Industrial, Commercial, Household, Special (may be flammable, irritant, toxic, harmful, carcinogenic or corrosive) and Liquid sludge (Industrial wastewater, sewage sludge and chemical wastes mixed with municipal solid waste).

A garage was identified occupying the northern-most part of the study site from the 1951 / 1977 mapping edition and was also present on the 2007 mapping edition. It was not however observed the recent site reconnaissance but remnant manhole covers were noted.

The immediate surrounding areas been mainly developed for mixed usage. Eleven potentially contaminative land-uses have been identified within 250m of the study site including six electricity sub stations, a garage, Dye, Bleach and Chemical Works, a Railway, a Tramway, Brick Works, a Bus Depot, Refuse Heaps and a Metrolink Line. It is unlikely that contamination from these land-uses will have impacted on the study site.

3.3 *Site Geology, Hydrogeology and Hydrology*

BGS Sheet 85, Manchester (1:63,360) indicates that the drift geology beneath the site comprises Till, which is anticipated to mainly comprise clays interspersed with lenses of sands and gravels.

BGS Sheet 85, Manchester (1:50,000) indicates that the solid geology beneath the site is indicated to change from east to west as it becomes younger. The east and centre of the site is underlain by Carboniferous Westphalian C Coal Measures including the Worsley Delf Rock (sandstone unit). The west of the site is then underlain by the Permian aged Collyhurst Sandstone with Manchester Marls along the western edge of the site.

The Westphalian C Coal deposits comprise a mixture of shales, mudstones and sandstones. The Worsley Delf Rock is a sandstone bed. The Collyhurst Sandstone comprises soft red sandstone with abundant beds of ‘millet seed’ sand grains and the Manchester Marls comprise marl. A Fault is located between the Collyhurst Sandstone and the Manchester Marls beds in the western part of the study site. It has a downthrow to the west. Strata beneath the site are indicated to dip between 5˚ and 12˚ to the south-west.

The Environment Agency Groundwater Vulnerability Data Sheet 11, South Pennines (1:100,000 scale) shows the eastern and central part of the site to be underlain by a Minor Aquifer (variably permeable) represented by the Westphalian deposits. The western part of the site is underlain by a Major Aquifer (highly permeable) represented by the Sandstone Deposits. The western edge of the site is underlain by a non-Aquifer (negligible permeable) represented by the Marl deposits.

The nearest surface watercourse is the River Irk, which is located approximately 150m south-east of the study site and flows in a southerly direction. The Environment Agency have graded it River Quality E 269m south east from the study site in the year 2000.

3.4 *Landfill Sites*

A landfill search has been commissioned by LKA from the Local Authority. The full search is provided in Appendix C and is summarised below.

The Local Authority search, the Environment Agency records and the Envirocheck Report show the site is within the boundaries of two known/registered landfill sites. But for a strip of land next to the northern boundary, the whole of the site appears to be within the boundary of a historical land fill site, and only the eastern part of the site is within the boundary of a BGS Recorded Landfill Site.

- **Eastern part of the site.**

Landfill Name- H Evans Ltd
Licence Reference- N/A
No other information available

- **Whole of the site.**

Landfill Name- Queens Road Tip
Licence Holder- Manchester City Council
Location- Cheetham, Manchester, Manchester
Provider Reference- EAHLD16452
First Input Date- 31st December 1955
Last Input Date- 31st December 1970
WRC Ref- 4200/9728
BGS Ref- 848
Other Ref- F005,RD/LIC/241/82
Specified Waste- Inert, Industrial, Commercial, Household, Special (may be flammable, irritant, toxic, harmful, carcinogenic or corrosive) and Liquid sludge (Industrial wastewater, sewage sludge and chemical wastes mixed with municipal solid waste).
Additional Information- There is no evidence or no data currently available on Gas control measures or Leachate control measures.

This landfill was filled prior to the Control of Pollution Act 1974 and therefore, the exact nature of the fill material is not known.

The Envirocheck Report also identifies an additional three historical landfill sites within 500m of the site boundary.

A review of historical Ordnance Survey mapping by LKA has identified an additional 32 sites where landfill may be present being former ponds and reservoirs. The nearest of these was 10m south of the site boundary. The surrounding areas have also had significant cuttings, many of which are associated with the landfill sites which encroach onto the site.

3.5 *Coal Authority Search*

The Coal Authority search states that the site is within the likely zone of influence from workings in two seams of coal at 300m to 490m depth, and last worked in 1966. Any ground movement from these coal workings should by now have ceased. The site is not within the zone of likely influence of any present underground coal workings. There are no known coal mine entries on or within 20m of the study site boundary.

3.6 *Petroleum Officer Search*

A Petroleum Officer search was commissioned by LKA from the Greater Manchester Fire and Rescue Service. The results of this search indicate that three petrol tanks and one diesel tank and all associated pipe work and contaminated soil were removed off-site on the 16th April 1991.

3.7 *Site Reconnaissance*

A reconnaissance of the site was carried out at the time of the Phase I report. Key observations during the walkover included:

- The area of the former petrol station on the northern part of the site is currently vacant land. Manhole covers were noted in the north-eastern corner of this part of site and may be for underground tanks or interceptors used by the former petrol station.

- A car-parking area is located on the north-east of the study site. The ground cover across this part of the site was observed to be a concrete footing in the south-west, gravel in the south-east and tarmacadam in the north. There are two pairs of concrete strips in this area which may have been associated with the former Brick Works on this site.

- The main part of the study site was vacant land. A five metre high man-made bund runs near to the eastern boundary in this part of the site and leaves a thin strip of land with a gravel footpath adjacent to the eastern boundary. The ground cover across the main part of the study site is scrub grass, bramble bushes and semi –mature and mature trees. The site had much pooling water across it.

- Japanese Knotweed was identified on site, particularly in the northern and southerwestern parts of the study site.

3.8 *Previous Work*

A review of the data available pertaining to the proposed IWHC has previously been undertaken by Leyden Kirby Associates (February 2003). The review looked at 2 previous reports:

- The Irish World Heritage Centre – Geotechnical and Geoenvironmental Desk Study; Ove Arup & Partners, Consulting Engineers, September 2000; and
- Irish World Heritage Centre – Environmental Statement; Arup Environmental, March 2001.

The 2003 report comprised a review of factual and interpretive information including a review of the intrusive investigation undertaken across the whole of the former Queens Road Tip, associated laboratory testing, results and recommendations. A summary of the available information with respect to the study site only is provided below.

Previous site investigations within the study site area comprised a total of 12 boreholes and 35 trial pits. 15 samples were taken from these excavations and sent for chemical analyses.

Of the 12 boreholes excavated, 5 were converted to gas monitoring standpipes within the Made Ground and 2 were converted to gas piezometers which intercepted the Glacial Till sand layer at between 11 and 17m depth. 10 samples were taken from the boreholes and sent for chemical analysis.

The chemical results of the samples collected from the site showed high levels of contamination evenly distributed across the site. In particular, contaminants such as Arsenic, Lead, Nickel, Sulphate, PAHs, and TPHs were often found to exceed recommended Soil Guideline Values.

Limited numbers of gas monitoring visits were undertaken at the Queens Road site (maximum 4). Methane levels beneath the study site area ranged from 0% to 11.7% (BH31) and Carbon Dioxide levels ranged from 3.5% to 13.1% (BH31). Flow rates across the study site area were low to negligible.

3.9 *Potential Contaminants*

Potential contamination from the study site will be dependant upon the composition of the material used to infill the former clay pits, ponds and cuttings on site. Information from the previous site investigation work and the Envirocheck Report suggests that material is variable. Some of the material in is likely to be putrescible and is know to be generating carbon dioxide, methane and trace gases. Ash and clinker from hearths and boilers is also likely to be present (giving rise to contaminants such as heavy metals and Polycyclic Aromatic Hydrocarbons (PAHs) and asbestos).

In addition, the northern part of the site is likely to have been impacted by its previous use as a petrol filling station. As such, contaminants associated with petroleum hydrocarbons, Semi-volatile Organic Compounds (SVOCs) and Volatile Organic Compounds (VOCs) may be present.

The Environment Agency holds no evidence to suggest that the licensed landfill site had any Gas Control measures. Previous site investigation work has shown that hazardous landfill gases (carbon dioxide and methane) are present on the site.

3.10 *Potential Pathways*

Principal potential pathways associated with human health from soil contamination are ingestion, dermal and inhalation. The CLR10[1] document recognises ten such pathways comprising four ingestion, two dermal and four inhalation. These are listed as follows:

- Ingestion of soil
- Ingestion of soil-derived indoor dust
- Ingestion of contaminated vegetables
- Ingestion of soil attached to vegetables
- Dermal contact with soil
- Dermal contact with soil-derived indoor dust
- Inhalation of soil-derived outdoor dust
- Inhalation of soil-derived indoor dust
- Inhalation of vapours outside
- Inhalation of vapours inside

The proposed end-use for the Hotel and IWHC follows a standard conceptual model of a commercial/light industrial land use. The proposed end-use for the sports pitch and park follows non-standard conceptual models. ATRISK values for playing fields and parks have been used respectively in the assessment for these land uses. For each of these land-use scenarios eight of the pathways will need to be considered (Ingestion of contaminated vegetables and Ingestion of soil attached to vegetables are excluded).

[1] EA (2002). "Contaminated Land Exposure Assessment (CLEA) Model: Technical Basis and Algorithms." R&D Publication CLR10.

Surface water and groundwater are principal mechanisms for the migration of contaminants, with rainwater infiltrating through contaminated material and contamination possibly going into solution. Contaminated water may then find preferential pathways to surface waters and underlying aquifer. The Environment Agency holds no evidence of Leachate Control measures on the former licensed landfill on site

Culverts, ditches, drains may provide preferential pathways off site. Manhole covers were noted during the site reconnaissance.

The drift geology of Boulder Clay will likely impede any vertical migration of contaminants. The fault on the western part of the site may act as a pathway.

3.11 *Preliminary Contamination Conceptual Model*

The preliminary contamination conceptual model for the IWHC site is illustrated in Table 6-1 below and has identified seven potential pollutant linkages. Each linkage is discussed below along with an assessment of the likelihood of each linkage considering the available data and the nature of the development.

Pollutant Linkage No.	**Contaminant**					
	Asbestos	**Ground Gases**	**Inorganic Contaminants**	**Organic Contaminants**	**Pathway**	**Receptor**
1	?	x	?	?	- Dermal Contact. - Ingestion of soils. -Inhalation of contaminated soil and dust.	- Users of the playing field. -Future site workers. -Off-site receptor (windblown dust).
2	x	x	x	?	- Inhalation of vapours.	-Future site users. -Future site workers. -Off-site receptor (windblown dust).
3	x	?	x	x	- Ground and hazardous gas migration from infilled areas on and off site.	- Future site users. - Future site workers. - Off-site receptor
4	x	x	?	x	- Groundwater migration	- Major and Minor Aquifer. - River Irk.
5	x	?	?	x	- Contact with potential hazards	- Site Buildings
6	x	x	?	?	- Ingestion of tainted water supply. - Direct contact and inhalation of dust and vapours.	- Future site users. - Future pipe installers. - Maintenance workers.
7	x	x	?	x	- Root uptake of phytotoxic contaminants	- Flora in future landscaping.

Table 3-1 Contamination conceptual model for the IWHC site
(Key: ? – pollutant linkage possible; x – pollutant linkage unlikely)

Pollutant linkage 1 refers to the potential asbestos, heavy metals and organic contaminants coming into direct contact with future site residents, offsite receptors (windblown dust) and future site construction workers. This is considered possible in areas of proposed

landscaping and for future site users of the sports pitches and the entire site for construction workers who may come into contact with the soils.

Potential pollutant linkage 2 refers to possible inhalation of vapours affecting the future site residents and future site construction workers which need to operate in the northern part of the site from potential hydrocarbons. This linkage is considered possible given the unknown composition of any fill material and the former petrol station.

Potential pollutant linkage 3, refers to the likely hazardous and ground gas onsite (depending upon composition of the fill material) affecting the future site users and nearby areas off site. In addition, migration of hazardous gas to the site may be possible from infilled features within 250m of the site boundary.

Potential pollutant linkage 4 refers to the possible contaminants and the underlying Major and Minor Aquifers and nearby River Irk. This linkage is considered possible given the presence of made ground on the study site.

Potential pollutant linkage 5 refers to the possible deleterious effects that sulphate may have on building materials such as concrete, water pipes and building structures, as well as potential methane causing an explosion if allowed to build up in confined spaces within the proposed building..

Potential pollutant linkage 6 refers to the possible contaminants permeating potable water pipes and consumption by the future site users and workers of the tainted water supply. Given the presence of made ground on site and likely contaminants this linkage is also considered possible.

Potential pollutant linkage 7 refers to the possible phytotoxic contaminants affecting plant growth in future landscaped areas. Given the presence of made ground on site and likely contaminants (such as zinc and copper), this linkage is also considered possible.

4 GROUND INVESTIGATION

4.1 *Site Investigation Design and Methodology*

In order to investigate the potential pollutant linkages identified in the preliminary contamination conceptual model, an intrusive investigation was undertaken between the 2nd April and 12th April 2008.

The site investigation involved the drilling of ten window sample boreholes (referenced WS1 to WS10) to depths of between 5.0 and 6.0mbgl, six cable percussive boreholes (referenced CP1 and CP6) to depths of between 15.35 and 22.5mbgl, and the excavation of twenty-four trial pits (referenced TP1 to TP24) to depths of between 1.7 and 4.0mbgl.

All borehole locations are shown in Figure 4-1. All the borehole sample descriptions were carried out in accordance with BS5930[2] by suitably qualified and experienced members of staff. Borehole and trial pit logs for the site are presented in Appendix A.

4.2 *Sample Collection*

Soil samples of approximately 500g were recovered in amber jars and vials. All the samples were labelled and stored in cool boxes prior to being collected by courier for delivery to Chemtest Laboratories in Newmarket. Samples were tracked using appropriate Chain of Custody forms provided by Chemtest.

Forty-eight representative soil samples taken during the site investigation were selected for chemical contamination analysis. All samples were subjected to the following:

- Arsenic, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium, zinc, boron, cyanide, water soluble sulphate, pH, speciated banded TPH (TPH CWG), BTEX, MTBE, USEPA speciated polyaromatic hydrocarbons (PAHs), asbestos and Loss on Ignition.

The sample from TP23 was also analysed for VOCs and SVOCs.

LKA returned to site on 21st April 2008 and collected groundwater samples from WS2, WS5, CP1, CP4, CP5, CP6 and WS10. Sample collection was undertaken using a dedicated inertia lift Waterra sampling pump and the sample was collected in glass and plastic bottles and a glass vial. The boreholes were purged of all standing water and the sample collected from the recharged water.

Three soil samples from WS1, WS8 and TP24 were subjected to leachate tests as no groundwater was available within these wells to sample. Soils samples from WS6 and TP6 were also subjected to leachate testing due to their proximity to the proposed water feature on site. The water samples and leachate samples were tested for a similar suite of contaminants as the soil samples.

The majority of the tests are UKAS or MCERTS accredited and further details are given in the certificate of analyses presented in Appendix B. A summary of the analytical results is given in Section 6.

[2] British Standard (BS5930:1999). "Code of Practice for Site Investigations."

4.3 *Geotechnical Testing*

In-situ geotechnical tests were performed within each borehole to further characterise the sub-soil conditions. In total, sixty-one standard penetration tests (SPTs) were performed on the underlying sub-soils. Ten samples from CP1 (7.5m) CP1 (10.5m) CP1 (13.5m) CP2 (7.5m) CP2 (13.5m) CP2 (16.5m) CP3 (10.5m) CP3 (13.5m) CP4 (10.5m) CP4 (13.5m) have been tested for multistage triaxial tests, Atterberg Limits, moisture content, pH and sulphate by Ian Farmer Associates. A summary of the results are provided in Section 5.4 below.

4.4 *Gas Monitoring*

CP1-CP6, WS1–WS5, WS8 and WS9 were installed with gas monitoring wells. All were installed within the made ground material with the exception of CP4 and CP6 which were instrumented with response zones within the natural ground only.

The wells have been monitored on six occasions to date. The gas monitoring results are reproduced in full in Appendix C and are summarised in Section 6.

Monitoring was undertaken using a Geotechnical Instruments GA2000 plus in accordance with the monitoring protocol outlined in CIRIA C665.

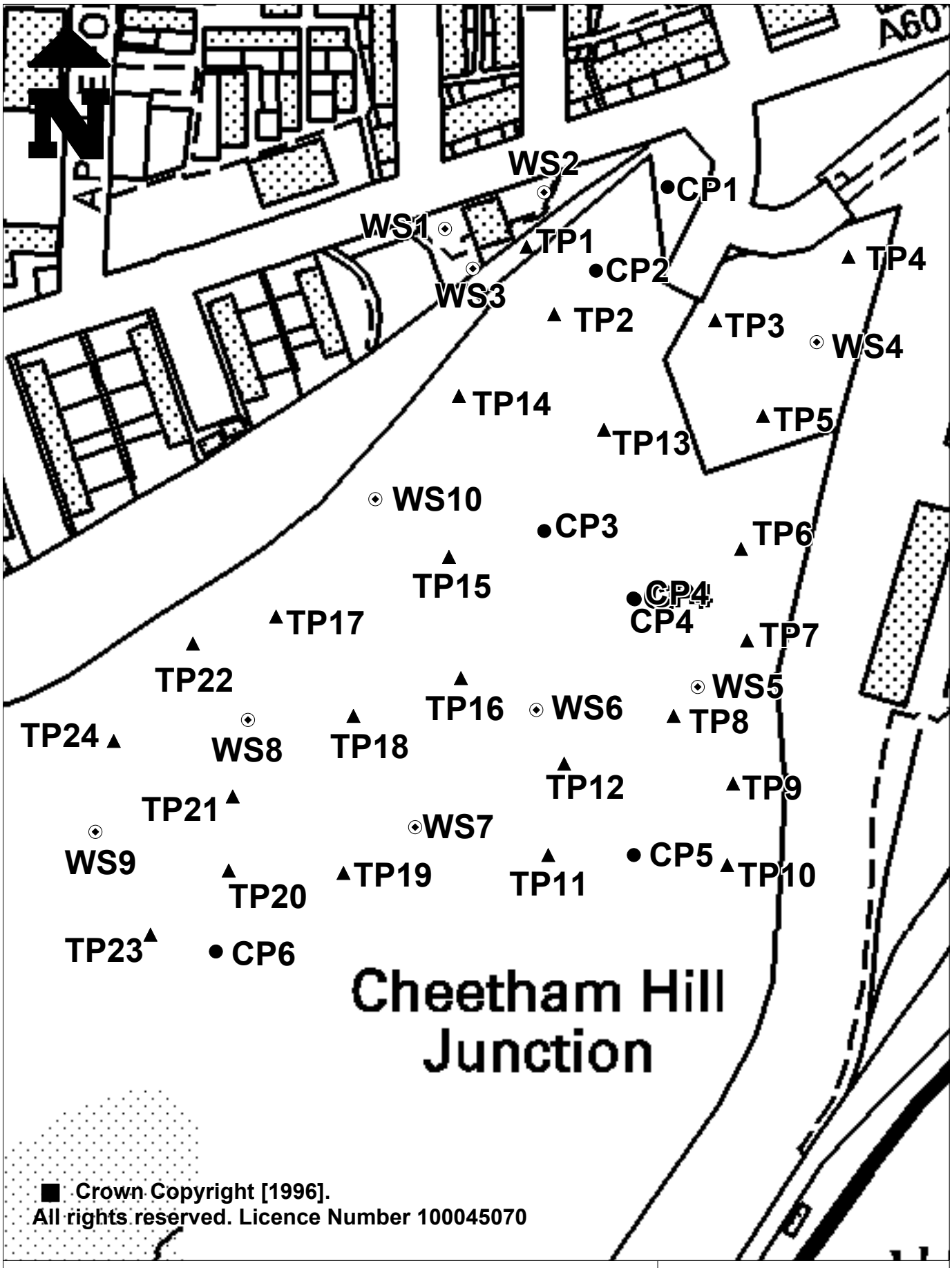

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Figure 4-1: Sampling Location Plan, IWHC, Queens Road, Manchester

Drawn: May 2008

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5 GROUND CONDITIONS

5.1 *Summary*

The general ground conditions beneath the IWHC site comprised of made ground underlain by clay/ sandy clay and/or sand.

5.2 *Made Ground*

Made ground was encountered in each of the sampling locations and was found to extend between 2.7 and 10.2 metres below ground level (mbgl).

The made ground across the site generally comprised sand or reworked clay with ash, clinker, bricks, gravel, cobbles, metal, glass, pottery and coal fragments.

Large quantities of putrescible material was not encountered however some cardboard, wood and paper was identified in some sampling locations.

Olfactory evidence of hydrocarbon contamination was encountered within the made ground in CP1, WS1 and WS3 in the area formally occupied by the petrol station, WS4 and TP5 in the north-eastern part of the site; and, WS6, WS7 and WS10.

The bund located on the eastern part of the site is predominantly made up of reworked clay with brick, glass, ash, pottery and cobbles.

5.3 *Natural Ground*

Natural ground was encountered in nine of the forty sampling locations.

The natural ground in WS2, WS8, CP1, CP2, CP3, CP4, CP5, CP6 comprised a soft becoming very stiff to hard clay/ sandy clay with inclusions of sand, rare fine gravel and coal fragments. This was underlain in CP5 by dense coarse sand.

The natural ground in TP4 comprised of clayey sand and visual and olfactory evidence of hydrocarbon contamination was present.

A weathered red/ brown sandstone was encountered within CP2 at 20.5m.

5.4 *Geotechnical Testing*

Sixty-one in situ standard penetration tests were undertaken. The results are summarised in Table 5-1 below and provided within the profile logs in Appendix A.

Depth	WS2	CP1	CP2	CP3	CP4	CP5	CP6
1.2m	-	37*	9*	14*	12*	16*	10*
2.0m	-	8*	-	9*	11*	6*	7*
3.0m	-	13*	12*	14*	21*	REF	6*
4.0m	12	8*	-	10*	REF	21*	7*
5.0m	15	12*	10*	16*	12*	12*	10*
6.0m	-	10*	17*	12*	11*	10*	6*
7.5m	-	-	-	-	-	10*	6*
9.0m	-	25	28	19	27	40	6*
10.5m	-	-	-	-	-	**REF**	-
12.0m	-	36	36	38	REF	-	REF
13.5	-	-	-	-	-	45	REF
15.0m	-	REF	REF	43	REF	REF	REF
18.0m	-	-	REF	-	-	-	-
19.5m	-	-	REF	-	-	-	-
21.0m	-	-	REF	-	-	-	-

Table 5-1: Summary of SPT (N) values recorded at IWHC. REF = Refusal. *denotes SPTs undertaken in made ground. Bold type denotes those SPTs undertaken in sand. The remainder of the SPTs were undertaken in natural clay.

All the SPTs undertaken in the natural clay characterise it as very stiff to hard. The SPT undertaken in the sand characterises it as very dense.

Ten samples from CP1 (7.5m), CP1 (10.5m), CP1 (13.5m), CP2 (7.5m), CP2 (13.5m), CP2 (16.5m), CP3 (10.5m), CP3 (13.5m), CP4 (10.5m) and CP4 (13.5m) have been tested for multistage triaxial tests, Atterberg Limits, moisture content and pH. A summary of the results are provided in the following table and the certificates of analysis are provided in Appendix B.

The results of the multistage triaxials show the glacial clay to be of variable consistency. The shallower clay encountered at around 7.5m appear to be soft in nature with measure undrained shear strength (Cu) values of 20 to 57kN/m^2. However, at depths of around 10mbgl the glacial clay becomes stiff to hard with Cu values of 114 to 182kN/m^2.

Borehole, Depth	Sample Description	Bulk Density (mg/m^3)	Dry Density (mg/m^3)	Shear Stress (kPa)	Plasticity Index (%)	Class
CP1, 7.5m	Soft dark brown sand clay with fine to medium gravel.	2.27	2.00	39 / 57 / 84	19	CL
CP1, 10.5m	Firm dark brown clay.	2.19	1.86	106 / 182 / 198	19	CI
CP1, 13.5m	Firm dark brown sandy clay with some gravel.	-	-	-	11	CL
CP2, 7.5m	Soft dark brown sandy clay with some gravel.	2.15	1.86	14 / 20 / 52	14	CL
CP2, 13.5m	Firm dark brown sandy clay.	2.28	2.03	105 / 159 / 183	18	CL
CP2, 16.5m	Dark brown friable sandy clay.	-	-	-	11	CL
CP3, 10.5m	Firm dark brown sandy clay.	2.37	2.06	93 / 114 / 148	20	CL / CI
CP3, 13.5m	Firm dark brown clay.	2.13	1.83	87 / 102 / 118	25	CI
CP4, 10.5m	Friable dark brown sandy clay with fine to medium gravel.	2.19	1.92	120 / 155 / 172	12	CL
CP4, 13.5m	Dark brown firm sandy clay with some gravel.	2.34	2.13	114 / 189 / 241	13	CL

Table 5-2: Summary of laboratory geotechnical results.

5.5 *Outline Foundation Considerations*

We are of the opinion that the Made Ground and any soft or disturbed upper zone of the Glacial Clay is unsuitable for the support of the proposed structure due to the risk of excessive or total and differential settlements developing.

It is recommended therefore that the following foundation designs are considered for the support of the proposed structures on the site, the final choice being dependent on cost and suitability criteria.

The first option is to support the proposed structures on gravel piles established into the stiff glacial clay deposits (at around 10mbgl). The placing of these gravel piles and the associated consolidation and stabilisation of the fill material can be carried out by vibro-flotation, vibro-compaction or other suitable techniques. Contractors who specialise in these techniques should be consulted on the cost and suitability of their particular method at the IWHC site.

The alternative option would be to consider the use of a piled foundation design which would also be supported on the stiff glacial clay deposits encountered at around 10mbgl. At this stage an End Bearing Driven pile would seem to be the most suitable foundation option. An appropriately qualified piling contractor should be contacted to provide more detailed advice on the type, nature and size of the pile to be adopted on the site.

Confirmation of these considerations and an assessment of the ground conditions with respect to the proposed building load should be sought from the appointed Structural Engineer.

6 GENERIC QUANTITATIVE RISK ASSESSMENT

6.1 *Introduction*

Current good practice requires that the findings from a site investigation be evaluated on a site specific basis, using a risk based approach. Risk assessment involves identification and evaluation of the hazards presented by the concentrations of contaminants measured, followed by an evaluation of the risks, which are associated with these hazards (CLR11[3]). Information gathered from the risk assessment has been collated in the revised contamination conceptual model in Section 2.9.

6.2 *Soil Risk Assessment*

For the purposes of the risk assessment the site has been divided into four discrete areas: the hotel area (Area A), the heritage centre (Area B), the heritage centre park (Area C) and the playing field (Area D) (Figure 6-1). This is due to the likely different receptor behaviour in each of these areas.

Soil Guideline Values (SGVs) have been used to risk assess the site. Unfortunately, however, there are only a select number of SGVs currently available and therefore, where there are no SGVs LQM[4] Generic Assessment Criteria (GAC) and Atkins ATRISK Values have been used as screening values. These have been generated using the current CLEA UK model and full justification for the derivation has been provided in their report. A summary of the GAC values is given in Appendix C. All justification for the derivation of the ATRISK Values is presented in their web page[5] and were generated using the RISC4 risk assessment package which was adjusted to include UK exposure parameters as outlined in the CLEA documentation.

Both the SGVs and GACs are dependent upon the land-use of the proposed development. The results of the investigation for Areas A and B have been compared with the commercial/ industrial SGVs and GACs. Area C has been assessed against the ATRISK values for parks and Area D has been assessed against ATRISK values for playing fields. There is no ATRISK value for lead so this has been assessed against the residential without plant uptake SGV as a conservative measure. Appropriate SGVs, GACs and ATRISK Values are indicated in the following tables. Only contaminants that were elevated have been shown in the tables.

LKA consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P), dibenzo(a,h)anthracene (D(a,h)A) and naphthalene. This is due to B(a)P and D(a,h)A possibly being a carcinogen and most toxic of the PAHs[6,7] and naphthalene the most volatile and soluble[8]. Therefore, these have been considered in the risk assessment for PAHs.

[3] Defra (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11
[4] LQM (2006). "Generic Assessment Criteria for Human Health Risk Assessment."
[5] WS Atkins (2008) "ATRisk Soil SSV Website". www.atrisksoil.co.uk
[6] EA (2002). "Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans. Benzo[a]pyrene." R&D Publication TOX2.
[7] USEPA (1984). "Health Effects Assessment of Polycyclic Aromatic Hydrocarbons (PAHs). EPA 540/1-86-013."
[8] EA (2003). "Review of the Fate and Transport of Selected Contaminants in the Soil Environment." Draft technical report P5-079/TR1

6.2.1 *Area A- Hotel*

	Contaminant	Units	No. of samples	Max. Result	No. Exceeded	Assessment Criteria	Source of Criteria
Metals	Lead	mg/kg	9	$2600_{(WS2)}$	2	750	CLEA SGV
PAHs	B(a)P	mg/kg	9	$420_{(WS1)}$	3	29.9	LQM GAC
	D(a,h)A	mg/kg	9	$48_{(WS1)}$	1	29.9	LQM GAC
General	pH	pH	9	Range: 7.3 to 8.5	Average: 7.8		
	LOI	%	9	Range: 2.4 to 28	Average: 11.9		

Table 6-1: Summary of analytical results, Area A, Queens Road.
Only results that exceeded SGV/GACs have been shown and results from all depths are noted. Assumed pH8 and a Soil Organic Matter (SOM) of 5% where those parameters are required.

Statistical tests were conducted on the sample data in accordance with guidance given in CLR7[9]. These tests comprise a Mean Value Test where the 95% percentile of the sample data is calculated (US_{95}) for comparison against the appropriate SGV or GAC and a Maximum Value Test which establishes if the sample data belongs to a normal distribution curve and allows identification of any statistical outliers in the dataset. Consideration of historical features and composition of the material will allow for a more accurate assessment of the distribution of contamination onsite. The statistical tests conducted on the samples are provided in Appendix D.

Following the completion of the statistical analysis, elevated levels of B(a)P have been identified across Area A.

One sample taken from CP1 at 7-7.5m was not included in the statistical analysis due to the sample depth and composition. No elevated levels of contaminants were encountered within this sample.

Therefore remedial measures are necessary in the landscaped areas and health and safety precautions are necessary for future construction workers, further details of which are provided in Section 6.

[9] Defra (2002). "Assessment of Risks to Human Health from Land Contamination: An Overview of the Development of Soil Guideline Values and related Research (CLR7)."

6.2.2 *Area B - Heritage Centre*

	Contaminant	Units	No. of samples	Max. Result	No. Exceeded	Assessment Criteria	Source of Criteria
Metals	Lead	mg/kg	12	$2000_{(TP4, 2.7m)}$	2	750	CLEA SGV
Metals							
Metals							
General	pH	pH	12	Range: 7.4 to 8.5	Average: 8.1		
General	LOI	%	12	Range: 2.6 to 16	Average: 6.8		
General							
General							

Table 6-2: Summary of analytical results, Area B, Queens Road.
Only results that exceeded SGV/GACs have been shown and results from all depths are noted. Assumed pH8 and a Soil Organic Matter (SOM) of 5% where those parameters are required.

The samples taken from TP4 (2.7m), TP4 (3.6m), TP6 (2.7-3.0m) and WS10 (4.5m) were not subjected to statistical analysis due to their depth and matrix.

The two elevated levels of lead were encountered in the samples from TP4 (2.7m) and WS10 (4.5m). These levels do not pose a risk to future site users due to their depth therefore no remedial measures are required. However, if there is any excavation in these areas health and safety considerations should be employed by the ground workers.

6.2.3 *Area C - Heritage Centre Park*

	Contaminant	Units	No. of samples	Max. Result	No. Exceeded	Assessment Criteria	Source of Criteria
Metals	Arsenic	mg/kg	13	$28_{(TP10)}$	2	26	ATRISK
Metals	Lead	mg/kg	13	$800_{(TP12)}$	5	450	CLEA SGV
Metals	Nickel	mg/kg	13	$290_{(CP4)}$	1	100	ATRISK
TPH	Aliphatic EC12 – EC16	mg/kg	13	$160_{(CP5, 3-3.45m)}$	1	38	ATRISK
TPH							
PAHs	B(a)P	mg/kg	13	$23_{(TP10)}$	11	1.18	ATRISK
PAHs	D(a,h)A	mg/kg	13	$4.7_{(TP10)}$	5	1.18	ATRISK
General	pH	pH	13	Range: 7.4 to 9.8	Average: 8.2		
General	LOI	%	13	Range: 1.1 to 16	Average: 7.3		
General							
General							

Table 6-3: Summary of analytical results, Area C, Queens Road.
Only results that exceeded SGV/GACs have been shown and results from all depths are noted. Assumed pH8 and a Soil Organic Matter (SOM) of 5% where those parameters are required.

Statistical analysis was conducted on the sample results and elevated levels of lead, B(a)P and D(a,h)A were identified across the site. A hotspot of nickel in CP4 was also identified from the statistical analysis. Therefore remedial measures will be required, further details of which are provided in Section 7.

The samples taken from TP9 (1.5-2.0m), CP5 (3-3.45m) and CP5 (10-10.5m) were not subjected to statistical analysis due to their depth and composition. Elevated levels of B(a)P were present in the samples from TP9 (1.5-2.0m) and an elevated level of petroleum

hydrocarbon fraction EC12-EC16 was identified in CP5 (3-3.45m). These do not pose a risk to future site users due to their depth however if there is any excavation in these areas health and safety considerations should be employed.

6.2.4 *Area D - Playing Field*

	Contaminant	Units	No. of samples	Max. Result	No. Exceeded	Assessment Criteria	Source of Criteria
Metals	Lead	mg/kg	14	$1400_{(TP24)}$	9	450	CLEA SGV
TPH	Aliphatic EC10 –EC12	mg/kg	14	$230_{(WS7)}$	1	86	ATRISK
	Aliphatic EC12-EC16	mg/kg	14	$820_{(WS7)}$	1	38	ATRISK
PAHs	B(a)P	mg/kg	14	$61_{(TP17))}$	11	4.56	ATRISK
	D(a,h)A	mg/kg	14	$9.4_{(TP17))}$	2	4.56	ATRISK
General	pH	pH	14	Range: 6.1 to 11.1	Average: 7.9		
	LOI	%	14	Range: 1.4 to 55	Average: 16.1		

Table 6-4: Summary of analytical results, Area C, Queens Road.
Only results that exceeded SGV/GACs have been shown and results from all depths are noted. Assumed pH8 and a Soil Organic Matter (SOM) of 5% where those parameters are required.

Following the statistical analysis elevated levels of lead and B(a)P were identified across the site. A hotspot of Aliphatic EC12-EC16 was identified in the sample from WS7. LKA understand that an artificial pitch is to be laid in this area which will mitigate the risk of direct contact with the underlying soils. However landscaped areas for spectators will surround the pitch and remedial measures will be required in these areas. Further details of which are provided in Section 7.

One sample (WS7, 4.8m) was not included in the statistical analysis due to its depth and composition. An elevated level of lead and a slightly elevated level of B(a)P were identified in this sample.

6.3 *Controlled Water Risk Assessment*

Seven groundwater samples and five solid samples for leachate analysis were undertaken. The results of the analysis were compared to Environment Agency Values for UK Drinking Water Standards (UKDWS), WHO health values and Environmental Quality Standards (EQS).

Contaminant		Units	No. of samples	Max. Result	No. Exceeded	Assessment Criteria	Source of Criteria
Metals	Arsenic	µg/l	12	$30_{(WS1)}$	1	10	UKDWS
	Lead	µg/l	12	$67_{(WS1)}$	3	25	UKDWS
Inorganics	Ammonium	mg/l	7	$20_{(CP6)}$	6	0.5	UKDWS
	Sulfate	mg/l	12	$2100_{(CP6)}$	6	250	UKDWS
TPH	Total TPH	µg/l	12	$2400_{(WS1)}$	3	10	UKDWS
PAHs	PAHs	µg/l	12	$637.5_{(WS1)}$	1	0.1	UKDWS

Table 6-5: Summary of analytical results, Queens Road.

The heavy metal, petroleum hydrocarbon and PAH contamination was encountered in the groundwater and leachate samples taken from the made ground. The highest contamination was encountered in WS1, in the area of the former petrol station, which was a leachate sample.

LKA understand from discussions with the EA that leaching tests for organics may be unrepresentative of true site conditions due to the use of deionised water to leach the soil samples which is aggressive and allows rapid dissolution of contaminants. This in turn may overestimate the risk to controlled waters. This area surrounding WS1 will be occupied by the hotel and therefore hardstood, preventing infiltration of water and subsequent mobilisation of contaminants.

In addition, the underlying Till will provide a layer of protection to the underlying Major Aquifer and contamination migrating to the River Irk which is located 150m southeast. In addition the results were assessed against the UK DWS values which are sensitive guideline values and are applicable should the water be used for potable supply. The nearest groundwater abstraction is 180m southeast and is used for commercial processes. Therefore, using the DWS values is considered conservative. The risk of contamination of the controlled waters from the contaminants encountered within the made ground is therefore considered to be low.

However, the highest levels of ammonium and sulphate were encountered in groundwater samples taken from the natural ground in the southern part of the site. There is not indication of there contaminants to be present within the perched water in the made ground deposits within the study site. The extent of the former landfill extends beyond the southern site boundary and the deepest areas of infilling are present in this area. It is therefore considered that the contamination of the perched groundwater (within the drift deposits) is likely to be occurring from the adjacent site and that the study site is unlikely to be the

source. As such any remedial works undertaken on the study site are unlikely to improve the general groundwater quality due to recontamination from the adjacent site.

Again – as for the perched groundwater within the made ground, the controlled water receptors (the major aquifer and the River Irk) are not considered to be at risk from these contaminants beneath the site due to till deposits encountered, as there are no potable water abstractions within influencing distance of the study site, and due to the distance of the River Irk from the study site.

6.4 *Hazardous Gas Risk Assessment*

Boreholes WS1 to WS5, WS8 to WS10 and CP1 to CP6 drilled on site were installed with gas monitoring wells. Six return gas monitoring visits to the site have been undertaken. The results of the visits are provided in Appendix E and a summary is presented in Table 6-4 below.

BH Ref	CH_4 max	CO_2 max	O_2 min	Flow (l/h) max	GSV* CH_4	GSV* CO_2
WS1	-	-	-	-	-	-
WS2	0	4.4	13.5	0	0	0.0044
WS3	0	2.5	16.5	0.1	0	0.0025
WS4	0.4	7.1	0.2	0.2	0.0008	0.0142
WS5	0	3.3	15.2	0	0	0.0033
WS8	15.5	15.8	0.4	0.1	0.0155	0.0158
WS9	4.9	8.8	7.6	0	0.0049	0.0088
WS10	0	4.9	6.8	0.2	0	0.0098
CP1	0.4	7.2	0.8	0	0.0004	0.0072
CP2	2	9.3	0.3	0.1	0.002	0.0093
CP3	2.2	4.7	1.3	0.1	0.0022	0.0047
CP4	0	3.2	13.7	0.2	0	0.0064
CP5	4.2	3.2	0.1	0.1	0.0042	0.0032
CP6	16.6	13.2	0.4	1.3	0.2158	0.1716

Table 6-6. Summary of Gas Monitoring Results. All values in %v/v unless otherwise stated

*GSV (litres of gas/hour) is calculated by multiplying the maximum gas concentration (%) by the maximum measured borehole flow rate (l/h). If no flow rate is detected the analyser's detection limit of 0.1l/h is used within the GSV calculation.

Methane was detected and concentrations peaked at 16.6%v/v (CP6). Carbon dioxide concentrations were detected and peaked at 15.8%v/v (WS8). The minimum oxygen concentration detected was 0.1%v/v (CP5). A maximum flow rate of 1.3 l/h was detected in CP6.

In accordance with CIRIA C665[10], a GSV may be calculated from the maximum values encountered across the whole survey as a conservative measure. For Queens Road this maximum GSV for methane is 0.2158 l/hr and for carbon dioxide is 0.1716 l/hr which places the site within Characteristic Situation 2 where protection measures are required within new buildings. No gas protection measures will be required within areas of landscaping and car parking. Further details are provided in Section 6.

[10] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665

6.5 *Additional Risk Assessment*

The concentrations of soluble sulphate in the soil when contrasted to BRE Digest 2005 categorise the concrete requirement as DS-2 AC-2 for the Heritage Centre (Area B). No special precautions are required for the Hotel (Area A)

Across the whole site the concentrations of arsenic, copper, lead, mercury, PAHs and petroleum hydrocarbons are above the action concentrations and concentrations of nickel and zinc are above the trigger concentrations as outlined in the United Utilities[11] Pipeline Risk Assessment document. United Utilities should be consulted as to whether protective water pipes and/or sterile trenches are required should the pipes be installed in the made ground.

The concentrations of copper and zinc present are considered to be phytotoxic as outlined in document ICRCL 59/83[12]. Although this document has been withdrawn by DEFRA as a basis for human health risk assessments, it still provides a useful tool in assessing the risk to areas of soft landscaping. Therefore remedial measures will be required for any areas of soft landscaping.

6.6 *Revised Conceptual Model*

A revised conceptual model may be undertaken for the site using all available data. A revised conceptual model is presented for each area in the following tables. Only pollutant linkages that possibly still exist and were determined from the site investigation are shown. A description of the likelihood for the pollutant linkage to exist is summarised below.

6.6.1 *Area A – Hotel*

Pollutant Linkage No.	Hazards			Pathway	Receptor
	Landfill Gas	Inorganic Contaminants	Organic Compounds		
1	x	X	✓	Dermal Contact, ingestion and inhalation of contaminated soil and dust.	Future site residents , future site workers
3	✓	X	x	Ground and hazardous gas migration from infilled areas on and off site.	Future site users. Future site workers. Off-site receptor
5	✓	x	x	Contact with sulphates are methane	Site Buildings
6	X	✓	✓	Permeation of potable water supply.	Future site users.
7	X	✓	x	Uptake of phytotoxic contaminants	Future landscaping

Table 5-5: Revised Contamination Conceptual Model for Queens Road.
Key: ✓ – pollutant linkage identified; x – pollutant linkage unlikely

Pollutant linkage 1 has been identified for arsenic, B(a)P and D(a,h)A. Remedial measures will therefore be required in areas of soft landscaping to mitigate the risk associated with

[11] United Utilities (2005)

[12] ICRCL 59/83 (1987). "Guidance on the assessment and redevelopment of contaminated land". 2nd edition

these hazards. Health and safety precautions should be implemented by all construction workers.

Pollutant linkage 3 has been identified and will require protection measures. These are outlined in Section 7.

Pollutant linkage 5 has been identified with respect to methane coming into contact with the site buildings. The protection measures used to mitigate Pollutant linkage 3 will also mitigate this pollutant linkage.

Pollutant linkage 6 relates to the potential for contaminants on site to permeate potable water supply pipes and for contaminants to affect those installing the pipes. Levels of heavy metals, PAHs and petroleum hydrocarbons are above the pipe line assessment criteria set by United Utilities. Therefore consultation with United Utilities is required.

Pollutant linkage 7 refers to the phytotoxic contaminants affecting plant growth. Elevated levels of copper and zinc have been detected and remedial measures will be necessary in areas of soft landscaping.

Further details of the outline remedial proposals are given in Section 7.

6.6.2 *Area B - Heritage Centre*

Pollutant Linkage No.	Hazards			Pathway	Receptor
	Landfill Gas	Inorganic Contaminants	Organic Compounds		
3	✓	x	x	Ground and hazardous gas migration from infilled areas on and off site.	Future site users. Future site workers. Off-site receptor
5	✓	✓	x	Contact with potential hazards	Site Buildings
6	x	✓	✓	Permeation of potable water supply.	Future site users.
7	x	✓	x	Uptake of phytotoxic contaminants	Future landscaping

Table 5-6: Revised Contamination Conceptual Model for Queens Road.
Key: ✓ – pollutant linkage identified; x – pollutant linkage unlikely

Pollutant linkage 3 and 5 (with respect to methane) have been identified and protection measures will be required for any new buildings. These are outlined in Section 7.

Pollutant linkage 5 has also been identified for sulphate and concrete type DS-2 AC-2 is required.

Pollutant linkage 6 relates to the potential for contaminants on site to permeate potable water supply pipes and for contaminants to affect those installing the pipes. Levels of heavy metals, PAHs and petroleum hydrocarbons are above the pipe line assessment criteria set by United Utilities. Therefore consultation with United Utilities is required.

Pollutant linkage 7 refers to the phytotoxic contaminants affecting plant growth. Elevated levels of copper and zinc have been detected and remedial measures will be necessary in areas of soft landscaping.

Further details of the outline remedial proposals are given in Section 6.

6.6.3 *Area C - Heritage Centre Park*

Pollutant Linkage No.	Hazards			Pathway	Receptor
	Landfill Gas	Inorganic Contaminants	Organic Compounds		
1	x	✓	✓	Dermal Contact, ingestion and inhalation of contaminated soil and dust.	Future site users, future site workers
7	x	✓	x	Uptake of phytotoxic contaminants	Future landscaping

Table 5-7: Revised Contamination Conceptual Model for Queens Road.
Key: ✓ – pollutant linkage identified; x – pollutant linkage unlikely

Pollutant linkage 1 has been identified for lead, B(a)P, D(a,h)A and a hotspot of nickel. Remedial measures will therefore be required in areas of soft landscaping to mitigate the risk associated with these hazards. Health and safety precautions should be implemented by all workers.

Pollutant linkage 7 refers to the phytotoxic contaminants affecting plant growth. Elevated levels of copper, nickel and zinc have been detected and remedial measures will be necessary in areas of landscaping.

Further details of the outline remedial proposals are given in Section 6.

6.6.4 *Area D - Playing Field*

Pollutant Linkage No.	Hazards			Pathway	Receptor
	Landfill Gas	Inorganic Contaminants	Organic Compounds		
1	x	✓	✓	Dermal Contact, ingestion and inhalation of contaminated soil and dust.	Future site residents , future site workers
3	✓	x	x	Ground and hazardous gas migration from infilled areas on and off site.	Future site users. Future site workers. Off-site receptor
7	x	✓	x	Uptake of phytotoxic contaminants	Future landscaping

Table 5-8: Revised Contamination Conceptual Model for Queens Road.
Key: ✓ – pollutant linkage identified; x – pollutant linkage unlikely

Pollutant linkage 1 has been identified for lead, petroleum hydrocarbons, B(a)P and D(a,h)A. Remedial measures will therefore be required in areas of soft landscaping to mitigate the risk associated with these hazards. Health and safety precautions should be implemented by ground workers.

Pollutant linkage 3 has been identified which requires protection measures should a fitness centre be constructed in this area. These are outlined in Section 7.

Pollutant linkage 7 refers to the phytotoxic contaminants affecting plant growth. Elevated levels of copper and zinc have been detected and remedial measures will be necessary in any areas of soft landscaping.

Further details of the outline remedial proposals are given in Section 6.

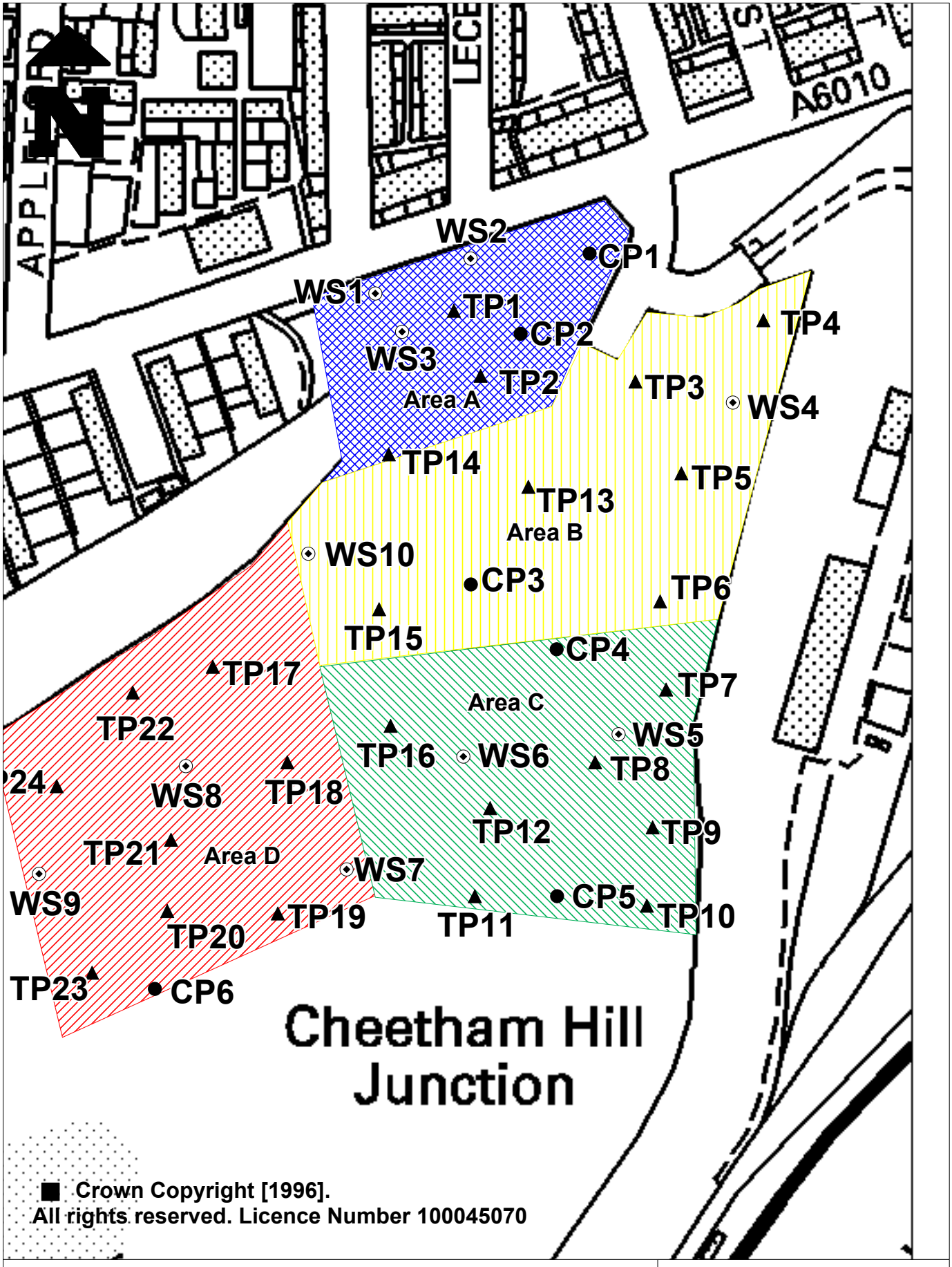

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Figure 6-1: Site Zoning Plan, IWHC, Queens Road, Manchester

Drawn: May 2008

LK ASSOCIATES LIMITED

7 CONCLUSIONS AND RECOMMENDATIONS

The site investigation has identified four pollutant linkages which are considered complete and require remediation or precautionary construction practices.

Based on the available data, LKA consider the site may be safely developed with recourse to standard remedial measures and precautionary construction practices.

Outline remedial recommendations and precautions are discussed below.

7.1 *Soil Contamination (Pollutant Linkages 1 and 7)*

7.1.1 *Site users / residents*

Pollutant linkage 1 has been identified for B(a)P and D(a,h)A in Area A, Area C and Area D; for lead in Area C and Area D; for arsenic in Area A; for nickel in Area C and for TPH in Area D. This contamination will need to be addressed to satisfy contaminated land planning conditions.

In addition, phytotoxic contamination was identified across all areas of the site.

In order to mitigate this risk to human health and the phytotoxic risk, LKA recommend the implementation of a clean cover system in soft landscaped areas to mitigate the risk associated with the identified on-site contamination. The capping layer should be 300mm thick comprising 100mm physical and capillary break layer (for example MOT type 1 and/or geotextile) at the base of the cover overlain by a minimum 200mm of chemically suitable soil (300m of soil if geotextile is used). Photographic evidence of the depth of the cover system should be taken.

Depending on proposed site levels the capping layer may be placed directly on existing soils or may be accommodated by excavation and removal off-site of an appropriate depth of soil.

The capping layer thickness and a rate of validation sampling for imported topsoil (typically 1 sample per 50m^3 of soil) is the general requirement of Manchester City Council.

7.1.2 *Construction / landscaping workers*

Across the whole site appropriate health and safety considerations should be adopted during site works to prevent direct contact of contamination to site workers. These should include as a minimum:

- ensuring wind blow is minimised by dampening down exposed surfaces;
- ensuring all vehicles leaving the site are clean and if necessary have used a wheel wash;
- limiting unauthorised access to the site to prevent exposure to contaminated materials; and,
- the provision and use of washing facilities for site staff, requirement for high standards of personal hygiene to be adopted by all site staff, particularly before and during meals.

7.2 *Hazardous Gas (Pollutant Linkage 3 and Pollutant linkage 5 with respect to methane)*

The results of the gas monitoring to date places the site within Characteristic Situation 2 which requires the following protection measures:

- Ventilation of confined spaces within the building.
- Well-constructed floor slab.
- Sub floor void vented to the atmosphere.
- Low permeable membrane such as 2000g, fitted by a professional contactor and validated by a third party.
- Minimum penetration of ground slab by services, with sufficient lapped and taped joints.

The installation of the gas membrane should be undertaken by a suitably competent contractor and quality assurance and control information should be collected. For example photographic evidence of ground joints, welds and service entry seals.

LKA would advise that the foundation design follow BRE 414[13] and drawings are provided to the Local Authority for approval. In addition, specifications of the proprietary gas membrane should be sent to the Local Authority for their approval.

7.3 *Site Buildings (Pollutant Linkage 5)*

The concentrations of soluble sulphate in the soil when contrasted to BRE Digest 2005 categorise the concrete requirement as DS-2 AC-2 for the Heritage Centre (Area B), no special precautions are required for the Hotel (Area A).

7.4 *Potable Water Supply (Pollutant Linkage 6)*

Potential risk to potable water supplies has been identified and LKA would advise consulting with United Utilities about suitable protection for water supplies. If pipes are to be installed in the made ground then all pipework should be protectaline or cast iron and installed in sterile trenches.

7.5 *Remediation Verification & Site Completion Report*

It is strongly recommended that any remediation carried out on the site is validated by a third party and suitable documentary evidence provided in a Site Completion Report, such as photographs, consignment documents and soil depth measurements. This should include as a minimum:

- Verification of all imported soil for soft landscaping. The sampling suite and regime should follow local authority guidance. A typical sampling regime would be 1 per $50m^3$ (or a minimum of 3 samples). Typical composite samples would be tested for metals, speciated PAHs, petroleum hydrocarbons and asbestos.

- Consultation with United Utilities and information on the installation of protective pipes and/or sterile trenches.

The Site Completion Report will assist the local authority in the discharge of any future relevant planning condition.

[13] BRE (2001). "Protective Measures for Housing on Gas-Contaminated Land." BRE 414.

This report should be sent to Manchester City Council and the Environment Agency for their comments prior to works commencing on site.

8 FURTHER CONSIDERATIONS

8.1 *The Bund*

It is understood that the bund present on the eastern part of the site will need to be excavated in order to accommodate the proposed development. LKA understands that this material may also be required for levelling the site along its southern boundary. Permissions and advice should be sought from the Environment Agency prior to any groundworks of this nature commencing on-site.

8.2 *The Water Feature*

A water feature is proposed adjacent to the heritage centre building. LKA understand that the pond will be fully lined. LKA recommend that health and safety considerations are employed while the area is excavated to accommodate the pond.

8.3 *The Interceptor Tanks*

Interceptor tanks associated with the former petrol station on the northern part of the site will need to be removed prior to construction of the hotel. Any impacted material associated with the interceptor tank should be removed off-site and validation sampling should be undertaken to ensure that all contamination has been removed.

8.4 *Japanese Knotweed*

Japanese Knotweed has been identified on the study site, particularly on the northern and south-eastern areas. LKA have undertaken a survey of the site to identify the location of the Japanese Knotweed. This is provided in Appendix F.

Japanese Knotweed can present a risk to future site buildings. The Environment Agency has stressed the importance of preventing the further spread of Japanese Knotweed and insists that these areas be treated properly in accordance with statutory requirements.

Under Schedule 9 of the Wildlife and Countryside Act (WCA) 1981, it is an offence to spread Japanese Knotweed. In addition, the Environment Act (EPA) 1990 states that any material contaminated with Japanese Knotweed must be classified as controlled waste, to which the duty of care applies. In other words, an offence under the WCA could face criminal prosecution and an infringement of the EPA could result in enforcement action being taken by the Environment Agency, which subsequently could lead to an unlimited fine.

It is recommended that this Japanese Knotweed should be treated or removed off site prior to works commencing.

APPENDIX A

BOREHOLE AND TRIAL PIT LOGS

LK ASSOCIATES LTD

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Site	Trial Pit Number
Irish World Heritage Centre	TP1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.60)	MADE GROUND. Light brown very clayey sandy topsoil with occasional brick fragments, some coal and rare wood.		
0.60-0.80	V				0.60			
0.60-0.80	T				(0.20)	MADE GROUND. Light grey fine to coarse sand with much ash and clinker and some brick and coal fragments.		
0.60-0.80	J				0.80			
					(0.20)	MADE GROUND. Light brown coarse sand.		
1.00-1.00	V				1.00			
1.00-1.00	T					MADE GROUND. Dark grey coarse sand and fine to coarse gravel, many cobbles and large pieces of clinker, occasional brick, rare tarmacadam, glass and pottery.		
1.00-1.00	J				(2.00)			
					3.00	Complete at 3.00m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	CL1294.TP1

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Site	Trial Pit Number
Irish World Heritage Centre	TP3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	MADE GROUND. Light brown very clayey coarse sandy topsoil with many rootlets and fine to medium angular gravel.		
					0.30			
					(0.20)	MADE GROUND. Dark grey coarse sand and fine to coarse sub-angular gravel with many rootlets.		
					0.50			
0.50-1.00 0.50-1.00 0.50-1.00	V T J				(2.70)	MADE GROUND. Dark grey slightly clayey coarse becoming fine sand with much fine to coarse sub-angular gravel, many brick fragments and cobbles, many coal fragments, and some wood and glass.		
					3.20			
						Complete at 3.20m		

Plan

Remarks

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Site	Trial Pit Number
Irish World Heritage Centre	TP4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	MADE GROUND. Dark grey coarse sand with fine to coarse sub-angular gravel with many rootlets.		
0.40-0.50 0.40-1.50 0.40-1.50	V T J				0.40 (1.10)	MADE GROUND. Light brown very clayey sand with many brick fragments, cobbles, coal fragments, masonry and some glass and pottery.		
1.50-2.70 1.50-2.70 1.50-2.70	V T J				1.50 (1.20)	MADE GROUND. Light brown slightly clayey fine sand with much ash and clinker, many brick fragments, coal fragments, cobbles, masonry and some glass and pottery.		
2.70-2.70 2.70-2.70 2.70-2.70 2.70-3.60 2.70-3.60 2.70-3.60	V T J V T J				2.70 (1.00)	Light brown clayey SAND with grey lenses. Visual and olfactory evidence of hydrocarbons between 2.7 and 3.6 m.		
3.60-3.60 3.60-3.60 3.60-3.60	V T J				3.70	Complete at 3.70m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP5

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20)	MADE GROUND. Concrete.		
0.10-1.00	J				0.20			
					(0.20)	MADE GROUND. Light brown and grey slightly clayey sand with much sub-angular medium to coarse gravel and cobbles.		
0.40-1.00	V				0.40			
0.40-1.00	T					MADE GROUND. Dark brown slightly clayey coarse sand with some light brown sandy clay inclusions, much medium to coarse sub-angular gravel and brick fragments, some large cobbles and rare fragments of pottery, coal, metal, plastic, wire, glass and wood.		
1.00-1.00	V					Brick cobbles @ 1m.		
1.00-1.00	T							
1.00-1.00	J					Black with slight olfactory evidence of hydrocarbons @ 1.5m.		
					(3.10)			
					3.50			
						Complete at 3.50m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP6

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.00 0.00-1.00 0.00-1.00	V T J				(2.00)	MADE GROUND. Light brown slightly clay sand with fine to medium rounded to sub-angular gravel, many clayey inclusions, much glass and brick fragments, some coal, wood and metal, and rare plastic material. A pink substance was observed.		
					2.00			
					(0.70)	MADE GROUND. Light brown fine sand with many clay inclusions.		
2.70-3.20 2.70-3.20 2.70-3.20	V T J				2.70			
					(0.50)	MADE GROUND. Dark grey clay with much glass, wood, plastic and brick.		
					3.20	Complete at 3.20m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP7

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	MADE GROUND. Brown clayey topsoil with many rootlets and much brick, glass and coal fragments.		
0.50-0.50 V 0.50-0.50 T 0.50-0.50 J					(1.60)	MADE GROUND. Dark grey coarse sand and fine to coarse angular gravel with some clay inclusions, many brick fragments, cobbles, ash, clinker and coal and rare pieces of tarmacadam, glass, wood, metal and masonry.		
			Water strike(1) at 1.80m.		1.80	Refusal on concrete @ 1.8m. Complete at 1.80m		▽1

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP8

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	MADE GROUND. Brown sandy clayey topsoil with much fine angular gravel and rootlets.		
					0.40			
0.80-0.80 0.80-0.80 0.80-0.80	V T J				(2.60)	MADE GROUND. Dark grey coarse sand and fine to coarse angular gravel with many brick cobbles and fragments, much masonry, metal, plastic and rare wood, glass, ash and clinker.		
					3.00	Complete at 3.00m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP9

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30) 0.30	MADE GROUND. Light brown slightly clayey sandy topsoil with fine to medium rounded to sub-angular gravel, many clay inclusions, much glass and brick fragments, some coal, wood and metal fragments and rare plastic material.		
					(0.60) 0.90	MADE GROUND. Light brown fine to coarse sand with some clay inclusions.		
0.90-1.00 0.90-1.00 0.90-1.00	V T J				(1.80) 2.70	MADE GROUND. Dark grey clay with much fine to medium rounded to angular gravel, fragments of brick and glass and some metal and pottery. Inclusions of coarse sand and fine to coarse sub-angular gravel with much ash and clinker between 1.5 and 2m.		
1.50-2.00 1.50-2.00 1.50-2.00	V T J							
						Complete at 2.70m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP10

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	MADE GROUND. Dark brown sandy topsoil with many rootlets.		
0.30-0.30 0.30-0.30 0.30-0.30	V T J				(1.30) 1.50	MADE GROUND. Dark brown clayey sand with much fine to coarse angular gravel, ash, clinker, coal, brick, wood and rare pottery fragments.		
					(1.40) 2.90	MADE GROUND. Dark grey clay with much fine to medium rounded to angular gravel, fragments of brick and glass and some metal and pottery.		
						Complete at 2.90m		

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Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP11

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.10 0.00-1.10 0.00-1.10	V T J				(1.10)	MADE GROUND. Light brown sandy clay with much medium to coarse rounded and angular gravel and some sand lenses, much wood and some brick.		
			Water strike(1) at 1.00m.			Many bricks @ 1.1m.		▽1
					1.10			
1.10-3.50 1.10-3.50 1.10-3.50	V T J				(2.40)	MADE GROUND. Dark grey very clayey sand and fine to coarse rounded to angular gravel with many fragments of brick, coal, ash and clinker and rare pieces of metal and pottery.		
						much wood @ 3m.		
					3.50	Complete at 3.50m		

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Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	CL1294.TP11

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Site	Trial Pit Number
Irish World Heritage Centre	TP12

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294

Location	Dates	Engineer	Sheet
	03/04/2008		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.80)	MADE GROUND. Brown clayey sand with much fine to medium rounded to angular gravel, many rootlets, fragments of brick, coal, ash and clinker.		
0.80-1.00 0.80-1.00 0.80-1.00	V T J				0.80 (0.70)	MADE GROUND. Dark grey clayey sand and fine to coarse rounded to angular gravel with many fragments of brick, coal, ash and clinker and rare pieces of metal and pottery.		
1.50-3.50 1.50-3.50 1.50-3.50	V T J				1.50 (2.00)	MADE GROUND. Black fine clayey sand with some fine to coarse sub-rounded gravel, much coal and some ash, clinker, cardboard and wood.		
					3.50	Complete at 3.50m		

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Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP13

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.50 0.00-1.50 0.00-1.50	V T J				(2.50)	MADE GROUND. Brown sandy clay with much fine sub-angular gravel, fragments of brick, coal, ash and clinker and some wood and metal. Becoming darker from 1.5m.		
					2.50 (0.50) 3.00	MADE GROUND. Light grey coarse sand and coarse angular gravel with much brick, coal, ash and clinker, some wood and metal.		
						Complete at 3.00m		

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Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP14

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30 0.00-0.30 0.00-0.30	V T J				(0.30) 0.30	MADE GROUND. Brown clayey topsoil with frequent fragments of coal, brick and pottery.		
0.30-1.70 0.30-1.70 0.30-1.70	V T J				(1.40) 1.70	MADE GROUND. Brown clayey coarse sand and medium to coarse sub-rounded gravel with much brick, some ash, clinker and rare wood. Many bricks and refusal @ 1.7m. Complete at 1.70m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP15

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.00 0.00-1.00 0.00-1.00	V T J				(1.00) 1.00	MADE GROUND. Brown clayey topsoil with frequent fragments of coal, brick and pottery.		
					(2.00) 3.00	MADE GROUND. Black fine clayey sand with some fine to coarse sub-rounded gravel, much coal and some ash, clinker, cardboard and wood. Much pottery @ 2.8m.		
						Complete at 3.00m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Excavation Method Volvo ECR 88	**Dimensions**	**Ground Level (mOD)**	**Client** Trustees of the Irish World Heritage Centre	**Job Number** CL1294
	Location	**Dates** 04/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.00 0.00-1.00 0.00-1.00	V T J				(1.00) 1.00	MADE GROUND. Brown clayey topsoil with frequent fragments of coal, brick and pottery.		
					(1.00) 2.00	MADE GROUND. Grey coarse sand and fine to medium sub-angular gravel with much ash, clinker and brick, and some inclusions of reworked clay and metal.		
					(1.50) 3.50	MADE GROUND. Grey very sandy clay with light brown coarse sand and medium to coarse rounded gravel, some glass, coal and brick.		
						Complete at 3.50m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP17

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 04/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	MADE GROUND. Brown clayey topsoil with frequent fragments of coal, brick and pottery.		
0.30-1.50 0.30-1.50 0.30-1.50	V T J				0.30 (1.20)	MADE GROUND. Dark brown clayey fine to coarse sand with frequent medium to coarse sub-rounded gravel, much coal and brick and rare pottery.		
					1.50 (1.50)	MADE GROUND. Orange coarse sand and fine to medium sub-angular gravel, much brick and frequent ash and clinker.		
3.00-3.30 3.00-3.30 3.00-3.30	V T J				3.00 (0.30)	MADE GROUND. Light brown clay with much ash, clinker, fine angular gravel, some fragments of brick and coal.		
					3.30	Complete at 3.30m		

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Remarks

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Site	Trial Pit Number
Irish World Heritage Centre	TP18

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 04/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.60 0.00-0.60 0.00-0.60	V T J				(0.60)	MADE GROUND. Brown very clayey sandy topsoil with frequent medium to coarse sub-rounded to sub-angular gravel, much brick and frequent fragments of coal, pottery and clay inclusions.		
					0.60			
0.60-1.00 0.60-1.00 0.60-1.00	V T J				(2.10)	MADE GROUND. Grey clayey coarse sand and fine to medium sub-angular gravel with much ash, clinker and brick, and some inclusions of reworked clay, glass, wood and metal.		
					2.70	MADE GROUND. Boulders of masonry and rubble.		
					(0.30)			
					3.00	Complete at 3.00m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
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Excavation Method Volvo ECR 88	**Dimensions**	**Ground Level (mOD)**	**Client** Trustees of the Irish World Heritage Centre	**Job Number** CL1294
	Location	**Dates** 04/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.00 0.00-1.00 0.00-1.00	V T J				(4.00) 4.00	MADE GROUND. Brown clayey coarse sand with much fine to coarse sub-angular to angular gravel, many bricks and cobbles, some ash and clinker and rare glass, wood, pottery, fabric and masonry. Much glass, metal, plastic, wood and organic material @ 1m. More coarse gravel, ash and clinker @ 2m. Much paper @ 3m.		

Plan

Remarks

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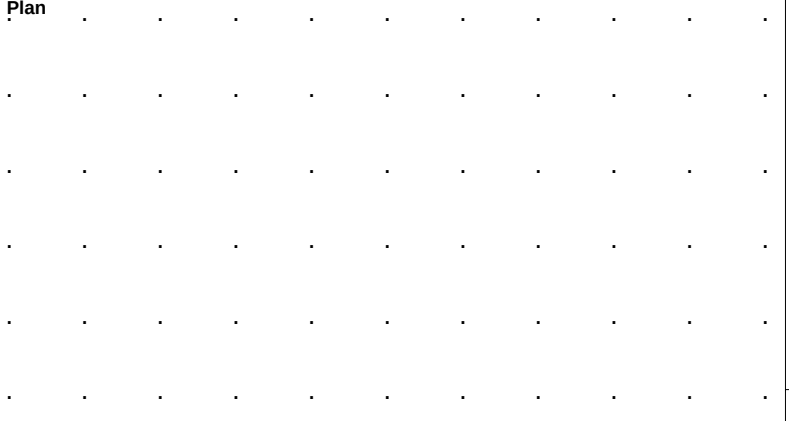
Site	Trial Pit Number
Irish World Heritage Centre	TP19

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.80 0.00-0.80 0.00-0.80	V T J				(0.80)	MADE GROUND. Dark brown very sandy clay with fine to coarse sub-rounded gravel, much brick and some coal, ash and clinker.		
					0.80	MADE GROUND. Black fine clayey sand with some fine to coarse sub-rounded gravel and dark brown silt inclusions, much coal and some ash, clinker, cardboard and wood.		
					(1.70)			
2.50-2.50 2.50-2.50 2.50-2.50	V T J				2.50	MADE GROUND. Light grey sand and gravel with much ash, clinker, wood, plastic, metal and glass.		
					(1.00)			
					3.50	Complete at 3.50m		

Plan



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Scale (approx)	Logged By	Figure No.
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Site	Trial Pit Number
Irish World Heritage Centre	TP2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.30	V				(1.30)	MADE GROUND. Brown sandy clay with much fine sub-angular gravel, many fragments of brick, coal, ash, clinker, wood and concrete and rare metal.		
0.00-1.30	T							
0.00-1.30	J							
					1.30			
					(1.20)	MADE GROUND. Dark grey dense clayey sand with much fine angular gravel, much brick and coal, and rare glass.		
					2.50			
					(0.10)	MADE GROUND. Brown and orange coarse sand and medium sub-angular gravel with much ash, clinker, metal and plastic.		
2.60-3.00	V				2.60			
2.60-3.00	T							
2.60-3.00	J				(0.40)	MADE GROUND. Light brown clay with frequent fine angular gravel, some fragments of brick, clinker and coal.		
					3.00			
						Complete at 3.00m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	CL1294.TP2

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Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com

Site	Trial Pit Number
Irish World Heritage Centre	TP20

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.60 0.00-0.60 0.00-0.60	V T J				(0.60)	MADE GROUND. Dark grey clayey sand and fine to coarse rounded to angular gravel with many fragments of brick, coal, ash and clinker and rare pieces of metal, pottery and wood.		
0.60-1.50 0.60-1.50 0.60-1.50	V T J				0.60 (0.90)	MADE GROUND. Dark grey slightly clayey fine to coarse sand and fine to coarse sub-angular gravel with some brick, coal, ash and clinker.		
1.50-1.60 1.50-1.60 1.50-1.60	V T J				1.50 (2.10)	MADE GROUND. Light grey slightly clayey fine to coarse sand and fine to coarse sub-angular gravel with many pieces of plastic, glass, metal, wood and pottery and some brick, coal, ash and clinker.		
					3.60	Complete at 3.60m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	CL1294.TP20

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Site	Trial Pit Number
Irish World Heritage Centre	TP22

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 04/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20)	MADE GROUND. Brown clayey topsoil with much brick and frequent fragments of coal and pottery.		
0.20-0.90	V				0.20	MADE GROUND. Light brown fine clayey sand with much medium to coarse sub-rounded gravel, ash, clinker, glass pottery and rare plastic and metal.		
0.20-0.90	T				(0.70)			
0.20-0.90	J				0.90	MADE GROUND. Orange coarse sand and fine to medium sub-angular gravel with much brick, ash and clinker.		
					(2.30)			
					3.20	MADE GROUND. Grey coarse sand and fine to medium sub-angular gravel with much ash, clinker and brick, and some inclusions of reworked clay.		
					(0.30)			
					3.50	Complete at 3.50m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	CL1294.TP22

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Bury Business Centre, Kay Street, Bury, BL9 6BU
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Site	Trial Pit Number
Irish World Heritage Centre	TP23

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 04/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.50 0.00-0.50	T J				(0.50)	MADE GROUND. Brown slightly clayey coarse sandy topsoil and medium to coarse sub-rounded gravel.		
0.50-1.00 0.50-1.00	T T				0.50 (0.50)	MADE GROUND. White and blue soft crumbly material, possibly chalk.		
					1.00 (1.70)	MADE GROUND. Dark turquoise hard material, possibly clinker.		
					2.70	Complete at 2.70m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	Cl1294.TP23

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Site	Trial Pit Number
Irish World Heritage Centre	TP24

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 04/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	V				(0.30)	MADE GROUND. Brown clayey topsil with much brick and frequent fragments of coal and pottery.		
0.00-0.30	T				0.30	MADE GROUND. Light brown fine sand and medium sub-rounded gravel, with much glass, pottery, plastic, ash and clinker.		
0.00-0.30	J				(3.20)			
					3.50	MADE GROUND. Grey coarse sand and fine to medium sub-angular gravel with much ash, clinker, brick, and some inclusions of reworked clay.		
					(0.50)			
					4.00			

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	CL1294.TP24

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP01

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 12.00m		L K Group	40323
	Location	**Dates** 03/04/2008-04/04/2008	**Engineer** L K Group	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.20	B1					(0.10) 0.10	Grass over MADE GROUND: Topsoil (driller's description).			
						(1.10)	MADE GROUND: Soft, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including brick, sandstone, mudstone and siltstone with rare ash and organic material.			
1.20-1.65 1.20-1.65	CPT N=37 B2	1.20	DRY	4,7/8,8,12,9		1.20	MADE GROUND: Loose, dark brown, sandy, angular to subangular, fine to coarse GRAVEL with pockets of clay and some ash. Gravel includes brick, concrete, limestone and sandstone.			
2.00-2.45 2.00-2.45	CPT N=8 B3	1.50	DRY	3,4/3,2,1,2		(2.80)				
3.00-3.45 3.00-3.45	CPT N=13 B4	3.00	DRY	1,2/5,3,2,3			Below 3.00m: medium dense.			
4.00-4.45 4.00-4.45	CPT N=8 B5	4.00	DRY	2,1/2,2,3,1		4.00	MADE GROUND: Very soft, brown/grey, sandy, gravelly CLAY. Gravel is angular to subangular, fine to coarse including brick, concrete and sandstone with some ash.			
						(1.00)			▼1	
5.00-5.45	B6			Water strike(1) at 5.00m, rose to 4.70m in 20 mins, sealed at 7.30m.		5.00	MADE GROUND: Medium dense, dark grey, clayey, sandy, subangular to angular, fine to coarse GRAVEL including brick, concrete and sandstone with some ash. Hydrocarbon odour noted.		▽1	
5.00-5.45	CPT N=12	4.50	4.70	1,1/2,4,3,3						
6.00-6.45 6.00-6.45	CPT N=10 B7	6.00	5.50	1,2/2,3,2,3		(1.90)				
7.00-7.50	B8					6.90	Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and siltstone.			
7.50-7.95	U9 0.45	7.50	DRY	60 blows						
8.00 8.00-8.50	D10 B11						Below 8.00m: stiff.			
9.00-9.45 9.00-9.45 9.00-9.45	SPT N=25 D13 B12	9.00	DRY	2,3/4,6,7,8						

Remarks
Excavating from 0.00m to 1.20m for 1.00 hour.

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH01

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP01

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 12.00m		L K Group	40323
	Location	**Dates** 03/04/2008-04/04/2008	**Engineer** L K Group	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.50	B14									
10.50-10.95	U15 0.45	10.50	DRY	90 blows						
11.00	D16						Below 11.00m: laminations of silt.			
11.00-11.50	B17									
12.00-12.45	SPT N=36	12.00	DRY	3,5/7,8,10,11			Below 12.00m: very stiff.			
12.00-12.45	B18									
12.00-12.45	D19					(8.10)				
13.00-13.50	B20									
13.50-13.95	U21 0.45	12.00	DRY	110 blows						
14.00	D22						Below 14.00m: no gravel. Thin bands of sand.			
14.00-14.50	B23									
15.00-15.45	SPT 50/295	12.00	DRY	4,6/8,11,14,17		15.00				
15.00-15.45	D24						Complete at 15.00m			

Remarks
Chiselling from 12.60m to 12.80m for 0.50 hours.

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH01

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP02

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 21.00m		L K Group	40323
	Location	**Dates** 02/04/2008-03/04/2008	**Engineer** L K Group	**Sheet** 1/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.20	B1					(1.80)	Grass over MADE GROUND: Loose, dark brown, clayey, gravelly, fine to coarse SAND with pockets of clay. Gravel is angular to subangular, fine to coarse including brick, concrete and limestone with some ash and wood.			
1.20-1.65 1.20-1.65	CPT N=9 B2	1.20	DRY	1,1/2,2,3,2		1.80				
2.00-2.45	U3 0.45	1.50	DRY	65 blows			MADE GROUND: Firm, locally soft, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and siltstone.			
2.50 2.50-3.00	D4 B5									
3.00-3.45 3.00-3.45	SPT N=12 D6	3.00	DRY	1,2/2,3,3,4		(2.40)				
3.50-4.00	B7									
4.00-4.45	U8 0.45	4.00	DRY	50 blows		4.20			▽1	
				slight seepage(1) at 4.20m.		(0.30)	MADE GROUND: Loose, dark brown, clayey, gravelly, fine to coarse SAND with pockets of clay. Gravel is angular to subangular, fine to coarse including brick, concrete and sandstone with some ash and wood.			
4.50 4.50-5.00	D9 B10					4.50				
5.00-5.45 5.00-5.45	SPT N=10 D11	4.50	DRY	1,1/2,2,3,3		(1.00)	MADE GROUND: Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse including brick, ceramics, sandstone, mudstone and siltstone with rare ash.		▼2	
5.50-6.00	B12			Water strike(2) at 5.50m, rose to 5.20m in 20 mins, sealed at 7.50m.		5.50			▽2	
6.00-6.45 6.00-6.45	SPT N=17 D13	6.00	5.50	1,2/7,4,3,3		(1.50)	Very soft, brown, sandy, gravelly CLAY with some ash and cobbles of brick. Gravel is angular to subangular, fine to coarse including brick and concrete.			
6.50-7.00	B14									
7.00-7.50	B15					7.00	Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and siltstone.			
7.50-7.95	U16 0.45	7.50	DRY	65 blows						
8.00 8.00-8.50	D17 B18						Below 8.00m: stiff.			
9.00-9.45 9.00-9.45 9.00-9.45	SPT N=28 B19 D20	9.00	DRY	2,4/5,6,8,9			Below 9.00m: lenses of silt.			

Remarks
Excavating from 0.00m to 1.20m for 1.00 hour.

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH02

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP02

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 21.00m		L K Group	40323
	Location	**Dates** 02/04/2008-03/04/2008	**Engineer** L K Group	**Sheet** 2/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.50-10.95	U21 0.45	10.50	DRY	95 blows						
11.00	D22									
11.00-11.50	B23									
12.00-12.45	SPT N=36	12.00	DRY	3,5/7,9,10,10			Below 12.00m: very stiff.			
12.00-12.45	B24									
12.00-12.45	D25									
13.00-13.50	B26						Below 13.00m: occasional thin bands of sand.			
13.50-13.95	U27 0.25	13.50	DRY	120 blows						
14.00	D28									
14.00-14.50	B29									
15.00-15.37	SPT 50/220	15.00	DRY	4,7/11,17,22		(13.50)				
15.00-15.45	B30									
15.00-15.45	D31									
16.00-16.50	B32						Below 16.00m: no gravel.			
16.50-16.95	U33 0.30	15.00	DRY	120 blows						
17.00	D34						Below 17.00m: thin laminations of silt.			
17.00-17.50	B35									
18.00-18.32	SPT 50/170	15.00	DRY	3,6/8,10,32			Below 18.00m: sandy.			
18.00-18.45	B36									
18.00-18.45	D37									
19.00-19.50	B38									
19.50-19.80	SPT 50/145	19.50	DRY	9,16/24,26						
19.50-19.80	D39									

Remarks

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH02

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP02

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 21.00m		L K Group	40323
	Location	**Dates** 02/04/2008-03/04/2008	**Engineer** L K Group	**Sheet** 3/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
20.00-20.50	B40					(13.50)				
						20.50	Highly weathered, red brown SANDSTONE, recovered as very stiff, sandy, slightly gravelly clay. Gravel is subangular to subrounded, fine to coarse of sandstone.			
21.00-21.29	SPT 50/140	21.00	DRY	8,15/23,27						
21.00-21.30	D43									
21.00-21.30	B41					(2.00)				
22.00-22.50	B44									
						22.50	Complete at 22.50m			

Remarks
Chiselling from 22.30m to 22.50m for 1.00 hour.

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH02

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP03

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 12.00m		L K Group	40323
	Location	**Dates** 07/04/2008	**Engineer** L K Group	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.20	B1					(1.65)	Grass over MADE GROUND: Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including brick, ash and concrete.			
1.20-1.65 1.20-1.65	CPT N=14 B2	1.20	DRY	1,2/2,4,3,5		1.65	MADE GROUND: Loose, dark brown, gravelly, fine to coarse SAND with occasional pockets of clay. Gravel is angular to subrounded, fine to coarse including ash, brick, ceramics and sandstone.			
2.00-2.45 2.00-2.45	CPT N=9 B3	1.50	DRY	2,3/2,3,2,2						
3.00-3.45 3.00-3.45	CPT N=14 B4	3.00	DRY	1,2/3,3,5,3			At 3.00m: Medium dense, frequent pockets of partially decayed plant material.			
4.00-4.45 4.00-4.45	CPT N=10 B5	4.00	DRY	1,2/2,2,3,3		(4.35)				
5.00-5.45 5.00-5.45	CPT N=16 B6	4.50	DRY	2,3/7,4,3,2						
6.00-6.45 6.00-6.45	CPT N=12 B7	6.00	DRY	2,2/4,3,2,3		6.00	MADE GROUND: Firm, brown, slightly sandy, gravelly CLAY. Gravel is angular to subrounded, fine to coarse including brick, ash and sandstone.			
7.00-7.50	B8					(1.20)				
7.50-7.95	U9 0.45	7.50	DRY	65 blows		7.20	Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse including sandstone and mudstone.			
8.00 8.00-8.50	D10 B11						At 8.00m: medium bedded, brown, sandy silt.			
9.00-9.45 9.00-9.45 9.00-9.45	SPT N=19 D13 B12	9.00	DRY	1,3/3,4,5,7			At 9.00m: occasional pockets of sand. Below 9.00m: stiff.			

Remarks
Chiselling from 6.60m to 6.80m for 0.50 hours. Excavating from 0.00m to 1.20m for 1.00 hour.

Scale (approx)	Logged By
1:50	JT

Figure No. 40323.BH03

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Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP03

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 12.00m		L K Group	40323
	Location	**Dates** 07/04/2008	**Engineer** L K Group	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.50	B14									
10.50-10.95	U15 0.45	10.50	DRY	120 blows						
11.00	D16									
11.00-11.50	B17									
12.00-12.45	SPT N=38	12.00	DRY	2,4/7,9,10,12			Below 12.00m: very stiff, becoming sandy with occasional thin bands of sand.			
12.00-12.45	B18									
12.00-12.45	D19					(7.80)				
13.00-13.50	B20									
13.50-13.95	U21 0.30	12.00	DRY	120 blows						
14.00	D22						At 14.00m: medium bedded, brown, slightly sandy silt. Rare thin bands of sand.			
14.00-14.50	B23									
15.00-15.45	SPT N=43	12.00	DRY	3,6/8,10,12,13		15.00				
15.00-15.45	D24									
							Complete at 15.45m			

Remarks

Scale (approx)	Logged By
1:50	JT

Figure No. 40323.BH03

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP04

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 12.00m		L K Group	40323
	Location	**Dates** 08/04/2008-09/04/2008	**Engineer** L K Group	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.20	B1						MADE GROUND: Firm, dark brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse including brick, ash, sandstone, wood, concrete and cloth.			
							At 0.10m: rare subangular cobbles of brick.			
1.20-1.65 1.20-1.65	CPT N=12 B2	1.20	DRY	2,3/3,2,4,3						
2.00-2.45 2.00-2.45	CPT N=11 B3	1.50	DRY	1,2/2,3,3,3						
3.00-3.45 3.00-3.45	CPT N=21 B4	3.00	DRY	3,4/5,5,7,4			Below 3.00m: stiff.			
						(7.40)				
4.00-4.33 4.00-4.45	CPT 50/180 B5	4.00	DRY	1,3/4,19,27			Below 4.00m: very stiff. At 4.00m: occasional cobbles of sandstone.			
5.00-5.45 5.00-5.45	CPT N=12 B6	4.50	DRY	2,3/2,4,3,3			Below 5.00m: firm. At 5.00m: rare subangular cobbles of concrete.			
6.00-6.45 6.00-6.45	CPT N=11 B7	6.00	DRY	1,3/3,2,3,3						
7.00-7.50	B8								▼1	
				Water strike(1) at 7.30m, rose to 7.00m in 20 mins, sealed at 7.50m.		7.40			▽1	
							Brown SILT with thinly bedded laminations of clay.			
7.50-7.95	U9 0.45	7.50	WET	60 blows		(0.60)				
8.00 8.00-8.50	D10 B11					8.00	Stiff, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine and medium including mudstone and sandstone.			
9.00-9.45 9.00-9.45 9.00-9.45	SPT N=27 D13 B12	9.00	DRY	2,3/5,6,7,9			At 9.00m: frequent pockets of sand.			

Remarks
Excavating from 0.00m to 1.20m for 1.00 hour.

Scale (approx)	Logged By
1:50	JT

Figure No. 40323.BH04

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP04

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 12.00m		L K Group	40323
	Location	**Dates**	**Engineer**	**Sheet**
		08/04/2008-09/04/2008	L K Group	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.50	B14									
10.50-10.95	U15 0.45	10.50	DRY	100 blows						
11.00	D16									
11.00-11.50	B17									
12.00-12.37	SPT 50/220	12.00	DRY	5,12/15,18,17			Below 12.00m: very stiff.			
12.00-12.45	B18						At 12.00m: occasional pockets of sand.			
12.00-12.45	D19									
						(7.00)				
13.00-13.50	B20						Below 13.00m: no pockets of sand.			
13.50-13.95	U21 0.40	12.00	DRY	120 blows						
14.00	D22									
14.00-14.50	B23									
15.00-15.44	SPT 50/290	12.00	DRY	4,9/11,13,14,12		15.00				
15.00-15.45	D24						Complete at 15.00m			

Remarks

Scale (approx)	Logged By
1:50	JT

Figure No. 40323.BH04

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Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP05

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 15.00m		L K Group	40323
	Location	**Dates** 09/04/2008-10/04/2008	**Engineer** L K Group	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.20	B1						MADE GROUND: Stiff, dark brown, sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse including brick, ash, wood, sandstone, concrete, glass and plastic. Below 0.10m: occasional angular to subangular cobbles.			
1.20-1.65	CPT N=16	1.20	DRY	2,4/4,5,4,3						
1.20-1.65	B2									
2.00-2.45	CPT N=6	2.00	DRY	3,2/1,1,2,2			Below 2.00m: soft.			
2.00-2.45	B3									
3.00-3.28	CPT 50/125	3.00	DRY	2,5/7,43			Below 3.00m: very stiff. No cobbles.			
3.00-3.45	B4									
4.00-4.45	CPT N=21	4.00	DRY	3,4/5,5,8,3			Below 4.00m: stiff.			
4.00-4.45	B5					(9.00)				
5.00-5.45	CPT N=12	4.50	DRY	1,2/2,4,3,3			Below 5.00m: firm.			
5.00-5.45	B6									
6.00-6.45	CPT N=10	6.00	DRY	1,3/2,1,3,4			At 6.00m: rare cobbles.			
6.00-6.45	B7									
7.00-7.50	B8									
7.50-7.95	CPT N=10	7.50	DRY	1,1/2,2,3,3						
7.50-7.95	B9									
8.50-9.00	B10						Below 8.50m: slightly gravelly.		▽1	
				slight seepage(1) at 8.70m.						
9.00-9.45	SPT N=40	9.00	WET	4,7/7,9,11,13		9.00				
9.00-9.45	D12						Very stiff, brown, sandy, slightly gravelly CLAY with occasional bands of sand. Gravel is subrounded to rounded, fine and medium including sandstone and mudstone.			
9.00-9.45	B11					(0.80)				
						9.80	Very dense, slightly clayey, fine to coarse SAND.			

Remarks
Chiselling from 3.30m to 3.50m for 0.50 hours. Excavating from 0.00m to 1.20m for 1.0 hour.

Scale (approx)	Logged By
1:50	JT

Figure No. 40323.BH05

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Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP05

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 15.00m		L K Group	40323
	Location	**Dates** 09/04/2008-10/04/2008	**Engineer** L K Group	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.50	B13						At 10.00m: slightly gravelly. Gravel is subrounded to rounded, fine including mudstone.			
10.50-10.90	SPT 50/250	10.50	DRY	5,9/12,15,17,6						
10.50-10.95	B14									
10.50-10.95	D15									
						(2.20)				
11.50-12.00	B16									
						12.00				
12.00-12.45	U17 0.30	12.00	DRY	120 blows			Orange brown, slightly sandy SILT.			
						(0.50)				
						12.50				
12.50	D18						Very stiff, brown, sandy, slightly gravelly CLAY. Gravel is subrounded to rounded, fine and medium including sandstone, mudstone, coal and ash.			
12.50-13.00	B19									
13.50-13.95	SPT N=45	13.50	DRY	4,7/9,11,12,13			At 13.50m: occasional pockets of sand.			
13.50-13.95	B20									
13.50-13.95	D21									
						(2.50)				
14.50-15.00	B22									
						15.00				
15.00-15.34	SPT 50/190	15.00	DRY	7,13/17,20,13			Complete at 15.00m			
15.00-15.35	D23									

Remarks

Scale (approx)	Logged By
1:50	JT

Figure No. 40323.BH05

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Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP06

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 10.50m		L K Group	40323
	Location	**Dates** 10/04/2008-11/04/2008	**Engineer** L K Group	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.20	B1						MADE GROUND: Firm, dark brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse including brick, ash, concrete and glass.			
						(2.00)				
1.20-1.65 1.20-1.65	CPT N=10 B2	1.20	DRY	1,2/2,3,2,3						
						2.00				
2.00-2.45 2.00-2.45	CPT N=7 B3	1.50	DRY	1,1/1,2,3,1			MADE GROUND: Loose, dark brown, slightly clayey, fine to coarse SAND and angular to subrounded, fine to coarse GRAVEL. Gravel includes brick, ash, wood, glass, ceramics, paper, card and wire.			
3.00-3.45 3.00-3.45	CPT N=6 B4	3.00	DRY	1,2/1,1,2,2						
4.00-4.45 4.00-4.45	CPT N=7 B5	4.00	DRY	2,3/3,2,1,1						
5.00-5.45 5.00-5.45	CPT N=10 B6	4.50	DRY	1,1/4,2,2,2						
6.00-6.45 6.00-6.45	CPT N=6 B7	6.00	DRY	2,2/1,2,1,2		(8.20)				
7.00-7.50	B8									
7.50-7.95 7.50-7.95	CPT N=6 B9	7.50	DRY	1,1/2,1,1,2						
8.50-9.00	B10									
9.00-9.45 9.00-9.45	CPT N=6 B11	9.00	DRY	1,1/1,2,1,2 slight seepage(1) at 9.10m.					▽1	

Remarks
Excavating from 0.00m to 1.20m for 1.00 hour.

Scale (approx)	Logged By
1:50	JT

Figure No. 40323.BH06

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP06

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 10.50m		L K Group	40323
	Location	**Dates** 10/04/2008-11/04/2008	**Engineer** L K Group	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.50	B12					(8.20) 10.20	MADE GROUND: Firm, brown, sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse including ash and plastic.			
10.50-10.95	U13 0.30	10.50	DRY	120 blows		(0.80) 11.00				
11.00	D14						Very dense, brown, silty, fine to coarse SAND with occasional pockets of clay.			
11.00-11.50	B15						At 11.50m: rare pockets of clay.			
12.00-12.30	SPT 50/145	12.00	DRY	7,15/23,27						
12.00-12.45	B16									
12.50-13.00	B17					(4.00)				
13.50-13.87	SPT 50/220	13.50	MOIST	5,8/13,17,20			Below 13.00m: very silty sand, no pockets of clay. At 13.00m: slightly gravelly. Gravel is subrounded to rounded, fine and medium including quartz.			
13.50-13.95	B18									
14.50-15.00	B19									
15.00-15.40	SPT 50/250	15.00	WET	4,9/12,15,17,6		15.00				
15.00-15.40	D20						Complete at 15.00m			

Remarks
Water added from 13.00m to 15.00m.

Scale (approx)	Logged By
1:50	JT

Figure No. 40323.BH06

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Site	Number
Irish World Heritage Centre	**WS1**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.70 0.70 0.70	V T J				(0.50) 0.50 (3.30) 3.80 (1.20) 5.00	MADE GROUND. Grass underlain by mid brown sandy topsoil with much fine to medium angular gravel, occasional brick, coal and clinker fragments and rootlets. MADE GROUND. Compacted black ash, clinker, coal, tarmac, fine to coarse angular gravel, cobbles and hydrocarbon odour. Inclusions of reworked sandy clay with ash, coal and gravel were present at 1.6m to 2.0m, 2.4m to 2.5m and 2.8m to 3.0m. MADE GROUND. Reworked mid brown clay with ash, occasional brick fragments, coal, fine to coarse angular and sub-rounded gravel, wood and hydrocarbon odour. Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS1

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Site	Number
Irish World Heritage Centre	**WS2**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.60)	MADE GROUND. Grass underlain by mid brown sandy topsoil with rootlets, fine to medium angular gravel, occasional brick fragments and rare clinker.			
0.60	T				0.60				
0.60	V					MADE GROUND. Ash, clinker, fine to coarse angular gravel, coal, brick fragments and cobbles, inclusion of builder's sand and some inclusions of clay.			
0.60	J				(1.40)				
					2.00				
						MADE GROUND. Reworked light brown stiff sandy clay with brick fragments and cobbles, coarse angular gravel and coal fragments.			
					(1.10)				
					3.10				
						Stiff mid brown sandy CLAY with occasional fine coal fragments and small inclusions of sand and rare fine gravel.			
3.50	T								
3.50	V								
3.50	J								
4.00-4.45	SPT N=12		1,2/2,3,3,4		(2.35)				
5.00-5.45	SPT N=15		2,2/3,4,4,4						
					5.45				
						Complete at 5.45m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS2

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Site	Number
Irish World Heritage Centre	**WS3**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50 0.50 0.50	T V J				(0.10) 0.10	MADE GROUND. Concrete.			
						MADE GROUND. Ash, clinker, brick fragments and cobbles, some sand, coal, occasional cobbles, fine to coarse angular gravel and hydrocarbon odour.			
					(4.90)				
					5.00	Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS3

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Site	Number
Irish World Heritage Centre	**WS4**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.40 0.40 0.40	T V J				(1.00) 1.00	MADE GROUND. Tarmac underlain by dense sand and much fine to coarse angular gravel, brick fragments and cobbles, coal, some ash and clinker and slight hydrocarbon odour.			
1.50 1.50 1.50	T V J				(1.00) 2.00	MADE GROUND. Black sand with fine sub-rounded gravel, brick fragments and hydrocarbon odour.			
					(1.50) 3.50	MADE GROUND. Ash, clinker, fine to coarse angular gravel, brick fragments and cobbles, concrete, slate and hydrocarbon odour.			
4.70 4.70 4.70	T V J				(1.50) 5.00	MADE GROUND. Stiff mid brown reworked sandy clay with brick fragments, fine to medium gravel, inclusion of organic material and slight hydrocarbon odour.			
						Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS4

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Site	Number
Irish World Heritage Centre	WS5

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20 0.20 0.20	T V J				(0.80) 0.80	MADE GROUND. Grass underlain by reworked mid brown sandy clay with brick fragments and cobbles, occasional ash and clinker, wood, coal and slate.			
					(4.20) 5.00	MADE GROUND. Reworked mid brown stiff sandy clay with fine to coarse angular and sub rounded gravel, coal fragments, occasional brick fragments and cobbles and rare ash. More brick cobbles and wood from 4.0m.			
						Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS5

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Site	Number
Irish World Heritage Centre	**WS6**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50 0.50	T V J				(3.50)	MADE GROUND. Grass underlain by mid brown sandy clay with brick, cobbles, fine to coarse angular gravel, ash, clinker and wood.		
3.70 3.70 3.70	T V J				3.50 (1.00) 4.50	MADE GROUND. Black sand with ash, clinker and a possible hydrocarbon odour.		
					(0.50) 5.00	MADE GROUND. Sandstone cobbles, ash and brick fragments.		
						Complete at 5.00m		

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS6

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Site	Number
Irish World Heritage Centre	**WS7**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50 0.50	T V J				(2.60)	MADE GROUND. Grass underlain by mid brown sandy clay with brick cobbles and fragments, fine to coarse angular gravel, ash and clinker.		
					2.60	MADE GROUND. Black ash, clinker, fine to coarse angular gravel, pottery, glass, plastic, organic material. Paper from 4.0m. Hydrocarbon odour from 4.7m to 5.0m.		
4.80 4.80 4.80	T V J				(2.40)			
					5.00	Complete at 5.00m		

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS7

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Site	Number
Irish World Heritage Centre	**WS8**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50 0.50 0.50	T V J				(3.80)	MADE GROUND. Grass underlain by sandy clay with much fine to coarse angular gravel, brick, ash, clinker, glass, concrete, pottery and wood.			
5.50	B				3.80 (2.20) 6.00	Mid brown sandy CLAY with fine coal fragments and rare fine sub-rounded gravel.			
						Complete at 6.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS8

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Site	Number
Irish World Heritage Centre	**WS9**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.40 0.40 0.40	T V J				(0.10) 0.10	MADE GROUND. Sandy topsoil with ash, clinker, fine to medium angular gravel, glass and rootlets.			
					(0.90) 1.00	MADE GROUND. Mid brown clayey sand with much fine to coarse angular gravel, brick fragments and cobbles, wood and coal fragments.			
					(1.70) 2.70	MADE GROUND. Ash, clinker, fine to coarse angular gravel, coal, plastic, some sand, ceramic, fabric, wood and rare brick fragments.			
					(0.80) 3.50	MADE GROUND. Paper with some inclusions of ash and plastic.			
					(1.50) 5.00	MADE GROUND. Ash, clinker, fine to coarse angular gravel, glass and brick fragments.			
						Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS9

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Site	Number
Irish World Heritage Centre	**WS10**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.40	T				(0.30) 0.30	MADE GROUND. Grass underlain by mid brown clayey topsoil with rootlets, brick fragments, medium to coarse angular gravel and coal fragments.			
0.40	V								
0.40	J				(0.90)	MADE GROUND. Dark brown sand with brick fragments, coal, ash, clinker, fine to coarse angular gravel and metal.			
1.30	T				1.20				
1.30	V					MADE GROUND. Black ash, clinker, coal, brick fragments, fine to coarse angular gravel and hydrocarbon odour.			
1.30	J				(1.00)				
2.50	T				2.20				
2.50	V					MADE GROUND. Mid brown clayey sand with brick fragments, fine to coarse angular gravel, ash, some sand and some clay inclusions.			
2.50	J				(2.00)				
4.50	T				4.20				
4.50	V					MADE GROUND. Moist black silty sand with much wood, rootlets, occasional medium to coarse angular and sub-rounded gravel and visual and olfactory evidence of hydrocarbon odour.			
4.50	J				(0.80)				
					5.00				
						Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS10

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APPENDIX B

ANALYTICAL RESULTS

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

Login Batch No					90823							
Chemtest LIMS ID					AC91889	AC91890	AC91891	AC91892	AC91893	AC91894	AC91895	AC91896
Sample ID					WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS7
Sample No												
Depth					0.7	0.6	0.5	0.4	0.2	0.5	0.5	4.8
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*								
2300	Cyanide (total)	57125	mg kg-¹	M	2.2	0.7	< 0.5	< 0.5	9.5	0.6	4.4	1.8
2310	Cyanide (free)	57125	mg kg-¹	M	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
2625	Organic matter		%	M	17	28	21	5.2	10	6.0	34	8.1
2120	Boron (hot water soluble)	7440428	mg kg-¹	U	1	1.2	0.9	1.8	2.6	0.8	15	2.2
	Sulfate (2:1 water soluble)	14808798	g l-¹	M	0.12	<0.01	0.15	0.09	0.07	0.03	0.54	0.12
2450	Arsenic	7440382	mg kg-¹	M	20	48	17	11	27	7.9	75	26
	Cadmium	7440439	mg kg-¹	M	<0.1	<0.1	<0.1	<0.1	3.1	<0.1	1.3	4.3
	Chromium	7440473	mg kg-¹	M	22	23	17	19	33	20	33	34
	Copper	7440508	mg kg-¹	M	73	670	100	110	210	64	770	370
	Mercury	7439976	mg kg-¹	M	0.54	8.6	0.60	2.9	0.83	0.17	1.3	1.4
	Nickel	7440020	mg kg-¹	M	30	41	31	51	55	31	63	59
	Lead	7439921	mg kg-¹	M	150	2600	170	340	750	66	610	710
	Selenium	7782492	mg kg-¹	M	0.25	1.2	0.45	<0.2	1.5	0.26	1.2	0.48
	Zinc	7440666	mg kg-¹	M	86	460	110	160	580	100	750	610
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
2675	TPH aliphatic >C5-C6		mg kg-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		mg kg-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1
	TPH aliphatic >C8-C10		mg kg-¹	N	15	<0.1	<0.1	<0.1	<0.1	<0.1	54	<0.1
	TPH aliphatic >C10-C12		mg kg-¹	N	69	<0.1	<0.1	<0.1	<0.1	<0.1	230	<0.1
	TPH aliphatic >C12-C16		mg kg-¹	N	220	<0.1	<0.1	<0.1	<0.1	<0.1	820	<0.1
	TPH aliphatic >C16-C21		mg kg-¹	N	250	<0.1	<0.1	<0.1	160	<0.1	2100	<0.1
	TPH aliphatic >C21-C35		mg kg-¹	N	120	<0.1	<0.1	<0.1	500	<0.1	2900	<0.1
	TPH aromatic >C5-C7		mg kg-¹	N	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		mg kg-¹	N	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		mg kg-¹	N	280	<0.1	<0.1	<0.1	<0.1	<0.1	28	<0.1
	TPH aromatic >C10-C12		mg kg-¹	N	100	3.6	7.0	4.3	1.2	0.4	82	0.3
	TPH aromatic >C12-C16		mg kg-¹	N	4600	27	89	60	26	3.2	160	2.5
	TPH aromatic >C16-C21		mg kg-¹	N	4800	190	390	210	150	8.7	350	15
	TPH aromatic >C21-C35		mg kg-¹	N	2800	420	430	280	150	11	340	30
	Total Petroleum Hydrocarbons		mg kg-¹	N	13000	640	920	550	990	23	7100	48

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

Login Batch No					90823							
Chemtest LIMS ID					AC91897	AC91898	AC91899	AC91900	AC91901	AC91902	AC91903	AC91904
Sample ID					WS8	WS9	WS10	WS10	CP2	TP1	TP2	TP3
Sample No												
Depth					0.9	0.4	0.4	4.5	0.1-1.2	0.6-0.8	0-1.5	0.5-1
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓									
2300	Cyanide (total)	57125	mg kg⁻¹	M	1.1	1.5	1.4	2.7	1.6	< 0.5	< 0.5	0.8
2310	Cyanide (free)	57125	mg kg⁻¹	M	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
2625	Organic matter		%	M	11	6.0	16	6.4	5.2	2.9	8.6	7.4
2120	Boron (hot water soluble)	7440428	mg kg⁻¹	U	1.9	1.4	0.7	1.1	2.1	0.5	1	1
	Sulfate (2:1 water soluble)	14808798	g l⁻¹	M	0.3	0.62	0.02	0.71	0.14	0.14	0.02	0.09
2450	Arsenic	7440382	mg kg⁻¹	M	37	19	20	35	13	9.5	21	14
	Cadmium	7440439	mg kg⁻¹	M	1.7	0.78	0.71	<0.1	<0.1	<0.1	<0.1	12
	Chromium	7440473	mg kg⁻¹	M	62	84	33	17	20	7.9	23	29
	Copper	7440508	mg kg⁻¹	M	210	1000	180	270	71	48	62	220
	Mercury	7439976	mg kg⁻¹	M	1.7	0.83	0.75	4.4	0.74	0.35	0.86	1.0
	Nickel	7440020	mg kg⁻¹	M	46	120	34	28	24	8.7	26	44
	Lead	7439921	mg kg⁻¹	M	720	440	490	760	230	790	220	380
	Selenium	7782492	mg kg⁻¹	M	0.65	0.40	0.48	0.67	0.30	0.35	0.43	0.41
	Zinc	7440666	mg kg⁻¹	M	710	300	420	290	210	110	170	670
2490	Chromium (hexavalent)	18540299	mg kg⁻¹	N	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
2675	TPH aliphatic >C5-C6		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		mg kg⁻¹	N	<0.1	<0.1	<0.1	0.5	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		mg kg⁻¹	N	<0.1	<0.1	<0.1	160	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C16-C21		mg kg⁻¹	N	<0.1	<0.1	<0.1	680	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C21-C35		mg kg⁻¹	N	<0.1	<0.1	<0.1	3700	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C5-C7		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		mg kg⁻¹	N	4.6	1.3	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
	TPH aromatic >C10-C12		mg kg⁻¹	N	9.9	1.5	1.4	12	2.2	1.2	5.3	3.3
	TPH aromatic >C12-C16		mg kg⁻¹	N	63	6.9	18	81	14	20	39	25
	TPH aromatic >C16-C21		mg kg⁻¹	N	200	32	73	170	51	83	220	100
	TPH aromatic >C21-C35		mg kg⁻¹	N	150	40	100	220	57	79	170	120
	Total Petroleum Hydrocarbons		mg kg⁻¹	N	430	82	190	5000	120	180	430	250

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

Login Batch No					90823							
Chemtest LIMS ID					AC91905	AC91906	AC91907	AC91908	AC91909	AC91910	AC91911	AC91912
Sample ID					TP4	TP4	TP4	TP5	TP6	TP6	TP7	TP8
Sample No												
Depth					0.4-1.5	2.7	3.6	0.4-1	0-1	2.7-3.0	0.5	0.8
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓									
2300	Cyanide (total)	57125	mg kg⁻¹	M	< 0.5	< 0.5	< 0.5	< 0.5	4.4	25.1	2.7	2.7
2310	Cyanide (free)	57125	mg kg⁻¹	M	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
2625	Organic matter		%	M	6.7	3.3	2.9	2.6	9.5	5.9	6.0	11
2120	Boron (hot water soluble)	7440428	mg kg⁻¹	U	1.1	1.4	0.7	1	1.1	1.9	2.7	1.5
	Sulfate (2:1 water soluble)	14808798	g l⁻¹	M	0.12	0.36	0.31	0.1	0.27	0.29	0.28	0.51
2450	Arsenic	7440382	mg kg⁻¹	M	22	6.6	3.6	15	18	17	11	17
	Cadmium	7440439	mg kg⁻¹	M	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.8
	Chromium	7440473	mg kg⁻¹	M	23	5.5	18	18	22	42	19	23
	Copper	7440508	mg kg⁻¹	M	100	40	18	41	60	160	70	120
	Mercury	7439976	mg kg⁻¹	M	1.3	0.12	<0.1	0.17	0.43	0.52	0.42	0.98
	Nickel	7440020	mg kg⁻¹	M	33	6.6	25	11	26	48	17	25
	Lead	7439921	mg kg⁻¹	M	420	2000	23	410	260	300	260	500
	Selenium	7782492	mg kg⁻¹	M	0.44	<0.2	<0.2	0.35	0.34	0.35	<0.2	0.37
	Zinc	7440666	mg kg⁻¹	M	790	64	46	85	230	300	120	240
2490	Chromium (hexavalent)	18540299	mg kg⁻¹	N	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
2675	TPH aliphatic >C5-C6		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C16-C21		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	14	<0.1	<0.1
	TPH aliphatic >C21-C35		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	110	<0.1	<0.1
	TPH aromatic >C5-C7		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		mg kg⁻¹	N	2.9	0.9	6.9	2.0	1.0	<0.1	0.4	2.2
	TPH aromatic >C10-C12		mg kg⁻¹	N	2.6	1.3	20	1.1	1.9	0.1	7.5	1.3
	TPH aromatic >C12-C16		mg kg⁻¹	N	17	5.0	400	5.2	7.9	5.6	42	12
	TPH aromatic >C16-C21		mg kg⁻¹	N	76	22	330	16	31	17	170	63
	TPH aromatic >C21-C35		mg kg⁻¹	N	95	27	25	29	72	30	250	73
	Total Petroleum Hydrocarbons		mg kg⁻¹	N	190	56	780	53	110	180	570	150

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

Login Batch No					**90823**								
Chemtest LIMS ID					AC91913	AC91914	AC91915	AC91916	AC91917	AC91918	AC91919	AC91920
Sample ID					TP9	TP10	TP11	TP12	TP13	TP14	TP15	TP16
Sample No												
Depth					1.5-2	0.3	0-1.1	0.8-1	0-1.5	0.3-1.7	0-1	0-1
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓									
2300	Cyanide (total)	57125	mg kg⁻¹	M	< 0.5	1.5	2.3	190.0	0.8	< 0.5	< 0.5	1.4
2310	Cyanide (free)	57125	mg kg⁻¹	M	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
2625	Organic matter		%	M	16	6.7	3.6	10	5.9	19	9.3	11
2120	Boron (hot water soluble)	7440428	mg kg⁻¹	U	0.9	0.9	0.7	1.2	0.5	1.1	0.5	0.8
	Sulfate (2:1 water soluble)	14808798	g l⁻¹	M	0.13	0.03	0.04	0.26	0.04	0.06	0.02	0.13
2450	Arsenic	7440382	mg kg⁻¹	M	17	28	9.4	12	9.4	12	17	21
	Cadmium	7440439	mg kg⁻¹	M	<0.1	0.28	<0.1	0.29	<0.1	5.3	<0.1	0.53
	Chromium	7440473	mg kg⁻¹	M	13	35	19	27	16	21	20	29
	Copper	7440508	mg kg⁻¹	M	100	110	44	250	40	100	66	150
	Mercury	7439976	mg kg⁻¹	M	0.20	0.59	0.22	2.1	0.12	0.75	0.20	0.70
	Nickel	7440020	mg kg⁻¹	M	25	26	21	31	24	26	29	35
	Lead	7439921	mg kg⁻¹	M	74	340	190	800	56	370	99	580
	Selenium	7782492	mg kg⁻¹	M	0.65	0.53	0.25	0.37	<0.2	0.31	0.25	0.46
	Zinc	7440666	mg kg⁻¹	M	120	500	160	650	69	620	100	880
2490	Chromium (hexavalent)	18540299	mg kg⁻¹	N	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
2675	TPH aliphatic >C5-C6		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.5	<0.1
	TPH aliphatic >C16-C21		mg kg⁻¹	N	12	<0.1	<0.1	<0.1	<0.1	<0.1	25	<0.1
	TPH aliphatic >C21-C35		mg kg⁻¹	N	71	<0.1	<0.1	<0.1	<0.1	<0.1	23	<0.1
	TPH aromatic >C5-C7		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		mg kg⁻¹	N	<0.1	1.4	<0.1	3.7	<0.1	<0.1	<0.1	0.9
	TPH aromatic >C10-C12		mg kg⁻¹	N	<0.1	0.8	1.0	5.5	<0.1	44	1.3	2.9
	TPH aromatic >C12-C16		mg kg⁻¹	N	2.5	22	7.2	40	0.7	480	4.1	24
	TPH aromatic >C16-C21		mg kg⁻¹	N	11	130	27	200	10	1600	16	160
	TPH aromatic >C21-C35		mg kg⁻¹	N	13	170	43	240	13	1700	18	250
	Total Petroleum Hydrocarbons		mg kg⁻¹	N	110	320	78	490	24	3800	90	440

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
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FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

Login Batch No					**90823**								
Chemtest LIMS ID					AC91921	AC91922	AC91923	AC91924	AC91925	AC91926	AC91927	AC91928
Sample ID					TP17	TP18	TP18	TP19	TP20	TP21	TP22	TP23
Sample No												
Depth					0.3-1.5	0-0.6	0.6-1	0-0.8	0-0.6	0-1	0.2-0.9	0.5-1
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓									
2300	Cyanide (total)	57125	mg kg⁻¹	M	1.5	0.6	0.6	2.9	0.8	5.3	4.7	0.8
2310	Cyanide (free)	57125	mg kg⁻¹	M	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
2625	Organic matter		%	M	21	7.4	11	11	55	7.1	29	1.4
2120	Boron (hot water soluble)	7440428	mg kg⁻¹	U	1.7	0.9	1.6	1	1.4	1.2	4.7	0.9
	Sulfate (2:1 water soluble)	14808798	g l⁻¹	M	0.24	0.07	0.49	0.18	0.25	0.31	0.5	1.8
2450	Arsenic	7440382	mg kg⁻¹	M	72	25	13	27	56	17	100	6.7
	Cadmium	7440439	mg kg⁻¹	M	3.3	0.41	<0.1	0.23	0.14	<0.1	6.7	<0.1
	Chromium	7440473	mg kg⁻¹	M	36	27	23	230	29	50	47	21
	Copper	7440508	mg kg⁻¹	M	280	200	150	220	400	110	610	17
	Mercury	7439976	mg kg⁻¹	M	0.73	0.95	0.56	0.98	2.2	0.60	1.8	0.41
	Nickel	7440020	mg kg⁻¹	M	60	37	23	37	47	27	200	14
	Lead	7439921	mg kg⁻¹	M	800	700	260	660	970	360	1000	24
	Selenium	7782492	mg kg⁻¹	M	0.94	0.62	0.34	0.76	1.7	0.41	1.5	<0.2
	Zinc	7440666	mg kg⁻¹	M	530	310	420	500	200	350	1400	66
2490	Chromium (hexavalent)	18540299	mg kg⁻¹	N	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
2675	TPH aliphatic >C5-C6		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	5.1	<0.1	<0.1	<0.1
	TPH aliphatic >C16-C21		mg kg⁻¹	N	<0.1	<0.1	120	<0.1	87	<0.1	<0.1	<0.1
	TPH aliphatic >C21-C35		mg kg⁻¹	N	<0.1	<0.1	430	<0.1	590	<0.1	<0.1	<0.1
	TPH aromatic >C5-C7		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		mg kg⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		mg kg⁻¹	N	0.2	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C10-C12		mg kg⁻¹	N	12	3.0	3.1	1.0	<0.1	1.7	1.2	<0.1
	TPH aromatic >C12-C16		mg kg⁻¹	N	140	45	20	11	4.0	26	10	<0.1
	TPH aromatic >C16-C21		mg kg⁻¹	N	700	220	93	49	35	120	49	<0.1
	TPH aromatic >C21-C35		mg kg⁻¹	N	780	200	88	78	41	230	20	<0.1
	Total Petroleum Hydrocarbons		mg kg⁻¹	N	1600	470	750	140	760	380	80	<10

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

FAO R. McKellar

Report Date
17 April 2008

Login Batch No					90823		
Chemtest LIMS ID					AC91929	AC91930	AC91931
Sample ID					TP24	CP1	CP1
Sample No							
Depth					0-0.3	0.1-1.2	7-7.5
Matrix					*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓				
2300	Cyanide (total)	57125	mg kg-¹	M	21.0	< 0.5	< 0.5
2310	Cyanide (free)	57125	mg kg-¹	M	< 0.5	< 0.5	< 0.5
2625	Organic matter		%	M	17	3.1	2.4
2120	Boron (hot water soluble)	7440428	mg kg-¹	U	1.2	0.5	0.6
	Sulfate (2:1 water soluble)	14808798	g l-¹	M	0.15	0.03	0.05
2450	Arsenic	7440382	mg kg-¹	M	65	7.1	3.7
	Cadmium	7440439	mg kg-¹	M	5.7	<0.1	<0.1
	Chromium	7440473	mg kg-¹	M	87	27	19
	Copper	7440508	mg kg-¹	M	610	33	19
	Mercury	7439976	mg kg-¹	M	1.7	0.12	<0.1
	Nickel	7440020	mg kg-¹	M	81	31	24
	Lead	7439921	mg kg-¹	M	1400	39	14
	Selenium	7782492	mg kg-¹	M	0.98	0.20	<0.2
	Zinc	7440666	mg kg-¹	M	1200	82	46
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	< 5	< 5	< 5
2675	TPH aliphatic >C5-C6		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aliphatic >C16-C21		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aliphatic >C21-C35		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aromatic >C5-C7		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		mg kg-¹	N	<0.1	<0.1	<0.1
	TPH aromatic >C10-C12		mg kg-¹	N	9.5	<0.1	3.3
	TPH aromatic >C12-C16		mg kg-¹	N	29	<0.1	29
	TPH aromatic >C16-C21		mg kg-¹	N	150	1.1	73
	TPH aromatic >C21-C35		mg kg-¹	N	190	0.8	48
	Total Petroleum Hydrocarbons		mg kg-¹	N	380	<10	150

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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Report Date
17 April 2008

					90823							
					AC91889	AC91890	AC91891	AC91892	AC91893	AC91894	AC91895	AC91896
					WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS7
					0.7	0.6	0.5	0.4	0.2	0.5	0.5	4.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Naphthalene	91203	mg kg⁻¹	M	54	8.4	19	2.8	2.7	1.2	3	0.8
	Acenaphthylene	208968	mg kg⁻¹	M	19	1.2	3.7	0.5	1	0.4	3.7	0.5
	Acenaphthene	83329	mg kg⁻¹	M	140	7.3	22	5.1	3	0.9	5.7	1.3
	Fluorene	86737	mg kg⁻¹	M	110	2.9	17	5.2	2	0.5	2.7	0.7
	Phenanthrene	85018	mg kg⁻¹	M	750	37	98	33	14	3.1	20	5.6
	Anthracene	120127	mg kg⁻¹	M	210	12	31	9.7	5.4	1.2	7.3	2.1
	Fluoranthene	206440	mg kg⁻¹	M	1000	58	100	29	21	3.8	36	8.4
	Pyrene	129000	mg kg⁻¹	M	910	58	91	29	19	3.4	30	7.8
	Benzo[a]anthracene	56553	mg kg⁻¹	M	460	32	43	14	9.2	2	15	4.1
	Chrysene	218019	mg kg⁻¹	M	500	39	51	17	11	2.2	20	4.7
	Benzo[b]fluoranthene	205992	mg kg⁻¹	M	430	31	44	13	9.1	1.9	27	4.4
	Benzo[k]fluoranthene	207089	mg kg⁻¹	M	280	26	24	9.6	7.2	1.3	13	3
	Benzo[a]pyrene	50328	mg kg⁻¹	M	420	35	43	15	11	2.2	20	4.7
	Dibenzo[a,h]anthracene	53703	mg kg⁻¹	M	48	8.2	7.3	1.2	1.3	0.4	5.7	0.7
	Indeno[1,2,3-cd]pyrene	193395	mg kg⁻¹	M	260	24	29	6.4	5.7	1.4	17	3
	Benzo[g,h,i]perylene	191242	mg kg⁻¹	M	260	23	27	6.3	5.2	1.1	17	2.9
	Total (of 16) PAHs		mg kg⁻¹	M	5900	400	650	200	130	27	240	55
2750	Fuel Type (soils)			N	PAH	PAH	PAH	PAH	PAH/Lube Oil	PAH	PAH/Lube Oil	PAH
2760	Benzene	71432	µg kg⁻¹	M	150	<1	2.6	<1	<1	<1	18	<1
	Dichlorodifluoromethane	75718	µg kg⁻¹	U								
	Chloromethane	74873	µg kg⁻¹	M								
	Toluene	108883	µg kg⁻¹	M	290	<1	<1	1.7	<1	<1	16	<1
	Ethyl benzene	100414	µg kg⁻¹	M	380	<1	<1	1.6	<1	<1	1.3	<1
	Vinyl chloride	75014	µg kg⁻¹	M								
	Bromomethane	74839	µg kg⁻¹	U								
	m- & p-Xylene	1330207	µg kg⁻¹	M	470	<1	<1	1.3	<1	<1	10	<1
	Chloroethane	75003	µg kg⁻¹	U								
	o-Xylene	95476	µg kg⁻¹	M	290	<1	<1	2.1	<1	<1	6.2	<1
	Methyl tert-butyl ether	1634044	µg kg⁻¹	N	<1	<1	<1	<1	<1	<1	<1	<1
	Trichlorofluoromethane	75694	µg kg⁻¹	U								
	1,1-Dichloroethene	75354	µg kg⁻¹	U								

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

					90823							
					AC91897	AC91898	AC91899	AC91900	AC91901	AC91902	AC91903	AC91904
					WS8	WS9	WS10	WS10	CP2	TP1	TP2	TP3
					0.9	0.4	0.4	4.5	0.1-1.2	0.6-0.8	0-1.5	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Naphthalene	91203	mg kg-1	M	1.4	1.1	1	20	1.3	0.5	0.4	1.1
	Acenaphthylene	208968	mg kg-1	M	0.7	0.4	0.5	0.8	0.4	0.5	0.3	0.7
	Acenaphthene	83329	mg kg-1	M	3	1.6	2	12	2.7	1.8	0.7	2.9
	Fluorene	86737	mg kg-1	M	2	1	1.3	6	1.8	1.3	0.4	2.2
	Phenanthrene	85018	mg kg-1	M	16	6.1	11	6.6	13	10	2.8	16
	Anthracene	120127	mg kg-1	M	5.7	2.4	3.9	5	4.2	3.3	0.9	6.2
	Fluoranthene	206440	mg kg-1	M	25	9.1	18	20	17	14	6.1	24
	Pyrene	129000	mg kg-1	M	24	8.4	16	19	16	13	6.4	22
	Benzo[a]anthracene	56553	mg kg-1	M	12	4.5	8.5	6.7	7.7	6.6	3.3	11
	Chrysene	218019	mg kg-1	M	15	5.3	10	8.9	8.7	7.5	4.3	13
	Benzo[b]fluoranthene	205992	mg kg-1	M	11	4.3	7.9	8.7	8.1	6.5	3.1	11
	Benzo[k]fluoranthene	207089	mg kg-1	M	10	4	7.1	4.3	5.6	4.4	2.7	8.3
	Benzo[a]pyrene	50328	mg kg-1	M	13	4.8	9.3	7.7	8.4	6.7	3.3	12
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	2.6	1	1.6	0.1	1.5	0.5	0.6	2
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	M	9	3.4	6.6	4.4	5.8	3.7	2	7.8
	Benzo[g,h,i]perylene	191242	mg kg-1	M	8.2	3.3	5.3	3.1	5.8	4.1	2.3	8
	Total (of 16) PAHs		mg kg-1	M	160	61	110	130	110	84	40	150
2750	Fuel Type (soils)			N	PAH	PAH	PAH	PAH/Lube Oil	PAH	PAH	PAH	PAH
2760	Benzene	71432	µg kg-1	M	<1	<1	<1	<1	4.1	<1	<1	<1
	Dichlorodifluoromethane	75718	µg kg-1	U								
	Chloromethane	74873	µg kg-1	M								
	Toluene	108883	µg kg-1	M	<1	<1	<1	<1	1.9	<1	<1	<1
	Ethyl benzene	100414	µg kg-1	M	<1	<1	<1	<1	<1	<1	<1	<1
	Vinyl chloride	75014	µg kg-1	M								
	Bromomethane	74839	µg kg-1	U								
	m- & p-Xylene	1330207	µg kg-1	M	<1	<1	<1	<1	1.3	<1	<1	<1
	Chloroethane	75003	µg kg-1	U								
	o-Xylene	95476	µg kg-1	M	<1	<1	<1	<1	1.4	<1	<1	<1
	Methyl tert-butyl ether	1634044	µg kg-1	N	<1	<1	<1	<1	<1	<1	<1	<1
	Trichlorofluoromethane	75694	µg kg-1	U								
	1,1-Dichloroethene	75354	µg kg-1	U								

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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Leyden Kirby Associates
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BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

					90823							
					AC91905	AC91906	AC91907	AC91908	AC91909	AC91910	AC91911	AC91912
					TP4	TP4	TP4	TP5	TP6	TP6	TP7	TP8
					0.4-1.5	2.7	3.6	0.4-1	0-1	2.7-3.0	0.5	0.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Naphthalene	91203	mg kg-1	M	0.9	0.2	7.5	<0.1	0.9	1.6	2.1	0.7
	Acenaphthylene	208968	mg kg-1	M	0.5	0.1	12	<0.1	0.4	0.6	1.2	0.7
	Acenaphthene	83329	mg kg-1	M	1.6	0.2	51	0.5	1.2	3.2	4.7	1.9
	Fluorene	86737	mg kg-1	M	1	0.1	58	0.3	1	1.9	3.2	1.5
	Phenanthrene	85018	mg kg-1	M	8.1	0.9	170	1.5	5.6	10	18	11
	Anthracene	120127	mg kg-1	M	2.8	0.4	31	0.5	3.1	4.2	7.1	4
	Fluoranthene	206440	mg kg-1	M	11	1.6	48	1.8	6.8	13	24	16
	Pyrene	129000	mg kg-1	M	9.8	1.5	36	1.5	5.7	12	20	15
	Benzo[a]anthracene	56553	mg kg-1	M	5.1	1	5.3	0.9	3.6	6	11	7.5
	Chrysene	218019	mg kg-1	M	6.2	1	5.3	0.9	4	7	12	8.8
	Benzo[b]fluoranthene	205992	mg kg-1	M	6	1	1.3	0.9	4.2	6.4	11	6.9
	Benzo[k]fluoranthene	207089	mg kg-1	M	3.8	0.8	1.1	1	2.8	5.7	7.5	5.6
	Benzo[a]pyrene	50328	mg kg-1	M	5.6	1	1.1	0.9	3.6	7	11	7.9
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	0.9	<0.1	<0.1	0.1	0.7	1	2	0.5
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	M	3.9	0.5	0.2	0.5	2.3	3.9	7.7	3.8
	Benzo[g,h,i]perylene	191242	mg kg-1	M	3.9	0.7	0.2	0.9	3.1	3.9	7.8	4
	Total (of 16) PAHs		mg kg-1	M	71	11	430	12	49	87	150	96
2750	Fuel Type (soils)			N	PAH	PAH	PAH	PAH	PAH	PAH/Lube Oil	PAH	PAH
2760	Benzene	71432	µg kg-1	M	<1	<1	<1	<1	1.7	1.0	<1	3.7
	Dichlorodifluoromethane	75718	µg kg-1	U								
	Chloromethane	74873	µg kg-1	M								
	Toluene	108883	µg kg-1	M	<1	<1	<1	<1	<1	<1	<1	<1
	Ethyl benzene	100414	µg kg-1	M	<1	<1	6.4	<1	<1	<1	<1	<1
	Vinyl chloride	75014	µg kg-1	M								
	Bromomethane	74839	µg kg-1	U								
	m- & p-Xylene	1330207	µg kg-1	M	<1	<1	<1	<1	<1	1.7	<1	1.2
	Chloroethane	75003	µg kg-1	U								
	o-Xylene	95476	µg kg-1	M	<1	<1	1.0	<1	<1	1.1	<1	<1
	Methyl tert-butyl ether	1634044	µg kg-1	N	<1	<1	<1	<1	<1	<1	<1	<1
	Trichlorofluoromethane	75694	µg kg-1	U								
	1,1-Dichloroethene	75354	µg kg-1	U								

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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LABORATORY TEST REPORT

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Report Date
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					90823							
					AC91913	AC91914	AC91915	AC91916	AC91917	AC91918	AC91919	AC91920
					TP9	TP10	TP11	TP12	TP13	TP14	TP15	TP16
					1.5-2	0.3	0-1.1	0.8-1	0-1.5	0.3-1.7	0-1	0-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Naphthalene	91203	mg kg-1	M	0.7	1.7	0.4	2.6	0.6	<0.1	1.5	2.3
	Acenaphthylene	208968	mg kg-1	M	0.4	1.2	0.2	1.3	0.4	<0.1	0.7	0.7
	Acenaphthene	83329	mg kg-1	M	0.6	6.2	0.9	5	1	<0.1	4.7	5
	Fluorene	86737	mg kg-1	M	0.3	4.6	0.5	4.2	0.2	<0.1	3.1	4.2
	Phenanthrene	85018	mg kg-1	M	1.9	33	3.6	28	1.2	6.4	17	29
	Anthracene	120127	mg kg-1	M	1.3	11	1.3	11	0.9	1.8	6.2	12
	Fluoranthene	206440	mg kg-1	M	3	47	5.6	38	1.4	12	19	39
	Pyrene	129000	mg kg-1	M	2.9	42	5.1	31	1.2	9.9	16	33
	Benzo[a]anthracene	56553	mg kg-1	M	2.1	22	2.3	15	0.6	5.3	7.6	18
	Chrysene	218019	mg kg-1	M	2.5	26	2.7	17	0.6	6.6	8.6	20
	Benzo[b]fluoranthene	205992	mg kg-1	M	2.2	20	3	13	0.7	3.1	8.3	17
	Benzo[k]fluoranthene	207089	mg kg-1	M	2	18	2.5	12	0.7	1.5	6	13
	Benzo[a]pyrene	50328	mg kg-1	M	2.5	23	3.2	16	0.8	3.5	9.1	19
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	0.5	4.7	0.6	2.9	0.2	<0.1	0.6	2.9
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	M	1.4	16	2	10	0.3	2.7	4.1	12
	Benzo[g,h,i]perylene	191242	mg kg-1	M	0.9	15	2	9.2	0.3	2.9	4.3	11
	Total (of 16) PAHs		mg kg-1	M	25	290	36	220	11	56	120	240
2750	Fuel Type (soils)			N	PAH/Lube Oil	PAH	PAH	PAH	PAH	PAH	PAH/Lube Oil	PAH
2760	Benzene	71432	µg kg-1	M	<1	<1	<1	3.5	<1	<1	<1	<1
	Dichlorodifluoromethane	75718	µg kg-1	U								
	Chloromethane	74873	µg kg-1	M								
	Toluene	108883	µg kg-1	M	<1	<1	<1	1.5	<1	<1	<1	<1
	Ethyl benzene	100414	µg kg-1	M	<1	<1	<1	<1	<1	<1	<1	<1
	Vinyl chloride	75014	µg kg-1	M								
	Bromomethane	74839	µg kg-1	U								
	m- & p-Xylene	1330207	µg kg-1	M	<1	<1	<1	1.2	<1	<1	<1	<1
	Chloroethane	75003	µg kg-1	U								
	o-Xylene	95476	µg kg-1	M	<1	<1	<1	1.3	<1	<1	<1	<1
	Methyl tert-butyl ether	1634044	µg kg-1	N	<1	<1	<1	<1	<1	<1	<1	<1
	Trichlorofluoromethane	75694	µg kg-1	U								
	1,1-Dichloroethene	75354	µg kg-1	U								

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LABORATORY TEST REPORT

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					90823							
					AC91921	AC91922	AC91923	AC91924	AC91925	AC91926	AC91927	AC91928
					TP17	TP18	TP18	TP19	TP20	TP21	TP22	TP23
					0.3-1.5	0-0.6	0.6-1	0-0.8	0-0.6	0-1	0.2-0.9	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Naphthalene	91203	mg kg-1	M	5.7	4.5	1.4	1.4	3.1	1.4	0.5	
	Acenaphthylene	208968	mg kg-1	M	2.6	1.6	0.8	0.6	1.6	0.8	0.5	
	Acenaphthene	83329	mg kg-1	M	28	6.7	3.3	4.3	1.1	4.4	1.5	
	Fluorene	86737	mg kg-1	M	15	5.8	2.8	3	1.7	2.6	0.4	
	Phenanthrene	85018	mg kg-1	M	140	43	14	18	13	18	5.1	
	Anthracene	120127	mg kg-1	M	35	12	4.4	6.3	4.7	5.7	1.8	
	Fluoranthene	206440	mg kg-1	M	150	48	20	25	13	25	7.6	
	Pyrene	129000	mg kg-1	M	140	45	18	15	9.8	22	6.7	
	Benzo[a]anthracene	56553	mg kg-1	M	63	21	8.6	7.7	3.1	12	3.7	
	Chrysene	218019	mg kg-1	M	72	24	11	9.5	6.1	13	3.8	
	Benzo[b]fluoranthene	205992	mg kg-1	M	57	22	9.5	7.8	4	10	4	
	Benzo[k]fluoranthene	207089	mg kg-1	M	40	14	6.2	5	1.3	7.5	3.1	
	Benzo[a]pyrene	50328	mg kg-1	M	61	23	9.9	14	3.6	12	4.4	
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	9.4	3.8	1.8	1.4	<0.1	1.9	0.3	
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	M	41	15	7	5.5	1.7	8.2	2.7	
	Benzo[g,h,i]perylene	191242	mg kg-1	M	38	18	9	6.1	2.7	8.2	1.2	
	Total (of 16) PAHs		mg kg-1	M	900	310	130	130	71	150	47	
2750	Fuel Type (soils)			N	PAH	PAH	PAH/Lube Oil	PAH	PAH/Lube Oil	PAH	PAH	N/A
2760	Benzene	71432	µg kg-1	M	4.5	<1	<1	3.5	5.6	<1	1.3	<1
	Dichlorodifluoromethane	75718	µg kg-1	U								<1
	Chloromethane	74873	µg kg-1	M								<1
	Toluene	108883	µg kg-1	M	3.4	<1	<1	3.0	2.8	<1	1.2	<1
	Ethyl benzene	100414	µg kg-1	M	<1	<1	<1	<1	<1	<1	<1	<1
	Vinyl chloride	75014	µg kg-1	M								<1
	Bromomethane	74839	µg kg-1	U								<20
	m- & p-Xylene	1330207	µg kg-1	M	2.0	<1	<1	<1	2.0	<1	<1	<1
	Chloroethane	75003	µg kg-1	U								<2
	o-Xylene	95476	µg kg-1	M	2.4	<1	<1	<1	2.0	<1	<1	<1
	Methyl tert-butyl ether	1634044	µg kg-1	N	<1	<1	<1	<1	<1	<1	<1	<1
	Trichlorofluoromethane	75694	µg kg-1	U								<1
	1,1-Dichloroethene	75354	µg kg-1	U								<1

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

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Report Date
17 April 2008

					90823		
					AC91929	AC91930	AC91931
					TP24	CP1	CP1
					0-0.3	0.1-1.2	7-7.5
					SOIL	*SOIL*	*SOIL*
2700	Naphthalene	91203	mg kg-1	M	0.8	<0.1	0.7
	Acenaphthylene	208968	mg kg-1	M	0.6	0.3	0.3
	Acenaphthene	83329	mg kg-1	M	0.2	0.2	1.8
	Fluorene	86737	mg kg-1	M	0.5	<0.1	1.2
	Phenanthrene	85018	mg kg-1	M	6.1	0.5	5.2
	Anthracene	120127	mg kg-1	M	1.9	0.2	1.7
	Fluoranthene	206440	mg kg-1	M	11	0.6	4.8
	Pyrene	129000	mg kg-1	M	9.6	0.5	4.1
	Benzo[a]anthracene	56553	mg kg-1	M	5.3	0.2	1.5
	Chrysene	218019	mg kg-1	M	6.2	0.3	1.8
	Benzo[b]fluoranthene	205992	mg kg-1	M	6.6	0.5	1.6
	Benzo[k]fluoranthene	207089	mg kg-1	M	3.8	0.3	1
	Benzo[a]pyrene	50328	mg kg-1	M	6.3	0.3	1.7
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	1	0.3	0.2
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	M	4.4	0.2	1
	Benzo[g,h,i]perylene	191242	mg kg-1	M	4.6	0.6	1
	Total (of 16) PAHs		mg kg-1	M	69	5.1	30
2750	Fuel Type (soils)			N	PAH	N/A	PAH
2760	Benzene	71432	µg kg-1	M	<1	<1	<1
	Dichlorodifluoromethane	75718	µg kg-1	U			
	Chloromethane	74873	µg kg-1	M			
	Toluene	108883	µg kg-1	M	<1	<1	1.7
	Ethyl benzene	100414	µg kg-1	M	<1	<1	<1
	Vinyl chloride	75014	µg kg-1	M			
	Bromomethane	74839	µg kg-1	U			
	m- & p-Xylene	1330207	µg kg-1	M	<1	<1	1.7
	Chloroethane	75003	µg kg-1	U			
	o-Xylene	95476	µg kg-1	M	<1	<1	1.1
	Methyl tert-butyl ether	1634044	µg kg-1	N	<1	<1	<1
	Trichlorofluoromethane	75694	µg kg-1	U			
	1,1-Dichloroethene	75354	µg kg-1	U			

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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					90823							
					AC91889	AC91890	AC91891	AC91892	AC91893	AC91894	AC91895	AC91896
					WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS7
					0.7	0.6	0.5	0.4	0.2	0.5	0.5	4.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Dichloromethane	75092	µg kg⁻¹	U								
	trans-1,2-Dichloroethene	156605	µg kg⁻¹	M								
	1,1-Dichloroethane	75343	µg kg⁻¹	M								
	cis-1,2-Dichloroethene	156592	µg kg⁻¹	M								
	Bromochloromethane	74975	µg kg⁻¹	U								
	Trichloromethane	67663	µg kg⁻¹	M								
	1,1,1-Trichloroethane	71556	µg kg⁻¹	M								
	Tetrachloromethane	56235	µg kg⁻¹	M								
	1,1-Dichloropropene	563586	µg kg⁻¹	U								
	Benzene	71432	µg kg⁻¹	M								
	1,2-Dichloroethane	107062	µg kg⁻¹	M								
	Trichloroethene	79016	µg kg⁻¹	U								
	1,2-Dichloropropane	78875	µg kg⁻¹	U								
	Dibromomethane	74953	µg kg⁻¹	U								
	Bromodichloromethane	75274	µg kg⁻¹	U								
	cis-1,3-Dichloropropene	10061015	µg kg⁻¹	U								
	Toluene	108883	µg kg⁻¹	M								
	trans-1,3-Dichloropropene	10061026	µg kg⁻¹	U								
	1,1,2-Trichloroethane	79005	µg kg⁻¹	M								
	Tetrachloroethene	127184	µg kg⁻¹	M								
	1,3-Dichloropropane	142289	µg kg⁻¹	U								
	Dibromochloromethane	124481	µg kg⁻¹	U								
	1,2-Dibromoethane	106934	µg kg⁻¹	U								
	Chlorobenzene	108907	µg kg⁻¹	M								
	1,1,1,2-Tetrachloroethane	630206	µg kg⁻¹	M								
	Ethylbenzene	100414	µg kg⁻¹	M								
	m- & p-Xylene	1330207	µg kg⁻¹	M								
	o-Xylene	95476	µg kg⁻¹	M								
	Styrene	100425	µg kg⁻¹	U								
	Tribromomethane	75252	µg kg⁻¹	U								
	Isopropylbenzene	98828	µg kg⁻¹	U								

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

* Accreditation status

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LABORATORY TEST REPORT

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					90823							
					AC91897	AC91898	AC91899	AC91900	AC91901	AC91902	AC91903	AC91904
					WS8	WS9	WS10	WS10	CP2	TP1	TP2	TP3
					0.9	0.4	0.4	4.5	0.1-1.2	0.6-0.8	0-1.5	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Dichloromethane	75092	µg kg⁻¹	U								
	trans-1,2-Dichloroethene	156605	µg kg⁻¹	M								
	1,1-Dichloroethane	75343	µg kg⁻¹	M								
	cis-1,2-Dichloroethene	156592	µg kg⁻¹	M								
	Bromochloromethane	74975	µg kg⁻¹	U								
	Trichloromethane	67663	µg kg⁻¹	M								
	1,1,1-Trichloroethane	71556	µg kg⁻¹	M								
	Tetrachloromethane	56235	µg kg⁻¹	M								
	1,1-Dichloropropene	563586	µg kg⁻¹	U								
	Benzene	71432	µg kg⁻¹	M								
	1,2-Dichloroethane	107062	µg kg⁻¹	M								
	Trichloroethene	79016	µg kg⁻¹	U								
	1,2-Dichloropropane	78875	µg kg⁻¹	U								
	Dibromomethane	74953	µg kg⁻¹	U								
	Bromodichloromethane	75274	µg kg⁻¹	U								
	cis-1,3-Dichloropropene	10061015	µg kg⁻¹	U								
	Toluene	108883	µg kg⁻¹	M								
	trans-1,3-Dichloropropene	10061026	µg kg⁻¹	U								
	1,1,2-Trichloroethane	79005	µg kg⁻¹	M								
	Tetrachloroethene	127184	µg kg⁻¹	M								
	1,3-Dichloropropane	142289	µg kg⁻¹	U								
	Dibromochloromethane	124481	µg kg⁻¹	U								
	1,2-Dibromoethane	106934	µg kg⁻¹	U								
	Chlorobenzene	108907	µg kg⁻¹	M								
	1,1,1,2-Tetrachloroethane	630206	µg kg⁻¹	M								
	Ethylbenzene	100414	µg kg⁻¹	M								
	m- & p-Xylene	1330207	µg kg⁻¹	M								
	o-Xylene	95476	µg kg⁻¹	M								
	Styrene	100425	µg kg⁻¹	U								
	Tribromomethane	75252	µg kg⁻¹	U								
	Isopropylbenzene	98828	µg kg⁻¹	U								

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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LABORATORY TEST REPORT

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					90823							
					AC91905	AC91906	AC91907	AC91908	AC91909	AC91910	AC91911	AC91912
					TP4	TP4	TP4	TP5	TP6	TP6	TP7	TP8
					0.4-1.5	2.7	3.6	0.4-1	0-1	2.7-3.0	0.5	0.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Dichloromethane	75092	µg kg⁻¹	U								
	trans-1,2-Dichloroethene	156605	µg kg⁻¹	M								
	1,1-Dichloroethane	75343	µg kg⁻¹	M								
	cis-1,2-Dichloroethene	156592	µg kg⁻¹	M								
	Bromochloromethane	74975	µg kg⁻¹	U								
	Trichloromethane	67663	µg kg⁻¹	M								
	1,1,1-Trichloroethane	71556	µg kg⁻¹	M								
	Tetrachloromethane	56235	µg kg⁻¹	M								
	1,1-Dichloropropene	563586	µg kg⁻¹	U								
	Benzene	71432	µg kg⁻¹	M								
	1,2-Dichloroethane	107062	µg kg⁻¹	M								
	Trichloroethene	79016	µg kg⁻¹	U								
	1,2-Dichloropropane	78875	µg kg⁻¹	U								
	Dibromomethane	74953	µg kg⁻¹	U								
	Bromodichloromethane	75274	µg kg⁻¹	U								
	cis-1,3-Dichloropropene	10061015	µg kg⁻¹	U								
	Toluene	108883	µg kg⁻¹	M								
	trans-1,3-Dichloropropene	10061026	µg kg⁻¹	U								
	1,1,2-Trichloroethane	79005	µg kg⁻¹	M								
	Tetrachloroethene	127184	µg kg⁻¹	M								
	1,3-Dichloropropane	142289	µg kg⁻¹	U								
	Dibromochloromethane	124481	µg kg⁻¹	U								
	1,2-Dibromoethane	106934	µg kg⁻¹	U								
	Chlorobenzene	108907	µg kg⁻¹	M								
	1,1,1,2-Tetrachloroethane	630206	µg kg⁻¹	M								
	Ethylbenzene	100414	µg kg⁻¹	M								
	m- & p-Xylene	1330207	µg kg⁻¹	M								
	o-Xylene	95476	µg kg⁻¹	M								
	Styrene	100425	µg kg⁻¹	U								
	Tribromomethane	75252	µg kg⁻¹	U								
	Isopropylbenzene	98828	µg kg⁻¹	U								

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					90823							
					AC91913	AC91914	AC91915	AC91916	AC91917	AC91918	AC91919	AC91920
					TP9	TP10	TP11	TP12	TP13	TP14	TP15	TP16
					1.5-2	0.3	0-1.1	0.8-1	0-1.5	0.3-1.7	0-1	0-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Dichloromethane	75092	µg kg⁻¹	U								
	trans-1,2-Dichloroethene	156605	µg kg⁻¹	M								
	1,1-Dichloroethane	75343	µg kg⁻¹	M								
	cis-1,2-Dichloroethene	156592	µg kg⁻¹	M								
	Bromochloromethane	74975	µg kg⁻¹	U								
	Trichloromethane	67663	µg kg⁻¹	M								
	1,1,1-Trichloroethane	71556	µg kg⁻¹	M								
	Tetrachloromethane	56235	µg kg⁻¹	M								
	1,1-Dichloropropene	563586	µg kg⁻¹	U								
	Benzene	71432	µg kg⁻¹	M								
	1,2-Dichloroethane	107062	µg kg⁻¹	M								
	Trichloroethene	79016	µg kg⁻¹	U								
	1,2-Dichloropropane	78875	µg kg⁻¹	U								
	Dibromomethane	74953	µg kg⁻¹	U								
	Bromodichloromethane	75274	µg kg⁻¹	U								
	cis-1,3-Dichloropropene	10061015	µg kg⁻¹	U								
	Toluene	108883	µg kg⁻¹	M								
	trans-1,3-Dichloropropene	10061026	µg kg⁻¹	U								
	1,1,2-Trichloroethane	79005	µg kg⁻¹	M								
	Tetrachloroethene	127184	µg kg⁻¹	M								
	1,3-Dichloropropane	142289	µg kg⁻¹	U								
	Dibromochloromethane	124481	µg kg⁻¹	U								
	1,2-Dibromoethane	106934	µg kg⁻¹	U								
	Chlorobenzene	108907	µg kg⁻¹	M								
	1,1,1,2-Tetrachloroethane	630206	µg kg⁻¹	M								
	Ethylbenzene	100414	µg kg⁻¹	M								
	m- & p-Xylene	1330207	µg kg⁻¹	M								
	o-Xylene	95476	µg kg⁻¹	M								
	Styrene	100425	µg kg⁻¹	U								
	Tribromomethane	75252	µg kg⁻¹	U								
	Isopropylbenzene	98828	µg kg⁻¹	U								

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					90823							
					AC91921	AC91922	AC91923	AC91924	AC91925	AC91926	AC91927	AC91928
					TP17	TP18	TP18	TP19	TP20	TP21	TP22	TP23
					0.3-1.5	0-0.6	0.6-1	0-0.8	0-0.6	0-1	0.2-0.9	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Dichloromethane	75092	µg kg⁻¹	U								ne
	trans-1,2-Dichloroethene	156605	µg kg⁻¹	M								<1
	1,1-Dichloroethane	75343	µg kg⁻¹	M								<1
	cis-1,2-Dichloroethene	156592	µg kg⁻¹	M								<1
	Bromochloromethane	74975	µg kg⁻¹	U								<1
	Trichloromethane	67663	µg kg⁻¹	M								<1
	1,1,1-Trichloroethane	71556	µg kg⁻¹	M								<1
	Tetrachloromethane	56235	µg kg⁻¹	M								<1
	1,1-Dichloropropene	563586	µg kg⁻¹	U								<1
	Benzene	71432	µg kg⁻¹	M								<1
	1,2-Dichloroethane	107062	µg kg⁻¹	M								<2
	Trichloroethene	79016	µg kg⁻¹	U								<1
	1,2-Dichloropropane	78875	µg kg⁻¹	U								<1
	Dibromomethane	74953	µg kg⁻¹	U								<10
	Bromodichloromethane	75274	µg kg⁻¹	U								<5
	cis-1,3-Dichloropropene	10061015	µg kg⁻¹	U								<10
	Toluene	108883	µg kg⁻¹	M								<1
	trans-1,3-Dichloropropene	10061026	µg kg⁻¹	U								<10
	1,1,2-Trichloroethane	79005	µg kg⁻¹	M								<10
	Tetrachloroethene	127184	µg kg⁻¹	M								<1
	1,3-Dichloropropane	142289	µg kg⁻¹	U								<2
	Dibromochloromethane	124481	µg kg⁻¹	U								<10
	1,2-Dibromoethane	106934	µg kg⁻¹	U								<5
	Chlorobenzene	108907	µg kg⁻¹	M								<1
	1,1,1,2-Tetrachloroethane	630206	µg kg⁻¹	M								<2
	Ethylbenzene	100414	µg kg⁻¹	M								<1
	m- & p-Xylene	1330207	µg kg⁻¹	M								<1
	o-Xylene	95476	µg kg⁻¹	M								<1
	Styrene	100425	µg kg⁻¹	U								<1
	Tribromomethane	75252	µg kg⁻¹	U								<10
	Isopropylbenzene	98828	µg kg⁻¹	U								<1

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					90823		
					AC91929	AC91930	AC91931
					TP24	CP1	CP1
					0-0.3	0.1-1.2	7-7.5
					SOIL	*SOIL*	*SOIL*
2760	Dichloromethane	75092	µg kg-1	U			
	trans-1,2-Dichloroethene	156605	µg kg-1	M			
	1,1-Dichloroethane	75343	µg kg-1	M			
	cis-1,2-Dichloroethene	156592	µg kg-1	M			
	Bromochloromethane	74975	µg kg-1	U			
	Trichloromethane	67663	µg kg-1	M			
	1,1,1-Trichloroethane	71556	µg kg-1	M			
	Tetrachloromethane	56235	µg kg-1	M			
	1,1-Dichloropropene	563586	µg kg-1	U			
	Benzene	71432	µg kg-1	M			
	1,2-Dichloroethane	107062	µg kg-1	M			
	Trichloroethene	79016	µg kg-1	U			
	1,2-Dichloropropane	78875	µg kg-1	U			
	Dibromomethane	74953	µg kg-1	U			
	Bromodichloromethane	75274	µg kg-1	U			
	cis-1,3-Dichloropropene	10061015	µg kg-1	U			
	Toluene	108883	µg kg-1	M			
	trans-1,3-Dichloropropene	10061026	µg kg-1	U			
	1,1,2-Trichloroethane	79005	µg kg-1	M			
	Tetrachloroethene	127184	µg kg-1	M			
	1,3-Dichloropropane	142289	µg kg-1	U			
	Dibromochloromethane	124481	µg kg-1	U			
	1,2-Dibromoethane	106934	µg kg-1	U			
	Chlorobenzene	108907	µg kg-1	M			
	1,1,1,2-Tetrachloroethane	630206	µg kg-1	M			
	Ethylbenzene	100414	µg kg-1	M			
	m- & p-Xylene	1330207	µg kg-1	M			
	o-Xylene	95476	µg kg-1	M			
	Styrene	100425	µg kg-1	U			
	Tribromomethane	75252	µg kg-1	U			
	Isopropylbenzene	98828	µg kg-1	U			

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BL9 6BU

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LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

					90823							
					AC91889	AC91890	AC91891	AC91892	AC91893	AC91894	AC91895	AC91896
					WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS7
					0.7	0.6	0.5	0.4	0.2	0.5	0.5	4.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Bromobenzene	108861	µg kg⁻¹	U								
	1,1,2,2-Tetrachloroethane	79345	µg kg⁻¹	M								
	1,2,3-Trichloropropane	96184	µg kg⁻¹	U								
	n-Propylbenzene	103651	µg kg⁻¹	U								
	2-Chlorotoluene	95498	µg kg⁻¹	U								
	1,3,5-Trimethylbenzene	108678	µg kg⁻¹	U								
	4-Chlorotoluene	106434	µg kg⁻¹	U								
	tert-Butylbenzene	98066	µg kg⁻¹	U								
	1,2,4-Trimethylbenzene	95636	µg kg⁻¹	U								
	sec-Butylbenzene	135988	µg kg⁻¹	U								
	1,3-Dichlorobenzene	541731	µg kg⁻¹	U								
	4-Isopropyltoluene	99876	µg kg⁻¹	U								
	1,4-Dichlorobenzene	106467	µg kg⁻¹	U								
	n-Butylbenzene	104518	µg kg⁻¹	U								
	1,2-Dichlorobenzene	95501	µg kg⁻¹	U								
	1,2-Dibromo-3-chloropropane	96128	µg kg⁻¹	U								
	1,2,4-Trichlorobenzene	120821	µg kg⁻¹	U								
	Hexachlorobutadiene	87683	µg kg⁻¹	U								
	1,2,3-Trichlorobenzene	87616	µg kg⁻¹	U								
2790	N-Nitrosodimethylamine	62759	mg kg⁻¹	N								
	Phenol	108952	mg kg⁻¹	N								
	bis(2-Chloroethyl)ether	111444	mg kg⁻¹	N								
	2-Chlorophenol	95578	mg kg⁻¹	N								
	1,3-Dichlorobenzene	541731	mg kg⁻¹	N								
	1,4-Dichlorobenzene	106467	mg kg⁻¹	N								
	1,2-Dichlorobenzene	95501	mg kg⁻¹	N								
	2-Methylphenol	95487	mg kg⁻¹	N								
	bis(2-Chloroisopropyl)ether	108601	mg kg⁻¹	N								
	4-Methylphenol	106445	mg kg⁻¹	N								
	N-Nitrosodi-n-propylamine	621647	mg kg⁻¹	N								
	Hexachloroethane	67721	mg kg⁻¹	N								

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
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BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

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Chemtest

Report Date
17 April 2008

					90823							
					AC91897	AC91898	AC91899	AC91900	AC91901	AC91902	AC91903	AC91904
					WS8	WS9	WS10	WS10	CP2	TP1	TP2	TP3
					0.9	0.4	0.4	4.5	0.1-1.2	0.6-0.8	0-1.5	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Bromobenzene	108861	µg kg-1	U								
	1,1,2,2-Tetrachloroethane	79345	µg kg-1	M								
	1,2,3-Trichloropropane	96184	µg kg-1	U								
	n-Propylbenzene	103651	µg kg-1	U								
	2-Chlorotoluene	95498	µg kg-1	U								
	1,3,5-Trimethylbenzene	108678	µg kg-1	U								
	4-Chlorotoluene	106434	µg kg-1	U								
	tert-Butylbenzene	98066	µg kg-1	U								
	1,2,4-Trimethylbenzene	95636	µg kg-1	U								
	sec-Butylbenzene	135988	µg kg-1	U								
	1,3-Dichlorobenzene	541731	µg kg-1	U								
	4-Isopropyltoluene	99876	µg kg-1	U								
	1,4-Dichlorobenzene	106467	µg kg-1	U								
	n-Butylbenzene	104518	µg kg-1	U								
	1,2-Dichlorobenzene	95501	µg kg-1	U								
	1,2-Dibromo-3-chloropropane	96128	µg kg-1	U								
	1,2,4-Trichlorobenzene	120821	µg kg-1	U								
	Hexachlorobutadiene	87683	µg kg-1	U								
	1,2,3-Trichlorobenzene	87616	µg kg-1	U								
2790	N-Nitrosodimethylamine	62759	mg kg-1	N								
	Phenol	108952	mg kg-1	N								
	bis(2-Chloroethyl)ether	111444	mg kg-1	N								
	2-Chlorophenol	95578	mg kg-1	N								
	1,3-Dichlorobenzene	541731	mg kg-1	N								
	1,4-Dichlorobenzene	106467	mg kg-1	N								
	1,2-Dichlorobenzene	95501	mg kg-1	N								
	2-Methylphenol	95487	mg kg-1	N								
	bis(2-Chloroisopropyl)ether	108601	mg kg-1	N								
	4-Methylphenol	106445	mg kg-1	N								
	N-Nitrosodi-n-propylamine	621647	mg kg-1	N								
	Hexachloroethane	67721	mg kg-1	N								

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Chemtest

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					90823							
					AC91905	AC91906	AC91907	AC91908	AC91909	AC91910	AC91911	AC91912
					TP4	TP4	TP4	TP5	TP6	TP6	TP7	TP8
					0.4-1.5	2.7	3.6	0.4-1	0-1	2.7-3.0	0.5	0.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Bromobenzene	108861	µg kg-1	U								
	1,1,2,2-Tetrachloroethane	79345	µg kg-1	M								
	1,2,3-Trichloropropane	96184	µg kg-1	U								
	n-Propylbenzene	103651	µg kg-1	U								
	2-Chlorotoluene	95498	µg kg-1	U								
	1,3,5-Trimethylbenzene	108678	µg kg-1	U								
	4-Chlorotoluene	106434	µg kg-1	U								
	tert-Butylbenzene	98066	µg kg-1	U								
	1,2,4-Trimethylbenzene	95636	µg kg-1	U								
	sec-Butylbenzene	135988	µg kg-1	U								
	1,3-Dichlorobenzene	541731	µg kg-1	U								
	4-Isopropyltoluene	99876	µg kg-1	U								
	1,4-Dichlorobenzene	106467	µg kg-1	U								
	n-Butylbenzene	104518	µg kg-1	U								
	1,2-Dichlorobenzene	95501	µg kg-1	U								
	1,2-Dibromo-3-chloropropane	96128	µg kg-1	U								
	1,2,4-Trichlorobenzene	120821	µg kg-1	U								
	Hexachlorobutadiene	87683	µg kg-1	U								
	1,2,3-Trichlorobenzene	87616	µg kg-1	U								
2790	N-Nitrosodimethylamine	62759	mg kg-1	N								
	Phenol	108952	mg kg-1	N								
	bis(2-Chloroethyl)ether	111444	mg kg-1	N								
	2-Chlorophenol	95578	mg kg-1	N								
	1,3-Dichlorobenzene	541731	mg kg-1	N								
	1,4-Dichlorobenzene	106467	mg kg-1	N								
	1,2-Dichlorobenzene	95501	mg kg-1	N								
	2-Methylphenol	95487	mg kg-1	N								
	bis(2-Chloroisopropyl)ether	108601	mg kg-1	N								
	4-Methylphenol	106445	mg kg-1	N								
	N-Nitrosodi-n-propylamine	621647	mg kg-1	N								
	Hexachloroethane	67721	mg kg-1	N								

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LABORATORY TEST REPORT

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					90823							
					AC91913	AC91914	AC91915	AC91916	AC91917	AC91918	AC91919	AC91920
					TP9	TP10	TP11	TP12	TP13	TP14	TP15	TP16
					1.5-2	0.3	0-1.1	0.8-1	0-1.5	0.3-1.7	0-1	0-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Bromobenzene	108861	µg kg-1	U								
	1,1,2,2-Tetrachloroethane	79345	µg kg-1	M								
	1,2,3-Trichloropropane	96184	µg kg-1	U								
	n-Propylbenzene	103651	µg kg-1	U								
	2-Chlorotoluene	95498	µg kg-1	U								
	1,3,5-Trimethylbenzene	108678	µg kg-1	U								
	4-Chlorotoluene	106434	µg kg-1	U								
	tert-Butylbenzene	98066	µg kg-1	U								
	1,2,4-Trimethylbenzene	95636	µg kg-1	U								
	sec-Butylbenzene	135988	µg kg-1	U								
	1,3-Dichlorobenzene	541731	µg kg-1	U								
	4-Isopropyltoluene	99876	µg kg-1	U								
	1,4-Dichlorobenzene	106467	µg kg-1	U								
	n-Butylbenzene	104518	µg kg-1	U								
	1,2-Dichlorobenzene	95501	µg kg-1	U								
	1,2-Dibromo-3-chloropropane	96128	µg kg-1	U								
	1,2,4-Trichlorobenzene	120821	µg kg-1	U								
	Hexachlorobutadiene	87683	µg kg-1	U								
	1,2,3-Trichlorobenzene	87616	µg kg-1	U								
2790	N-Nitrosodimethylamine	62759	mg kg-1	N								
	Phenol	108952	mg kg-1	N								
	bis(2-Chloroethyl)ether	111444	mg kg-1	N								
	2-Chlorophenol	95578	mg kg-1	N								
	1,3-Dichlorobenzene	541731	mg kg-1	N								
	1,4-Dichlorobenzene	106467	mg kg-1	N								
	1,2-Dichlorobenzene	95501	mg kg-1	N								
	2-Methylphenol	95487	mg kg-1	N								
	bis(2-Chloroisopropyl)ether	108601	mg kg-1	N								
	4-Methylphenol	106445	mg kg-1	N								
	N-Nitrosodi-n-propylamine	621647	mg kg-1	N								
	Hexachloroethane	67721	mg kg-1	N								

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Chemtest

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					90823							
					AC91921	AC91922	AC91923	AC91924	AC91925	AC91926	AC91927	AC91928
					TP17	TP18	TP18	TP19	TP20	TP21	TP22	TP23
					0.3-1.5	0-0.6	0.6-1	0-0.8	0-0.6	0-1	0.2-0.9	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Bromobenzene	108861	µg kg-1	U								<1
	1,1,2,2-Tetrachloroethane	79345	µg kg-1	M								<10
	1,2,3-Trichloropropane	96184	µg kg-1	U								<50
	n-Propylbenzene	103651	µg kg-1	U								<1
	2-Chlorotoluene	95498	µg kg-1	U								<1
	1,3,5-Trimethylbenzene	108678	µg kg-1	U								<1
	4-Chlorotoluene	106434	µg kg-1	U								<1
	tert-Butylbenzene	98066	µg kg-1	U								<1
	1,2,4-Trimethylbenzene	95636	µg kg-1	U								<1
	sec-Butylbenzene	135988	µg kg-1	U								<1
	1,3-Dichlorobenzene	541731	µg kg-1	U								<1
	4-Isopropyltoluene	99876	µg kg-1	U								<1
	1,4-Dichlorobenzene	106467	µg kg-1	U								<1
	n-Butylbenzene	104518	µg kg-1	U								<1
	1,2-Dichlorobenzene	95501	µg kg-1	U								<1
	1,2-Dibromo-3-chloropropane	96128	µg kg-1	U								<50
	1,2,4-Trichlorobenzene	120821	µg kg-1	U								<1
	Hexachlorobutadiene	87683	µg kg-1	U								<1
	1,2,3-Trichlorobenzene	87616	µg kg-1	U								<2
2790	N-Nitrosodimethylamine	62759	mg kg-1	N								<0.5
	Phenol	108952	mg kg-1	N								<0.5
	bis(2-Chloroethyl)ether	111444	mg kg-1	N								<0.5
	2-Chlorophenol	95578	mg kg-1	N								<0.5
	1,3-Dichlorobenzene	541731	mg kg-1	N								<0.5
	1,4-Dichlorobenzene	106467	mg kg-1	N								<0.5
	1,2-Dichlorobenzene	95501	mg kg-1	N								<0.5
	2-Methylphenol	95487	mg kg-1	N								<0.5
	bis(2-Chloroisopropyl)ether	108601	mg kg-1	N								<0.5
	4-Methylphenol	106445	mg kg-1	N								<0.5
	N-Nitrosodi-n-propylamine	621647	mg kg-1	N								<0.5
	Hexachloroethane	67721	mg kg-1	N								<0.5

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					90823		
					AC91929	AC91930	AC91931
					TP24	CP1	CP1
					0-0.3	0.1-1.2	7-7.5
					SOIL	*SOIL*	*SOIL*
2760	Bromobenzene	108861	µg kg-1	U			
	1,1,2,2-Tetrachloroethane	79345	µg kg-1	M			
	1,2,3-Trichloropropane	96184	µg kg-1	U			
	n-Propylbenzene	103651	µg kg-1	U			
	2-Chlorotoluene	95498	µg kg-1	U			
	1,3,5-Trimethylbenzene	108678	µg kg-1	U			
	4-Chlorotoluene	106434	µg kg-1	U			
	tert-Butylbenzene	98066	µg kg-1	U			
	1,2,4-Trimethylbenzene	95636	µg kg-1	U			
	sec-Butylbenzene	135988	µg kg-1	U			
	1,3-Dichlorobenzene	541731	µg kg-1	U			
	4-Isopropyltoluene	99876	µg kg-1	U			
	1,4-Dichlorobenzene	106467	µg kg-1	U			
	n-Butylbenzene	104518	µg kg-1	U			
	1,2-Dichlorobenzene	95501	µg kg-1	U			
	1,2-Dibromo-3-chloropropane	96128	µg kg-1	U			
	1,2,4-Trichlorobenzene	120821	µg kg-1	U			
	Hexachlorobutadiene	87683	µg kg-1	U			
	1,2,3-Trichlorobenzene	87616	µg kg-1	U			
2790	N-Nitrosodimethylamine	62759	mg kg-1	N			
	Phenol	108952	mg kg-1	N			
	bis(2-Chloroethyl)ether	111444	mg kg-1	N			
	2-Chlorophenol	95578	mg kg-1	N			
	1,3-Dichlorobenzene	541731	mg kg-1	N			
	1,4-Dichlorobenzene	106467	mg kg-1	N			
	1,2-Dichlorobenzene	95501	mg kg-1	N			
	2-Methylphenol	95487	mg kg-1	N			
	bis(2-Chloroisopropyl)ether	108601	mg kg-1	N			
	4-Methylphenol	106445	mg kg-1	N			
	N-Nitrosodi-n-propylamine	621647	mg kg-1	N			
	Hexachloroethane	67721	mg kg-1	N			

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					90823							
					AC91889	AC91890	AC91891	AC91892	AC91893	AC91894	AC91895	AC91896
					WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS7
					0.7	0.6	0.5	0.4	0.2	0.5	0.5	4.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Nitrobenzene	98953	mg kg-1	N								
	Isophorone	78591	mg kg-1	N								
	2-Nitrophenol	88755	mg kg-1	N								
	2,4-Dimethylphenol	105679	mg kg-1	N								
	bis(2-Chloroethoxy)methane	111911	mg kg-1	N								
	2,4-Dichlorophenol	120832	mg kg-1	N								
	1,2,4-Trichlorobenzene	120821	mg kg-1	N								
	Naphthalene	91203	mg kg-1	N								
	4-Chloroaniline	106478	mg kg-1	N								
	Hexachlorobutadiene	87683	mg kg-1	N								
	4-Chloro-3-methylphenol	59507	mg kg-1	N								
	2-Methylnaphthalene	91576	mg kg-1	N								
	Hexachlorocyclopentadiene	77474	mg kg-1	N								
	2,4,6-Trichlorophenol	88062	mg kg-1	N								
	2,4,5-Trichlorophenol	95954	mg kg-1	N								
	2-Chloronaphthalene	91587	mg kg-1	N								
	2-Nitroaniline	88744	mg kg-1	N								
	Dimethylphthalate	131113	mg kg-1	N								
	2,6-Dinitrotoluene	606202	mg kg-1	N								
	Acenaphthylene	208968	mg kg-1	N								
	3-Nitroaniline	99092	mg kg-1	N								
	Acenaphthene	83329	mg kg-1	N								
	Dibenzofuran	132649	mg kg-1	N								
	2,4-Dinitrotoluene	121142	mg kg-1	N								
	Diethylphthalate	84662	mg kg-1	N								
	Fluorene	86737	mg kg-1	N								
	4-Chlorophenylether	7005723	mg kg-1	N								
	4-Nitroaniline	100016	mg kg-1	N								
	2-Methyl-4,6-dinitrophenol	534521	mg kg-1	N								
	Azobenzene	103333	mg kg-1	N								
	4-Bromophenylphenylether	101553	mg kg-1	N								

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					AC91897	AC91898	AC91899	AC91900	AC91901	AC91902	AC91903	AC91904
					WS8	WS9	WS10	WS10	CP2	TP1	TP2	TP3
					0.9	0.4	0.4	4.5	0.1-1.2	0.6-0.8	0-1.5	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Nitrobenzene	98953	mg kg-1	N								
	Isophorone	78591	mg kg-1	N								
	2-Nitrophenol	88755	mg kg-1	N								
	2,4-Dimethylphenol	105679	mg kg-1	N								
	bis(2-Chloroethoxy)methane	111911	mg kg-1	N								
	2,4-Dichlorophenol	120832	mg kg-1	N								
	1,2,4-Trichlorobenzene	120821	mg kg-1	N								
	Naphthalene	91203	mg kg-1	N								
	4-Chloroaniline	106478	mg kg-1	N								
	Hexachlorobutadiene	87683	mg kg-1	N								
	4-Chloro-3-methylphenol	59507	mg kg-1	N								
	2-Methylnaphthalene	91576	mg kg-1	N								
	Hexachlorocyclopentadiene	77474	mg kg-1	N								
	2,4,6-Trichlorophenol	88062	mg kg-1	N								
	2,4,5-Trichlorophenol	95954	mg kg-1	N								
	2-Chloronaphthalene	91587	mg kg-1	N								
	2-Nitroaniline	88744	mg kg-1	N								
	Dimethylphthalate	131113	mg kg-1	N								
	2,6-Dinitrotoluene	606202	mg kg-1	N								
	Acenaphthylene	208968	mg kg-1	N								
	3-Nitroaniline	99092	mg kg-1	N								
	Acenaphthene	83329	mg kg-1	N								
	Dibenzofuran	132649	mg kg-1	N								
	2,4-Dinitrotoluene	121142	mg kg-1	N								
	Diethylphthalate	84662	mg kg-1	N								
	Fluorene	86737	mg kg-1	N								
	4-Chlorophenylether	7005723	mg kg-1	N								
	4-Nitroaniline	100016	mg kg-1	N								
	2-Methyl-4,6-dinitrophenol	534521	mg kg-1	N								
	Azobenzene	103333	mg kg-1	N								
	4-Bromophenylphenylether	101553	mg kg-1	N								

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					90823							
					AC91905	AC91906	AC91907	AC91908	AC91909	AC91910	AC91911	AC91912
					TP4	TP4	TP4	TP5	TP6	TP6	TP7	TP8
					0.4-1.5	2.7	3.6	0.4-1	0-1	2.7-3.0	0.5	0.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Nitrobenzene	98953	mg kg-1	N								
	Isophorone	78591	mg kg-1	N								
	2-Nitrophenol	88755	mg kg-1	N								
	2,4-Dimethylphenol	105679	mg kg-1	N								
	bis(2-Chloroethoxy)methane	111911	mg kg-1	N								
	2,4-Dichlorophenol	120832	mg kg-1	N								
	1,2,4-Trichlorobenzene	120821	mg kg-1	N								
	Naphthalene	91203	mg kg-1	N								
	4-Chloroaniline	106478	mg kg-1	N								
	Hexachlorobutadiene	87683	mg kg-1	N								
	4-Chloro-3-methylphenol	59507	mg kg-1	N								
	2-Methylnaphthalene	91576	mg kg-1	N								
	Hexachlorocyclopentadiene	77474	mg kg-1	N								
	2,4,6-Trichlorophenol	88062	mg kg-1	N								
	2,4,5-Trichlorophenol	95954	mg kg-1	N								
	2-Chloronaphthalene	91587	mg kg-1	N								
	2-Nitroaniline	88744	mg kg-1	N								
	Dimethylphthalate	131113	mg kg-1	N								
	2,6-Dinitrotoluene	606202	mg kg-1	N								
	Acenaphthylene	208968	mg kg-1	N								
	3-Nitroaniline	99092	mg kg-1	N								
	Acenaphthene	83329	mg kg-1	N								
	Dibenzofuran	132649	mg kg-1	N								
	2,4-Dinitrotoluene	121142	mg kg-1	N								
	Diethylphthalate	84662	mg kg-1	N								
	Fluorene	86737	mg kg-1	N								
	4-Chlorophenylether	7005723	mg kg-1	N								
	4-Nitroaniline	100016	mg kg-1	N								
	2-Methyl-4,6-dinitrophenol	534521	mg kg-1	N								
	Azobenzene	103333	mg kg-1	N								
	4-Bromophenylphenylether	101553	mg kg-1	N								

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

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					90823							
					AC91913	AC91914	AC91915	AC91916	AC91917	AC91918	AC91919	AC91920
					TP9	TP10	TP11	TP12	TP13	TP14	TP15	TP16
					1.5-2	0.3	0-1.1	0.8-1	0-1.5	0.3-1.7	0-1	0-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Nitrobenzene	98953	mg kg-1	N								
	Isophorone	78591	mg kg-1	N								
	2-Nitrophenol	88755	mg kg-1	N								
	2,4-Dimethylphenol	105679	mg kg-1	N								
	bis(2-Chloroethoxy)methane	111911	mg kg-1	N								
	2,4-Dichlorophenol	120832	mg kg-1	N								
	1,2,4-Trichlorobenzene	120821	mg kg-1	N								
	Naphthalene	91203	mg kg-1	N								
	4-Chloroaniline	106478	mg kg-1	N								
	Hexachlorobutadiene	87683	mg kg-1	N								
	4-Chloro-3-methylphenol	59507	mg kg-1	N								
	2-Methylnaphthalene	91576	mg kg-1	N								
	Hexachlorocyclopentadiene	77474	mg kg-1	N								
	2,4,6-Trichlorophenol	88062	mg kg-1	N								
	2,4,5-Trichlorophenol	95954	mg kg-1	N								
	2-Chloronaphthalene	91587	mg kg-1	N								
	2-Nitroaniline	88744	mg kg-1	N								
	Dimethylphthalate	131113	mg kg-1	N								
	2,6-Dinitrotoluene	606202	mg kg-1	N								
	Acenaphthylene	208968	mg kg-1	N								
	3-Nitroaniline	99092	mg kg-1	N								
	Acenaphthene	83329	mg kg-1	N								
	Dibenzofuran	132649	mg kg-1	N								
	2,4-Dinitrotoluene	121142	mg kg-1	N								
	Diethylphthalate	84662	mg kg-1	N								
	Fluorene	86737	mg kg-1	N								
	4-Chlorophenylether	7005723	mg kg-1	N								
	4-Nitroaniline	100016	mg kg-1	N								
	2-Methyl-4,6-dinitrophenol	534521	mg kg-1	N								
	Azobenzene	103333	mg kg-1	N								
	4-Bromophenylphenylether	101553	mg kg-1	N								

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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					90823							
					AC91921	AC91922	AC91923	AC91924	AC91925	AC91926	AC91927	AC91928
					TP17	TP18	TP18	TP19	TP20	TP21	TP22	TP23
					0.3-1.5	0-0.6	0.6-1	0-0.8	0-0.6	0-1	0.2-0.9	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Nitrobenzene	98953	mg kg-1	N								<0.5
	Isophorone	78591	mg kg-1	N								<0.5
	2-Nitrophenol	88755	mg kg-1	N								<0.5
	2,4-Dimethylphenol	105679	mg kg-1	N								<0.5
	bis(2-Chloroethoxy)methane	111911	mg kg-1	N								<0.5
	2,4-Dichlorophenol	120832	mg kg-1	N								<0.5
	1,2,4-Trichlorobenzene	120821	mg kg-1	N								<0.5
	Naphthalene	91203	mg kg-1	N								<0.5
	4-Chloroaniline	106478	mg kg-1	N								<0.5
	Hexachlorobutadiene	87683	mg kg-1	N								<0.5
	4-Chloro-3-methylphenol	59507	mg kg-1	N								<0.5
	2-Methylnaphthalene	91576	mg kg-1	N								<0.5
	Hexachlorocyclopentadiene	77474	mg kg-1	N								<0.5
	2,4,6-Trichlorophenol	88062	mg kg-1	N								<0.5
	2,4,5-Trichlorophenol	95954	mg kg-1	N								<0.5
	2-Chloronaphthalene	91587	mg kg-1	N								<0.5
	2-Nitroaniline	88744	mg kg-1	N								<0.5
	Dimethylphthalate	131113	mg kg-1	N								<0.5
	2,6-Dinitrotoluene	606202	mg kg-1	N								<0.5
	Acenaphthylene	208968	mg kg-1	N								<0.5
	3-Nitroaniline	99092	mg kg-1	N								<0.5
	Acenaphthene	83329	mg kg-1	N								<0.5
	Dibenzofuran	132649	mg kg-1	N								<0.5
	2,4-Dinitrotoluene	121142	mg kg-1	N								<0.5
	Diethylphthalate	84662	mg kg-1	N								<0.5
	Fluorene	86737	mg kg-1	N								<0.5
	4-Chlorophenylether	7005723	mg kg-1	N								<0.5
	4-Nitroaniline	100016	mg kg-1	N								<0.5
	2-Methyl-4,6-dinitrophenol	534521	mg kg-1	N								<0.5
	Azobenzene	103333	mg kg-1	N								<0.5
	4-Bromophenylphenylether	101553	mg kg-1	N								<0.5

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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					90823		
					AC91929	AC91930	AC91931
					TP24	CP1	CP1
					0-0.3	0.1-1.2	7-7.5
					SOIL	*SOIL*	*SOIL*
2790	Nitrobenzene	98953	mg kg-1	N			
	Isophorone	78591	mg kg-1	N			
	2-Nitrophenol	88755	mg kg-1	N			
	2,4-Dimethylphenol	105679	mg kg-1	N			
	bis(2-Chloroethoxy)methane	111911	mg kg-1	N			
	2,4-Dichlorophenol	120832	mg kg-1	N			
	1,2,4-Trichlorobenzene	120821	mg kg-1	N			
	Naphthalene	91203	mg kg-1	N			
	4-Chloroaniline	106478	mg kg-1	N			
	Hexachlorobutadiene	87683	mg kg-1	N			
	4-Chloro-3-methylphenol	59507	mg kg-1	N			
	2-Methylnaphthalene	91576	mg kg-1	N			
	Hexachlorocyclopentadiene	77474	mg kg-1	N			
	2,4,6-Trichlorophenol	88062	mg kg-1	N			
	2,4,5-Trichlorophenol	95954	mg kg-1	N			
	2-Chloronaphthalene	91587	mg kg-1	N			
	2-Nitroaniline	88744	mg kg-1	N			
	Dimethylphthalate	131113	mg kg-1	N			
	2,6-Dinitrotoluene	606202	mg kg-1	N			
	Acenaphthylene	208968	mg kg-1	N			
	3-Nitroaniline	99092	mg kg-1	N			
	Acenaphthene	83329	mg kg-1	N			
	Dibenzofuran	132649	mg kg-1	N			
	2,4-Dinitrotoluene	121142	mg kg-1	N			
	Diethylphthalate	84662	mg kg-1	N			
	Fluorene	86737	mg kg-1	N			
	4-Chlorophenylether	7005723	mg kg-1	N			
	4-Nitroaniline	100016	mg kg-1	N			
	2-Methyl-4,6-dinitrophenol	534521	mg kg-1	N			
	Azobenzene	103333	mg kg-1	N			
	4-Bromophenylphenylether	101553	mg kg-1	N			

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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					90823							
					AC91889	AC91890	AC91891	AC91892	AC91893	AC91894	AC91895	AC91896
					WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS7
					0.7	0.6	0.5	0.4	0.2	0.5	0.5	4.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Hexachlorobenzene	118741	mg kg-1	N								
	Pentachlorophenol	87865	mg kg-1	N								
	Phenanthrene	85018	mg kg-1	N								
	Anthracene	120127	mg kg-1	N								
	Carbazole	86748	mg kg-1	N								
	Di-n-butylphthalate	84742	mg kg-1	N								
	Fluoranthene	206440	mg kg-1	N								
	Pyrene	129000	mg kg-1	N								
	Butylbenzylphthalate	85687	mg kg-1	N								
	Benzo[a]anthracene	56553	mg kg-1	N								
	Chrysene	218019	mg kg-1	N								
	bis(2-Ethylhexyl)phthalate	117817	mg kg-1	N								
	Di-n-octylphthalate	117840	mg kg-1	N								
	Benzo[b]fluoranthene	205992	mg kg-1	N								
	Benzo[k]fluoranthene	207089	mg kg-1	N								
	Benzo[a]pyrene	50328	mg kg-1	N								
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	N								
	Dibenzo[a,h]anthracene	53703	mg kg-1	N								
	Benzo[g,h,i]perylene	191242	mg kg-1	N								
2920	Phenols (total)		mg kg-1	M	26	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
2010	pH		-	M	7.5	7.5	7.3	8.1	7.9	8.0	7.9	7.7
2030	Moisture		%	n/a	7.05	18.3	12.6	10.1	15.4	16.9	20.9	17.8
	Stone content (as received)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2140	Soil colour			n/a	brown	black	brown	brown	black	brown	brown	brown
	Soil texture			n/a	sand	sand	clay	clay	clay	clay	sand	sand
	Other material			n/a	stones	stones	stones	none	none	none	none	none
2186	Asbestos (presence/absence)		-	N	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

* Accreditation status

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					90823							
					AC91897	AC91898	AC91899	AC91900	AC91901	AC91902	AC91903	AC91904
					WS8	WS9	WS10	WS10	CP2	TP1	TP2	TP3
					0.9	0.4	0.4	4.5	0.1-1.2	0.6-0.8	0-1.5	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Hexachlorobenzene	118741	mg kg-1	N								
	Pentachlorophenol	87865	mg kg-1	N								
	Phenanthrene	85018	mg kg-1	N								
	Anthracene	120127	mg kg-1	N								
	Carbazole	86748	mg kg-1	N								
	Di-n-butylphthalate	84742	mg kg-1	N								
	Fluoranthene	206440	mg kg-1	N								
	Pyrene	129000	mg kg-1	N								
	Butylbenzylphthalate	85687	mg kg-1	N								
	Benzo[a]anthracene	56553	mg kg-1	N								
	Chrysene	218019	mg kg-1	N								
	bis(2-Ethylhexyl)phthalate	117817	mg kg-1	N								
	Di-n-octylphthalate	117840	mg kg-1	N								
	Benzo[b]fluoranthene	205992	mg kg-1	N								
	Benzo[k]fluoranthene	207089	mg kg-1	N								
	Benzo[a]pyrene	50328	mg kg-1	N								
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	N								
	Dibenzo[a,h]anthracene	53703	mg kg-1	N								
	Benzo[g,h,i]perylene	191242	mg kg-1	N								
2920	Phenols (total)		mg kg-1	M	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
2010	pH		-	M	7.8	7.5	8.0	7.5	7.6	7.9	7.8	8.0
2030	Moisture		%	n/a	13.8	11.7	14.6	19.1	13.9	15	15.2	11.8
	Stone content (as received)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2140	Soil colour			n/a	brown	brown	brown	brown	brown	brown	brown	brown
	Soil texture			n/a	sand	sand	sand	sand	sand	sand	sand	sand
	Other material			n/a	none	none	none	none	none	none	none	none
2186	Asbestos (presence/absence)		-	N	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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					90823							
					AC91905	AC91906	AC91907	AC91908	AC91909	AC91910	AC91911	AC91912
					TP4	TP4	TP4	TP5	TP6	TP6	TP7	TP8
					0.4-1.5	2.7	3.6	0.4-1	0-1	2.7-3.0	0.5	0.8
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Hexachlorobenzene	118741	mg kg-1	N								
	Pentachlorophenol	87865	mg kg-1	N								
	Phenanthrene	85018	mg kg-1	N								
	Anthracene	120127	mg kg-1	N								
	Carbazole	86748	mg kg-1	N								
	Di-n-butylphthalate	84742	mg kg-1	N								
	Fluoranthene	206440	mg kg-1	N								
	Pyrene	129000	mg kg-1	N								
	Butylbenzylphthalate	85687	mg kg-1	N								
	Benzo[a]anthracene	56553	mg kg-1	N								
	Chrysene	218019	mg kg-1	N								
	bis(2-Ethylhexyl)phthalate	117817	mg kg-1	N								
	Di-n-octylphthalate	117840	mg kg-1	N								
	Benzo[b]fluoranthene	205992	mg kg-1	N								
	Benzo[k]fluoranthene	207089	mg kg-1	N								
	Benzo[a]pyrene	50328	mg kg-1	N								
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	N								
	Dibenzo[a,h]anthracene	53703	mg kg-1	N								
	Benzo[g,h,i]perylene	191242	mg kg-1	N								
2920	Phenols (total)		mg kg-1	M	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
2010	pH		-	M	8.0	8.2	8.1	8.0	8.0	8.1	8.3	7.9
2030	Moisture		%	n/a	14.4	16.6	26.2	14.8	13.9	14.4	12.2	12.7
	Stone content (as received)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2140	Soil colour			n/a	brown	brown	brown	brown	brown	brown	brown	brown
	Soil texture			n/a	sand	sand	sand	sand	sand	sand	sand	sand
	Other material			n/a	stones	none	none	none	none	none	stones	stones
2186	Asbestos (presence/absence)		-	N	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

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					90823							
					AC91913	AC91914	AC91915	AC91916	AC91917	AC91918	AC91919	AC91920
					TP9	TP10	TP11	TP12	TP13	TP14	TP15	TP16
					1.5-2	0.3	0-1.1	0.8-1	0-1.5	0.3-1.7	0-1	0-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Hexachlorobenzene	118741	mg kg-1	N								
	Pentachlorophenol	87865	mg kg-1	N								
	Phenanthrene	85018	mg kg-1	N								
	Anthracene	120127	mg kg-1	N								
	Carbazole	86748	mg kg-1	N								
	Di-n-butylphthalate	84742	mg kg-1	N								
	Fluoranthene	206440	mg kg-1	N								
	Pyrene	129000	mg kg-1	N								
	Butylbenzylphthalate	85687	mg kg-1	N								
	Benzo[a]anthracene	56553	mg kg-1	N								
	Chrysene	218019	mg kg-1	N								
	bis(2-Ethylhexyl)phthalate	117817	mg kg-1	N								
	Di-n-octylphthalate	117840	mg kg-1	N								
	Benzo[b]fluoranthene	205992	mg kg-1	N								
	Benzo[k]fluoranthene	207089	mg kg-1	N								
	Benzo[a]pyrene	50328	mg kg-1	N								
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	N								
	Dibenzo[a,h]anthracene	53703	mg kg-1	N								
	Benzo[g,h,i]perylene	191242	mg kg-1	N								
2920	Phenols (total)		mg kg-1	M	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
2010	pH		-	M	7.4	8.1	8.3	8.1	8.2	8.0	8.2	8.0
2030	Moisture		%	n/a	14.6	13.3	17.1	12.6	12.2	12.4	13.6	14.2
	Stone content (as received)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2140	Soil colour			n/a	brown	brown	brown	brown	brown	brown	brown	brown
	Soil texture			n/a	sand	sand	sand	sand	sand	sand	sand	sand
	Other material			n/a	none	none	none	stones	stones	stones	stones	stones
2186	Asbestos (presence/absence)		-	N	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected

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					90823							
					AC91921	AC91922	AC91923	AC91924	AC91925	AC91926	AC91927	AC91928
					TP17	TP18	TP18	TP19	TP20	TP21	TP22	TP23
					0.3-1.5	0-0.6	0.6-1	0-0.8	0-0.6	0-1	0.2-0.9	0.5-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Hexachlorobenzene	118741	mg kg-1	N								<0.5
	Pentachlorophenol	87865	mg kg-1	N								<0.5
	Phenanthrene	85018	mg kg-1	N								<0.5
	Anthracene	120127	mg kg-1	N								<0.5
	Carbazole	86748	mg kg-1	N								<0.5
	Di-n-butylphthalate	84742	mg kg-1	N								<0.5
	Fluoranthene	206440	mg kg-1	N								<0.5
	Pyrene	129000	mg kg-1	N								<0.5
	Butylbenzylphthalate	85687	mg kg-1	N								<0.5
	Benzo[a]anthracene	56553	mg kg-1	N								<0.5
	Chrysene	218019	mg kg-1	N								<0.5
	bis(2-Ethylhexyl)phthalate	117817	mg kg-1	N								<0.5
	Di-n-octylphthalate	117840	mg kg-1	N								<0.5
	Benzo[b]fluoranthene	205992	mg kg-1	N								<0.5
	Benzo[k]fluoranthene	207089	mg kg-1	N								<0.5
	Benzo[a]pyrene	50328	mg kg-1	N								<0.5
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	N								<0.5
	Dibenzo[a,h]anthracene	53703	mg kg-1	N								<0.5
	Benzo[g,h,i]perylene	191242	mg kg-1	N								<0.5
2920	Phenols (total)		mg kg-1	M	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
2010	pH		-	M	7.3	8.2	7.9	7.7	6.1	7.9	7.5	11.1
2030	Moisture		%	n/a	27.6	15.2	14.8	21.9	20.4	12.8	30.6	73.4
	Stone content (as received)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2140	Soil colour			n/a	brown	brown	brown	brown	brown	brown	brown	white
	Soil texture			n/a	sand	sand	sand	sand	sand	sand	sand	chalk
	Other material			n/a	stones	stones	stones	stones	stones	stones	stones	none
2186	Asbestos (presence/absence)		-	N	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R. McKellar

LABORATORY TEST REPORT

Results of analysis of 43 samples
received 04 September 2008

IWHC

Chemtest

Report Date
17 April 2008

					90823		
					AC91929	AC91930	AC91931
					TP24	CP1	CP1
					0-0.3	0.1-1.2	7-7.5
					SOIL	*SOIL*	*SOIL*
2790	Hexachlorobenzene	118741	mg kg-1	N			
	Pentachlorophenol	87865	mg kg-1	N			
	Phenanthrene	85018	mg kg-1	N			
	Anthracene	120127	mg kg-1	N			
	Carbazole	86748	mg kg-1	N			
	Di-n-butylphthalate	84742	mg kg-1	N			
	Fluoranthene	206440	mg kg-1	N			
	Pyrene	129000	mg kg-1	N			
	Butylbenzylphthalate	85687	mg kg-1	N			
	Benzo[a]anthracene	56553	mg kg-1	N			
	Chrysene	218019	mg kg-1	N			
	bis(2-Ethylhexyl)phthalate	117817	mg kg-1	N			
	Di-n-octylphthalate	117840	mg kg-1	N			
	Benzo[b]fluoranthene	205992	mg kg-1	N			
	Benzo[k]fluoranthene	207089	mg kg-1	N			
	Benzo[a]pyrene	50328	mg kg-1	N			
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	N			
	Dibenzo[a,h]anthracene	53703	mg kg-1	N			
	Benzo[g,h,i]perylene	191242	mg kg-1	N			
2920	Phenols (total)		mg kg-1	M	<0.3	<0.3	<0.3
2010	pH		-	M	8.1	8.4	8.5
2030	Moisture		%	n/a	18.6	0.95	12.7
	Stone content (as received)		%	n/a	<0.02	<0.02	<0.02
2140	Soil colour			n/a	brown	brown	brown
	Soil texture			n/a	sand	clay	clay
	Other material			n/a	stones	none	none
2186	Asbestos (presence/absence)		-	N	not detected	not detected	not detected

All tests undertaken between 20-Mar-2008 and 4-Nov-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO Brendan Rouse

LABORATORY TEST REPORT

Results of analysis of 5 samples
received 14 April 2008

CL1294 - IWHC

Chemtest

Report Date
22 April 2008

Login Batch No					38684				
Chemtest LIMS ID					AC93523	AC93524	AC93525	AC93526	AC93527
Sample ID					CP4	CP5	CP5	CP5	CP6
Sample No									
Depth					0.1-1.2	0-1	3-3.45	10-10.5	0-1
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*					
2300	Cyanide (total)	57125	mg kg-¹	M	1.3	< 0.5	3.3	< 0.5	0.5
2310	Cyanide (free)	57125	mg kg-¹	M	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
2625	Organic matter		%	M	5.3	2.8	5.0	1.1	6.4
2120	Boron (hot water soluble)	7440428	mg kg-¹	U	0.9	0.5	1.3	0.6	0.7
	Sulfate (2:1 water soluble)	14808798	g l-¹	M	0.08	0.04	0.49	<0.01	0.09
2450	Arsenic	7440382	mg kg-¹	M	22	9.0	13	<2	30
	Cadmium	7440439	mg kg-¹	M	1.2	0.29	83	0.88	1.7
	Chromium	7440473	mg kg-¹	M	41	24	31	7.2	48
	Copper	7440508	mg kg-¹	M	1900	130	150	10	310
	Mercury	7439976	mg kg-¹	M	0.77	0.20	0.42	<0.1	0.96
	Nickel	7440020	mg kg-¹	M	290	30	44	8.7	37
	Lead	7439921	mg kg-¹	M	660	120	410	15	430
	Selenium	7782492	mg kg-¹	M	0.63	<0.2	<0.2	<0.2	1.4
	Zinc	7440666	mg kg-¹	M	3700	150	210	35	320
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	< 5	< 5	< 5	< 5	< 5
2675	TPH aliphatic >C5-C6		mg kg-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		mg kg-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		mg kg-¹	N	<0.1	<0.1	11	<0.1	<0.1
	TPH aliphatic >C10-C12		mg kg-¹	N	<0.1	<0.1	18	<0.1	<0.1
	TPH aliphatic >C12-C16		mg kg-¹	N	<0.1	<0.1	160	<0.1	<0.1
	TPH aliphatic >C16-C21		mg kg-¹	N	<0.1	<0.1	540	<0.1	<0.1
	TPH aliphatic >C21-C35		mg kg-¹	N	<0.1	<0.1	970	<0.1	<0.1
	TPH aromatic >C5-C7		mg kg-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		mg kg-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		mg kg-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C10-C12		mg kg-¹	N	1.2	0.4	0.4	<0.1	<0.1
	TPH aromatic >C12-C16		mg kg-¹	N	17	5.6	41	0.3	9.0
	TPH aromatic >C16-C21		mg kg-¹	N	36	18	98	0.7	33
	TPH aromatic >C21-C35		mg kg-¹	N	37	24	73	1.1	63
	Total Petroleum Hydrocarbons		mg kg-¹	N	91	48	1900	<10	110

All tests undertaken between 15-Apr-2008 and 22-Apr-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO Brendan Rouse

LABORATORY TEST REPORT

Results of analysis of 5 samples
received 14 April 2008

CL1294 - IWHC

Chemtest

Report Date
22 April 2008

					38684				
					AC93523	AC93524	AC93525	AC93526	AC93527
					CP4	CP5	CP5	CP5	CP6
					0.1-1.2	0-1	3-3.45	10-10.5	0-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Naphthalene	91203	mg kg⁻¹	M	0.4	0.3	2.1	<0.1	1.2
	Acenaphthylene	208968	mg kg⁻¹	M	0.4	0.3	2.3	<0.1	0.9
	Acenaphthene	83329	mg kg⁻¹	M	0.2	0.8	5.8	<0.1	2.3
	Fluorene	86737	mg kg⁻¹	M	0.2	0.3	2	<0.1	1.5
	Phenanthrene	85018	mg kg⁻¹	M	1	2.9	9.2	0.4	10
	Anthracene	120127	mg kg⁻¹	M	0.4	1	7.5	0.3	4
	Fluoranthene	206440	mg kg⁻¹	M	1.4	4.2	12	0.4	16
	Pyrene	129000	mg kg⁻¹	M	1.2	3.5	11	0.3	14
	Benzo[a]anthracene	56553	mg kg⁻¹	M	0.8	1.6	7.1	0.2	7.2
	Chrysene	218019	mg kg⁻¹	M	0.8	1.8	7.6	0.2	8.8
	Benzo[b]fluoranthene	205992	mg kg⁻¹	M	0.8	1.8	3.5	<0.1	6.8
	Benzo[k]fluoranthene	207089	mg kg⁻¹	M	0.4	1.1	2.6	0.3	5.4
	Benzo[a]pyrene	50328	mg kg⁻¹	M	0.8	1.6	4.6	0.2	8.2
	Dibenzo[a,h]anthracene	53703	mg kg⁻¹	M	0.1	<0.1	0.6	<0.1	1.3
	Indeno[1,2,3-cd]pyrene	193395	mg kg⁻¹	M	0.4	0.7	2.8	0.2	4.7
	Benzo[g,h,i]perylene	191242	mg kg⁻¹	M	0.3	0.9	2.6	0.2	4.7
	Total (of 16) PAHs		mg kg⁻¹	M	9.6	23	83	2.5	97
2750	Fuel Type (soils)			N	PAH	PAH	Lube oil/Diese	N/A	PAH
2760	Benzene	71432	µg kg⁻¹	M	3.6	1.2	3.9	<1	12
	Toluene	108883	µg kg⁻¹	M	2.4	1.3	5.5	<1	8.9
	Ethyl benzene	100414	µg kg⁻¹	M	<1	<1	4.2	<1	<1
	m- & p-Xylene	1330207	µg kg⁻¹	M	1.7	<1	9.5	<1	1.4
	o-Xylene	95476	µg kg⁻¹	M	1.4	<1	4.9	<1	<1
	Methyl tert-butyl ether	1634044	µg kg⁻¹	N	<1	<1	<1	<1	<1
2920	Phenols (total)		mg kg⁻¹	M	<0.3	<0.3	<0.3	<0.3	<0.3
2010	pH		-	M	7.9	8.5	9.8	8.6	8.1
2030	Moisture		%	n/a	17.9	15.1	20.5	11.1	17.5
	Stone content (as received)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02
2140	Soil colour			n/a	brown	brown	brown	brown	brown
	Soil texture			n/a	loam	clay	sand	clay	clay
	Other material			n/a	stones wood	stones wood	stones wood	stones wood	stones roots

All tests undertaken between 15-Apr-2008 and 22-Apr-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

LABORATORY TEST REPORT

Results of analysis of 5 samples
received 14 April 2008

Report Date
22 April 2008

FAO Brendan Rouse

CL1294 - IWHC

					38684				
					AC93523	AC93524	AC93525	AC93526	AC93527
					CP4	CP5	CP5	CP5	CP6
					0.1-1.2	0-1	3-3.45	10-10.5	0-1
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2186	Asbestos (presence/absence)		-	N	not detected	not detected	not detected	not detected	not detected

All tests undertaken between 15-Apr-2008 and 22-Apr-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO B.Rouse

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

Login Batch No					**47045**							
Chemtest LIMS ID					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
Sample ID					WS2	CP1	WS10	CP4	WS5	CP5	CP6
Sample No											
Depth											
Matrix					*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓	*							
1010	pH	PH	-	U	7.3	7.0	6.9	6.9	7.1	7.1	6.9
1020	Electrical Conductivity	EC	µS cm-¹	U	1100	1300	1500	1600	1300	1300	2100
1300	Cyanide (total)	57125	mg l-¹	U	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1310	Cyanide (free)	57125	mg l-¹	U	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1420	Ammonium	14798039	mg l-¹	U	0.73	1.2	3.3	0.24	1.9	9.0	20
1120	Sulfate	14808798	mg l-¹	U	270	190	410	350	420	390	2100
1220	Chloride	16887006	mg l-¹	N	32	33	19	27	47	60	24
	Nitrate	14797558	mg l-¹	N	0.61	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Nitrite	14797650	mg l-¹	N	0.089	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1450	Arsenic	7440382	µg l-¹	U	<1	2.0	<1	<1	<1	<1	<1
	Boron	7440428	µg l-¹	U	65	90	90	220	48	170	<20
	Cadmium	7440439	µg l-¹	U	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chromium	7440473	µg l-¹	U	<1	<1	<1	<1	<1	<1	<1
	Copper	7440508	µg l-¹	U	1.0	<1	<1	<1	<1	<1	<1
	Lead	7439921	µg l-¹	U	<1	2.5	1.1	<1	<1	<1	<1
	Mercury	7439976	µg l-¹	U	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Nickel	7440020	µg l-¹	U	4.5	4.2	4.5	11	6.5	3.0	5.5
	Selenium	7782492	µg l-¹	U	<1	<1	<1	<1	2.2	<1	<1
	Zinc	7440666	µg l-¹	U	5	18	4.5	24	5	1.9	1.6
1490	Chromium (hexavalent)	18540299	µg l-¹	N	<50	<50	<50	<50	<50	<50	<50
1675	TPH aliphatic >C5-C6		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C16-C21		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C21-C35		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C6-C7		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

All tests undertaken between 27-Apr-2008 and 7-May-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO B.Rouse

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1675	TPH aromatic >C10-C12		µg l⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C12-C16		µg l⁻¹	N	<0.1	4.3	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C16-C21		µg l⁻¹	N	<0.1	6.2	11	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C21-C35		µg l⁻¹	N	<0.1	5.3	6.9	<0.1	<0.1	<0.1	<0.1
	Total Petroleum Hydrocarbons		µg l⁻¹	N	<10	16	18	<10	<10	<10	<10
1700	Naphthalene	91203	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Acenaphthylene	208968	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Acenaphthene	83329	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Fluorene	86737	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Phenanthrene	85018	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Anthracene	120127	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Fluoranthene	206440	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Pyrene	129000	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[a]anthracene	56553	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Chrysene	218019	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[b]fluoranthene	205992	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[k]fluoranthene	207089	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[a]pyrene	50328	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Dibenzo[a,h]anthracene	53703	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[g,h,i]perylene	191242	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Total (of 16) PAHs		µg l⁻¹	N	<0.2			<0.2	<0.2	<0.2	<0.2
1750	Fuel Type (waters)			n/a	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1760	Benzene	71432	µg l⁻¹	U	<1			<1	<1	<1	<1
	Dichlorodifluoromethane	75718	µg l⁻¹	U		<1	<1				
	Chloromethane	74873	µg l⁻¹	U		<1	<1				
	Toluene	108883	µg l⁻¹	U	<1			<1	<1	<1	<1
	Ethyl benzene	100414	µg l⁻¹	U	<1			<1	<1	<1	<1
	Vinyl chloride	75014	µg l⁻¹	U		<1	<1				
	Bromomethane	74839	µg l⁻¹	U		<20	<20				
	m- & p-Xylene	1330207	µg l⁻¹	U	<1			<1	<1	<1	<1

All tests undertaken between 27-Apr-2008 and 7-May-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO B.Rouse

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1760	Chloroethane	75003	µg l-1	U		<2	<2				
	o-Xylene	95476	µg l-1	U	<1			<1	<1	<1	<1
	Methyl tert-buty ether	1634044	µg l-1	U	<1			<1	<1	<1	<1
	Trichlorofluoromethane	75694	µg l-1	U		<1	<1				
	1,1-Dichloroethene	75354	µg l-1	U		<1	<1				
	Dichloromethane	75092	µg l-1	U		ne	ne				
	trans-1,2-Dichloroethene	156605	µg l-1	U		<1	<1				
	1,1-Dichloroethane	75343	µg l-1	U		<1	<1				
	cis-1,2-Dichloroethene	156592	µg l-1	U		<1	<1				
	Bromochloromethane	74975	µg l-1	U		<1	<1				
	Trichloromethane	67663	µg l-1	U		<1	<1				
	1,1,1-Trichloroethane	71556	µg l-1	U		<1	<1				
	Tetrachloromethane	56235	µg l-1	U		<1	<1				
	1,1-Dichloropropene	563586	µg l-1	U		<1	<1				
	Benzene	71432	µg l-1	U		<1	<1				
	1,2-Dichloroethane	107062	µg l-1	U		<2	<2				
	Trichloroethene	79016	µg l-1	U		<1	<1				
	1,2-Dichloropropane	78875	µg l-1	U		<1	<1				
	Dibromomethane	74953	µg l-1	U		<10	<10				
	Bromodichloromethane	75274	µg l-1	U		<5	<5				
	cis-1,3-Dichloropropene	10061015	µg l-1	U		<10	<10				
	Toluene	108883	µg l-1	U		<1	<1				
	trans-1,3-Dichloropropene	10061026	µg l-1	U		<10	<10				
	1,1,2-Trichloroethane	79005	µg l-1	U		<10	<10				
	Tetrachloroethene	127184	µg l-1	U		<1	<1				
	1,3-Dichloropropane	142289	µg l-1	U		<2	<2				
	Dibromochloromethane	124481	µg l-1	U		<10	<10				
	1,2-Dibromoethane	106934	µg l-1	U		<5	<5				
	Chlorobenzene	108907	µg l-1	U		<1	<1				
	1,1,1,2-Tetrachloroethane	630206	µg l-1	U		<2	<2				
	Ethylbenzene	100414	µg l-1	U		<1	<1				

All tests undertaken between 27-Apr-2008 and 7-May-2008

* Accreditation status

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Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO B.Rouse

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1760	m- & p-Xylene	1330207	µg l-¹	U		<1	<1				
	o-Xylene	95476	µg l-¹	U		<1	<1				
	Styrene	100425	µg l-¹	U		<1	<1				
	Tribromomethane	75252	µg l-¹	U		<10	<10				
	Isopropylbenzene	98828	µg l-¹	U		<1	<1				
	Bromobenzene	108861	µg l-¹	U		<1	<1				
	1,1,2,2-Tetrachloroethane	79345	µg l-¹	U		<10	<10				
	1,2,3-Trichloropropane	96184	µg l-¹	U		<50	<50				
	n-Propylbenzene	103651	µg l-¹	U		<1	<1				
	2-Chlorotoluene	95498	µg l-¹	U		<1	<1				
	1,3,5-Trimethylbenzene	108678	µg l-¹	U		<1	<1				
	4-Chlorotoluene	106434	µg l-¹	U		<1	<1				
	tert-Butylbenzene	98066	µg l-¹	U		<1	<1				
	1,2,4-Trimethylbenzene	95636	µg l-¹	U		<1	<1				
	sec-Butylbenzene	135988	µg l-¹	U		<1	<1				
	1,3-Dichlorobenzene	541731	µg l-¹	U		<1	<1				
	4-Isopropyltoluene	99876	µg l-¹	U		<1	<1				
	1,4-Dichlorobenzene	106467	µg l-¹	U		<1	<1				
	n-Butylbenzene	104518	µg l-¹	U		<1	<1				
	1,2-Dichlorobenzene	95501	µg l-¹	U		<1	<1				
	1,2-Dibromo-3-chloropropane	96128	µg l-¹	U		<50	<50				
	1,2,4-Trichlorobenzene	120821	µg l-¹	U		<1	<1				
	Hexachlorobutadiene	87683	µg l-¹	U		<1	<1				
	1,2,3-Trichlorobenzene	87616	µg l-¹	U		<2	<2				
1790	N-Nitrosodimethylamine	62759	µg l-¹	N		<0.05	<0.05				
	Phenol	108952	µg l-¹	N		<0.05	<0.05				
	bis(2-Chloroethyl)ether	111444	µg l-¹	N		<0.05	<0.05				
	2-Chlorophenol	95578	µg l-¹	N		<0.05	<0.05				
	1,3-Dichlorobenzene	541731	µg l-¹	N		<0.05	<0.05				
	1,4-Dichlorobenzene	106467	µg l-¹	N		<0.05	<0.05				
	1,2-Dichlorobenzene	95501	µg l-¹	N		<0.05	<0.05				

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					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1790	2-Methylphenol	95487	µg l-¹	N		<0.05	<0.05				
	bis(2-Chloroisopropyl)ether	108601	µg l-¹	N		<0.05	<0.05				
	4-Methylphenol	106445	µg l-¹	N		<0.05	<0.05				
	N-Nitrosodi-n-propylamine	621647	µg l-¹	N		<0.05	<0.05				
	Hexachloroethane	67721	µg l-¹	N		<0.05	<0.05				
	Nitrobenzene	98953	µg l-¹	N		<0.05	<0.05				
	Isophorone	78591	µg l-¹	N		<0.05	<0.05				
	2-Nitrophenol	88755	µg l-¹	N		<0.05	<0.05				
	2,4-Dimethylphenol	105679	µg l-¹	N		<0.05	<0.05				
	bis(2-Chloroethoxy)methane	111911	µg l-¹	N		<0.05	<0.05				
	2,4-Dichlorophenol	120832	µg l-¹	N		<0.05	<0.05				
	1,2,4-Trichlorobenzene	120821	µg l-¹	N		<0.05	<0.05				
	Naphthalene	91203	µg l-¹	N		<0.05	<0.05				
	4-Chloroaniline	106478	µg l-¹	N		<0.05	<0.05				
	Hexachlorobutadiene	87683	µg l-¹	N		<0.05	<0.05				
	4-Chloro-3-methylphenol	59507	µg l-¹	N		<0.05	<0.05				
	2-Methylnaphthalene	91576	µg l-¹	N		<0.05	<0.05				
	Hexachlorocyclopentadiene	77474	µg l-¹	N		<0.05	<0.05				
	2,4,6-Trichlorophenol	88062	µg l-¹	N		<0.05	<0.05				
	2,4,5-Trichlorophenol	95954	µg l-¹	N		<0.05	<0.05				
	2-Chloronaphthalene	91587	µg l-¹	N		<0.05	<0.05				
	2-Nitroaniline	88744	µg l-¹	N		<0.05	<0.05				
	Dimethylphthalate	131113	µg l-¹	N		<0.05	<0.05				
	2,6-Dinitrotoluene	606202	µg l-¹	N		<0.05	<0.05				
	Acenaphthylene	208968	µg l-¹	N		<0.05	<0.05				
	3-Nitroaniline	99092	µg l-¹	N		<0.05	<0.05				
	Acenaphthene	83329	µg l-¹	N		2.9	1.8				
	Dibenzofuran	132649	µg l-¹	N		0.2	0.1				
	2,4-Dinitrotoluene	121142	µg l-¹	N		<0.05	<0.05				
	Diethylphthalate	84662	µg l-¹	N		<0.05	<0.05				
	Fluorene	86737	µg l-¹	N		0.2	0.1				

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					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1790	4-Chlorophenylether	7005723	µg l⁻¹	N		<0.05	<0.05				
	4-Nitroaniline	100016	µg l⁻¹	N		<0.05	<0.05				
	2-Methyl-4,6-dinitrophenol	534521	µg l⁻¹	N		<0.05	<0.05				
	Azobenzene	103333	µg l⁻¹	N		<0.05	<0.05				
	4-Bromophenylphenylether	101553	µg l⁻¹	N		<0.05	<0.05				
	Hexachlorobenzene	118741	µg l⁻¹	N		<0.05	<0.05				
	Pentachlorophenol	87865	µg l⁻¹	N		<0.05	<0.05				
	Phenanthrene	85018	µg l⁻¹	N		0.1	0.2				
	Anthracene	120127	µg l⁻¹	N		1.0	2.5				
	Carbazole	86748	µg l⁻¹	N		6.6	<0.05				
	Di-n-butylphthalate	84742	µg l⁻¹	N		<0.05	<0.05				
	Fluoranthene	206440	µg l⁻¹	N		0.3	0.9				
	Pyrene	129000	µg l⁻¹	N		0.1	0.6				
	Butylbenzylphthalate	85687	µg l⁻¹	N		<0.05	<0.05				
	Benzo[a]anthracene	56553	µg l⁻¹	N		<0.05	<0.05				
	Chrysene	218019	µg l⁻¹	N		<0.05	<0.05				
	bis(2-Ethylhexyl)phthalate	117817	µg l⁻¹	N		<0.05	<0.05				
	Di-n-octylphthalate	117840	µg l⁻¹	N		<0.05	<0.05				
	Benzo[b]fluoranthene	205992	µg l⁻¹	N		<0.05	<0.05				
	Benzo[k]fluoranthene	207089	µg l⁻¹	N		<0.05	<0.05				
	Benzo[a]pyrene	50328	µg l⁻¹	N		<0.05	<0.05				
	Indeno[1,2,3-cd]pyrene	193395	µg l⁻¹	N		<0.05	<0.05				
	Dibenzo[a,h]anthracene	53703	µg l⁻¹	N		<0.05	<0.05				
	Benzo[g,h,i]perylene	191242	µg l⁻¹	N		<0.05	<0.05				
1920	Phenols (total)		mg l⁻¹	N	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03

All tests undertaken between 27-Apr-2008 and 7-May-2008

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Leyden Kirby Associates
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BL9 6BU

FAO Michelle Pickford

LABORATORY TEST REPORT

Results of analysis of 3 samples
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IWHC

Chemtest

Report Date
07 May 2008

Login Batch No					55078		
Chemtest LIMS ID					AC96998	AC96999	AC97000
Sample ID					WS1	WS8	TP24
Sample No							
Depth					0.7m	0.9m	0-0.3m
Matrix					*LEACHATE*	*LEACHATE*	*LEACHATE*
SOP↓	Determinand↓	CAS No↓	Units↓	*			
1010	pH	PH	-	U	7.8	7.9	8.2
1300	Cyanide (total)	57125	mg l-1	U	< 0.05	< 0.05	< 0.05
1310	Cyanide (free)	57125	mg l-1	U	< 0.05	< 0.05	< 0.05
1120	Sulfate	14808798	mg l-1	U	7.7	42	7.0
1450	Arsenic	7440382	µg l-1	U	30	6.0	6.1
	Boron	7440428	µg l-1	U	83	35	130
	Cadmium	7440439	µg l-1	U	<0.5	<0.5	<0.5
	Chromium	7440473	µg l-1	U	2.9	4.3	4.2
	Copper	7440508	µg l-1	U	30	18	17
	Lead	7439921	µg l-1	U	67	62	31
	Mercury	7439976	µg l-1	U	<0.5	<0.5	<0.5
	Nickel	7440020	µg l-1	U	5.3	2.6	2.4
	Selenium	7782492	µg l-1	U	<1	1.1	<1
	Zinc	7440666	µg l-1	U	29	38	43
1490	Chromium (hexavalent)	18540299	µg l-1	N	<50	<50	<50
1675	TPH aliphatic >C5-C6		µg l-1	N	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		µg l-1	N	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		µg l-1	N	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		µg l-1	N	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		µg l-1	N	<0.1	<0.1	<0.1
	TPH aliphatic >C16-C21		µg l-1	N	<0.1	<0.1	<0.1
	TPH aliphatic >C21-C35		µg l-1	N	<0.1	<0.1	<0.1
	TPH aromatic >C6-C7		µg l-1	N	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		µg l-1	N	2.0	<0.1	<0.1
	TPH aromatic >C8-C10		µg l-1	N	37	<0.1	<0.1
	TPH aromatic >C10-C12		µg l-1	N	500	<0.1	<0.1
	TPH aromatic >C12-C16		µg l-1	N	990	<0.1	<0.1
	TPH aromatic >C16-C21		µg l-1	N	820	<0.1	<0.1
	TPH aromatic >C21-C35		µg l-1	N	45	<0.1	<0.1
	Total Petroleum Hydrocarbons		µg l-1	N	2400	<10	<10

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					55078		
					AC96998	AC96999	AC97000
					WS1	WS8	TP24
					0.7m	0.9m	0-0.3m
					LEACHATE	*LEACHATE*	*LEACHATE*
1700	Naphthalene	91203	µg l-1	N	210	<0.01	<0.01
	Acenaphthylene	208968	µg l-1	N	8.1	<0.01	<0.01
	Acenaphthene	83329	µg l-1	N	75	<0.01	<0.01
	Fluorene	86737	µg l-1	N	37	<0.01	<0.01
	Phenanthrene	85018	µg l-1	N	100	<0.01	<0.01
	Anthracene	120127	µg l-1	N	42	<0.01	<0.01
	Fluoranthene	206440	µg l-1	N	50	<0.01	<0.01
	Pyrene	129000	µg l-1	N	40	<0.01	<0.01
	Benzo[a]anthracene	56553	µg l-1	N	14	<0.01	<0.01
	Chrysene	218019	µg l-1	N	23	<0.01	<0.01
	Benzo[b]fluoranthene	205992	µg l-1	N	10	<0.01	<0.01
	Benzo[k]fluoranthene	207089	µg l-1	N	6.3	<0.01	<0.01
	Benzo[a]pyrene	50328	µg l-1	N	11	<0.01	<0.01
	Dibenzo[a,h]anthracene	53703	µg l-1	N	5.2	<0.01	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l-1	N	0.89	<0.01	<0.01
	Benzo[g,h,i]perylene	191242	µg l-1	N	5	<0.01	<0.01
	Total (of 16) PAHs		µg l-1	N	637.5	<0.2	<0.2
1750	Fuel Type (waters)			n/a	PAH	N/A	N/A
1760	Benzene	71432	µg l-1	U	<1	<1	<1
	Dichlorodifluoromethane	75718	µg l-1	U	<1		
	Chloromethane	74873	µg l-1	U	<1		
	Toluene	108883	µg l-1	U	1.5	<1	<1
	Ethyl benzene	100414	µg l-1	U	<1	<1	<1
	Vinyl chloride	75014	µg l-1	U	<1		
	Bromomethane	74839	µg l-1	U	<20		
	m- & p-Xylene	1330207	µg l-1	U	7.5	<1	<1
	Chloroethane	75003	µg l-1	U	<2		
	o-Xylene	95476	µg l-1	U	5.7	<1	<1
	Methyl tert-buty ether	1634044	µg l-1	U	<1	<1	<1
	Trichlorofluoromethane	75694	µg l-1	U	<1		
	1,1-Dichloroethene	75354	µg l-1	U	<1		

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					55078		
					AC96998	AC96999	AC97000
					WS1	WS8	TP24
					0.7m	0.9m	0-0.3m
					LEACHATE	*LEACHATE*	*LEACHATE*
1760	Dichloromethane	75092	µg l-¹	U	ne		
	trans-1,2-Dichloroethene	156605	µg l-¹	U	<1		
	1,1-Dichloroethane	75343	µg l-¹	U	<1		
	cis-1,2-Dichloroethene	156592	µg l-¹	U	<1		
	Bromochloromethane	74975	µg l-¹	U	<1		
	Trichloromethane	67663	µg l-¹	U	<1		
	1,1,1-Trichloroethane	71556	µg l-¹	U	<1		
	Tetrachloromethane	56235	µg l-¹	U	<1		
	1,1-Dichloropropene	563586	µg l-¹	U	<1		
	Benzene	71432	µg l-¹	U	<1		
	1,2-Dichloroethane	107062	µg l-¹	U	<2		
	Trichloroethene	79016	µg l-¹	U	<1		
	1,2-Dichloropropane	78875	µg l-¹	U	<1		
	Dibromomethane	74953	µg l-¹	U	<10		
	Bromodichloromethane	75274	µg l-¹	U	<5		
	cis-1,3-Dichloropropene	10061015	µg l-¹	U	<10		
	Toluene	108883	µg l-¹	U	1.5		
	trans-1,3-Dichloropropene	10061026	µg l-¹	U	<10		
	1,1,2-Trichloroethane	79005	µg l-¹	U	<10		
	Tetrachloroethene	127184	µg l-¹	U	<1		
	1,3-Dichloropropane	142289	µg l-¹	U	<2		
	Dibromochloromethane	124481	µg l-¹	U	<10		
	1,2-Dibromoethane	106934	µg l-¹	U	<5		
	Chlorobenzene	108907	µg l-¹	U	<1		
	1,1,1,2-Tetrachloroethane	630206	µg l-¹	U	<2		
	Ethylbenzene	100414	µg l-¹	U	<1		
	m- & p-Xylene	1330207	µg l-¹	U	7.5		
	o-Xylene	95476	µg l-¹	U	5.7		
	Styrene	100425	µg l-¹	U	<1		
	Tribromomethane	75252	µg l-¹	U	<10		
	Isopropylbenzene	98828	µg l-¹	U	<1		

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					55078		
					AC96998	AC96999	AC97000
					WS1	WS8	TP24
					0.7m	0.9m	0-0.3m
					LEACHATE	*LEACHATE*	*LEACHATE*
1760	Bromobenzene	108861	µg l-¹	U	<1		
	1,1,2,2-Tetrachloroethane	79345	µg l-¹	U	<10		
	1,2,3-Trichloropropane	96184	µg l-¹	U	<50		
	n-Propylbenzene	103651	µg l-¹	U	<1		
	2-Chlorotoluene	95498	µg l-¹	U	<1		
	1,3,5-Trimethylbenzene	108678	µg l-¹	U	3.5		
	4-Chlorotoluene	106434	µg l-¹	U	<1		
	tert-Butylbenzene	98066	µg l-¹	U	<1		
	1,2,4-Trimethylbenzene	95636	µg l-¹	U	11		
	sec-Butylbenzene	135988	µg l-¹	U	<1		
	1,3-Dichlorobenzene	541731	µg l-¹	U	<1		
	4-Isopropyltoluene	99876	µg l-¹	U	<1		
	1,4-Dichlorobenzene	106467	µg l-¹	U	<1		
	n-Butylbenzene	104518	µg l-¹	U	<1		
	1,2-Dichlorobenzene	95501	µg l-¹	U	<1		
	1,2-Dibromo-3-chloropropane	96128	µg l-¹	U	<50		
	1,2,4-Trichlorobenzene	120821	µg l-¹	U	<1		
	Hexachlorobutadiene	87683	µg l-¹	U	<1		
	1,2,3-Trichlorobenzene	87616	µg l-¹	U	<2		
1790	N-Nitrosodimethylamine	62759	µg l-¹	N	<0.5		
	Phenol	108952	µg l-¹	N	<0.5		
	bis(2-Chloroethyl)ether	111444	µg l-¹	N	<0.5		
	2-Chlorophenol	95578	µg l-¹	N	<0.5		
	1,3-Dichlorobenzene	541731	µg l-¹	N	<0.5		
	1,4-Dichlorobenzene	106467	µg l-¹	N	<0.5		
	1,2-Dichlorobenzene	95501	µg l-¹	N	<0.5		
	2-Methylphenol	95487	µg l-¹	N	<0.5		
	bis(2-Chloroisopropyl)ether	108601	µg l-¹	N	<0.5		
	4-Methylphenol	106445	µg l-¹	N	<0.5		
	N-Nitrosodi-n-propylamine	621647	µg l-¹	N	<0.5		
	Hexachloroethane	67721	µg l-¹	N	<0.5		

All tests undertaken between 27-Apr-2008 and 7-May-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO Michelle Pickford

LABORATORY TEST REPORT

Results of analysis of 3 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

					55078		
					AC96998	AC96999	AC97000
					WS1	WS8	TP24
					0.7m	0.9m	0-0.3m
					LEACHATE	*LEACHATE*	*LEACHATE*
1790	Nitrobenzene	98953	µg l-1	N	<0.5		
	Isophorone	78591	µg l-1	N	<0.5		
	2-Nitrophenol	88755	µg l-1	N	<0.5		
	2,4-Dimethylphenol	105679	µg l-1	N	0.7		
	bis(2-Chloroethoxy)methane	111911	µg l-1	N	<0.5		
	2,4-Dichlorophenol	120832	µg l-1	N	<0.5		
	1,2,4-Trichlorobenzene	120821	µg l-1	N	<0.5		
	Naphthalene	91203	µg l-1	N	210		
	4-Chloroaniline	106478	µg l-1	N	<0.5		
	Hexachlorobutadiene	87683	µg l-1	N	<0.5		
	4-Chloro-3-methylphenol	59507	µg l-1	N	<0.5		
	2-Methylnaphthalene	91576	µg l-1	N	65		
	Hexachlorocyclopentadiene	77474	µg l-1	N	<0.5		
	2,4,6-Trichlorophenol	88062	µg l-1	N	<0.5		
	2,4,5-Trichlorophenol	95954	µg l-1	N	<0.5		
	2-Chloronaphthalene	91587	µg l-1	N	<0.5		
	2-Nitroaniline	88744	µg l-1	N	<0.5		
	Dimethylphthalate	131113	µg l-1	N	<0.5		
	2,6-Dinitrotoluene	606202	µg l-1	N	<0.5		
	Acenaphthylene	208968	µg l-1	N	<0.5		
	3-Nitroaniline	99092	µg l-1	N	<0.5		
	Acenaphthene	83329	µg l-1	N	98		
	Dibenzofuran	132649	µg l-1	N	48		
	2,4-Dinitrotoluene	121142	µg l-1	N	<0.5		
	Diethylphthalate	84662	µg l-1	N	<0.5		
	Fluorene	86737	µg l-1	N	47		
	4-Chlorophenylether	7005723	µg l-1	N	<0.5		
	4-Nitroaniline	100016	µg l-1	N	<0.5		
	2-Methyl-4,6-dinitrophenol	534521	µg l-1	N	<0.5		
	Azobenzene	103333	µg l-1	N	<0.5		
	4-Bromophenylphenylether	101553	µg l-1	N	<0.5		

All tests undertaken between 27-Apr-2008 and 7-May-2008

* Accreditation status

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Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
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BL9 6BU

FAO Michelle Pickford

LABORATORY TEST REPORT

Results of analysis of 3 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

					55078		
					AC96998	AC96999	AC97000
					WS1	WS8	TP24
					0.7m	0.9m	0-0.3m
					LEACHATE	*LEACHATE*	*LEACHATE*
1790	Hexachlorobenzene	118741	µg l-¹	N	<0.5		
	Pentachlorophenol	87865	µg l-¹	N	<0.5		
	Phenanthrene	85018	µg l-¹	N	140		
	Anthracene	120127	µg l-¹	N	47		
	Carbazole	86748	µg l-¹	N	20		
	Di-n-butylphthalate	84742	µg l-¹	N	<0.5		
	Fluoranthene	206440	µg l-¹	N	54		
	Pyrene	129000	µg l-¹	N	46		
	Butylbenzylphthalate	85687	µg l-¹	N	<0.5		
	Benzo[a]anthracene	56553	µg l-¹	N	17		
	Chrysene	218019	µg l-¹	N	25		
	bis(2-Ethylhexyl)phthalate	117817	µg l-¹	N	<0.5		
	Di-n-octylphthalate	117840	µg l-¹	N	<0.5		
	Benzo[b]fluoranthene	205992	µg l-¹	N	12		
	Benzo[k]fluoranthene	207089	µg l-¹	N	4.7		
	Benzo[a]pyrene	50328	µg l-¹	N	12		
	Indeno[1,2,3-cd]pyrene	193395	µg l-¹	N	2.1		
	Dibenzo[a,h]anthracene	53703	µg l-¹	N	<0.5		
	Benzo[g,h,i]perylene	191242	µg l-¹	N	2.4		
1920	Phenols (total)		mg l-¹	N	1.6	0.1	<0.03

All tests undertaken between 27-Apr-2008 and 7-May-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO Michelle Pickford

LABORATORY TEST REPORT

Results of analysis of 2 samples
received 29 April 2008

IWHC

Chemtest

Report Date
09 May 2008

Login Batch No					55107	
Chemtest LIMS ID					AC98788	AC98789
Sample ID					WS6	TP8
Sample No						
Depth					0.5m	0.8m
Matrix					*LEACHATE*	*LEACHATE*
SOP↓	Determinand↓	CAS No↓	Units↓	*		
1010	pH	PH	-	U	9.3	8.6
1300	Cyanide (total)	57125	mg l-1	U	< 0.05	< 0.05
1310	Cyanide (free)	57125	mg l-1	U	< 0.05	< 0.05
1120	Sulfate	14808798	mg l-1	U	4.8	120
1450	Arsenic	7440382	µg l-1	U	13	7.8
	Boron	7440428	µg l-1	U	<20	92
	Cadmium	7440439	µg l-1	U	<0.5	<0.5
	Chromium	7440473	µg l-1	U	180	87
	Copper	7440508	µg l-1	U	<1	<1
	Lead	7439921	µg l-1	U	<1	5.1
	Mercury	7439976	µg l-1	U	<0.5	<0.5
	Nickel	7440020	µg l-1	U	1.1	1.3
	Selenium	7782492	µg l-1	U	4.9	2.4
	Zinc	7440666	µg l-1	U	4.8	30
1490	Chromium (hexavalent)	18540299	µg l-1	N	<50	<50
1675	TPH aliphatic >C5-C6		µg l-1	N	<0.1	<0.1
	TPH aliphatic >C6-C8		µg l-1	N	<0.1	<0.1
	TPH aliphatic >C8-C10		µg l-1	N	<0.1	<0.1
	TPH aliphatic >C10-C12		µg l-1	N	<0.1	<0.1
	TPH aliphatic >C12-C16		µg l-1	N	<0.1	<0.1
	TPH aliphatic >C16-C21		µg l-1	N	<0.1	<0.1
	TPH aliphatic >C21-C35		µg l-1	N	<0.1	<0.1
	TPH aromatic >C6-C7		µg l-1	N	<0.1	<0.1
	TPH aromatic >C7-C8		µg l-1	N	<0.1	<0.1
	TPH aromatic >C8-C10		µg l-1	N	<0.1	<0.1
	TPH aromatic >C10-C12		µg l-1	N	<0.1	<0.1
	TPH aromatic >C12-C16		µg l-1	N	<0.1	<0.1
	TPH aromatic >C16-C21		µg l-1	N	<0.1	<0.1
	TPH aromatic >C21-C35		µg l-1	N	<0.1	<0.1
	Total Petroleum Hydrocarbons		µg l-1	N	<10	<10

All tests undertaken between 02-May-2008 and 8-May-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

LABORATORY TEST REPORT

Results of analysis of 2 samples
received 29 April 2008

Report Date
09 May 2008

FAO Michelle Pickford

IWHC

					55107	
					AC98788	AC98789
					WS6	TP8
					0.5m	0.8m
					LEACHATE	*LEACHATE*
1700	Naphthalene	91203	µg l-¹	N	<0.01	<0.01
	Acenaphthylene	208968	µg l-¹	N	<0.01	<0.01
	Acenaphthene	83329	µg l-¹	N	<0.01	<0.01
	Fluorene	86737	µg l-¹	N	<0.01	<0.01
	Phenanthrene	85018	µg l-¹	N	<0.01	<0.01
	Anthracene	120127	µg l-¹	N	<0.01	<0.01
	Fluoranthene	206440	µg l-¹	N	<0.01	<0.01
	Pyrene	129000	µg l-¹	N	<0.01	<0.01
	Benzo[a]anthracene	56553	µg l-¹	N	<0.01	<0.01
	Chrysene	218019	µg l-¹	N	<0.01	<0.01
	Benzo[b]fluoranthene	205992	µg l-¹	N	<0.01	<0.01
	Benzo[k]fluoranthene	207089	µg l-¹	N	<0.01	<0.01
	Benzo[a]pyrene	50328	µg l-¹	N	<0.01	<0.01
	Dibenzo[a,h]anthracene	53703	µg l-¹	N	<0.01	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l-¹	N	<0.01	<0.01
	Benzo[g,h,i]perylene	191242	µg l-¹	N	<0.01	<0.01
	Total (of 16) PAHs		µg l-¹	N	<0.2	<0.2
1750	Fuel Type (waters)			n/a	N/A	N/A
1760	Benzene	71432	µg l-¹	U	<1	<1
	Toluene	108883	µg l-¹	U	<1	<1
	Ethyl benzene	100414	µg l-¹	U	<1	<1
	m- & p-Xylene	1330207	µg l-¹	U	<1	<1
	o-Xylene	95476	µg l-¹	U	<1	<1
	Methyl tert-buty ether	1634044	µg l-¹	U	<1	<1
1920	Phenols (total)		mg l-¹	N	<0.03	<0.03

All tests undertaken between 02-May-2008 and 8-May-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

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Ian Farmer Associates (1998) Ltd
17 Rivington Court
Warrington
Cheshire
WA1 4RT

F.A.O. Mr A Latimer

TEST REPORT - 40323

Site :	Queens Road, Cheetham Hill, Manchester
Job Number :	40323
Originating Client :	L K Group
Originating Reference :	Not Given
Date Sampled :	
Date Scheduled :	16/04/08
Date Testing Started :	06/05/08
Date Testing Finished :	16/05/08

Remarks :

- First Report for above Job Number
- Samples will be disposed of 28 days after the report is issue unless otherwise agreed
- This report may contain results from tests which are not included within the scope of the UKAS accreditation. Please see final sheet for details.

Authorised By: Brendan Luxton

Position : Laboratory Manager Date : 17/05/08

constructionline

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Registered Office: Unit 1, Bamburgh Court, TVTE, Gateshead, Tyne & Wear, NE11 0TX
Offices in: Coventry (02476) 456565. Harpenden, Herts. (01582) 460018. Truro (01827) 261775
Warrington (01925) 855440. Newcastle upon Tyne (0191) 4828500. Motherwell (01698) 230231.

AGS ASSOCIATION OF GEOTECHNICAL & GEOENVIRONMENTAL SPECIALISTS

UKAS TESTING
1464

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT

Borehole/ Trial Pit	Depth (m)	Sample	Moisture Content %	Description
BH01	7.50	U9	15	Soft dark brown sandy CLAY, with fine to medium gravel.
BH01	10.50	U15	7.4	Firm dark brown CLAY.
BH01	13.50	U21	6.3	Firm dark brown sandy CLAY with some gravel
BH02	7.50	U16	14	Soft dark brown sandy CLAY with some gravel
BH02	13.50	U27	15	Firm dark brown sandy CLAY.
BH02	16.50	U33	20	Dark brown friable sandy CLAY.
BH03	10.50	U15	14	Firm dark brown sandy CLAY.
BH03	13.50	U21	19	Firm dark brown CLAY.
BH04	10.50	U15	13	Friable dark brown sandy CLAY, with fine to medium gravel.
BH04	13.50	U21	8.5	Dark brown firm sandy CLAY with some gravel

Method of Preparation : BS 1377:PART 1:1990:7.4 Preparation of samples for classification tests BS 1377:PART 2:1990:4.2 & 5.2 Sample preparations

Method of Test : BS 1377:PART 2:1990:3.2 Determination of moisture content

Remarks :

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY AND LIQUIDITY INDEX

Borehole/ Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Moisture Content %	Sample Passing 425µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
					Percentage %	Moisture Content %						
BH01	7.50	U9	Natural	15	89	17	33	14	19	0.16	CL	Soft dark brown sandy CLAY, with fine to medium gravel.
BH01	10.50	U15	Natural	7.4	100	7.4	40	21	19	-0.72	CI	Firm dark brown CLAY.
BH01	13.50	U21	Sieved	6.3	92	11	26	15	11	-0.36	CL	Firm dark brown sandy CLAY with some gravel
BH02	7.50	U16	Sieved	14	88	16	28	14	14	0.14	CL	Soft dark brown sandy CLAY with some gravel
BH02	13.50	U27	Natural	15	100	15	33	15	18	0.00	CL	Firm dark brown sandy CLAY.
BH02	16.50	U33	Natural	20	100	20	32	21	11	-0.09	CL	Dark brown friable sandy CLAY.
BH03	10.50	U15	Natural	14	100	14	35	15	20	-0.05	CL/CI	Firm dark brown sandy CLAY.
BH03	13.50	U21	Natural	19	100	19	44	19	25	0.00	CI	Firm dark brown CLAY.
BH04	10.50	U15	Sieved	12	69	18	28	16	12	0.17	CL	Friable dark brown sandy CLAY, with fine to medium gravel.
BH04	13.50	U21	Sieved	8.5	83	10	28	15	13	-0.38	CL	Dark brown firm sandy CLAY with some gravel

Method of Preparation : BS 1377:PART 1:1990:7.4 Preparation of samples for classification tests BS 1377:PART 2:1990:4.2 & 5.2 Sample preparations

Method of Test : BS 1377:PART 2:1990:3 Determination of moisture content 1990:4 Determination of the liquid limit BS 1377:PART 2:1990:5 Determination of the plastic limit and plasticity index

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF THE pH VALUE AND THE SULPHATE CONTENT OF SOIL AND GROUNDWATER

Borehole/ Trial Pit	Depth (m)	Sample	Concentration of Soluble Sulphate			Percentage of sample passing 2mm Sieve %	pH	Description / Remarks
			Soil		Groundwater g /l			
			Total S04 %	S04 in 2:1 water:soil g /l				
BH01	7.50	U9		0.2		98	7.7	Soft dark brown sandy CLAY, with fine to medium gravel.
BH01	10.50	U15		<0.1		96	8.0	Firm dark brown CLAY.
BH01	13.50	U21		0.1		95	8.1	Firm dark brown sandy CLAY with some gravel
BH02	7.50	U16		0.1		97	8.1	Soft dark brown sandy CLAY with some gravel
BH02	13.50	U27		0.1		98	8.2	Firm dark brown sandy CLAY.
BH02	16.50	U33		0.1		97	8.3	Dark brown friable sandy CLAY.
BH03	10.50	U15		0.1		96	8.3	Firm dark brown sandy CLAY.
BH03	13.50	U21		0.1		99	8.3	Firm dark brown CLAY.
BH04	10.50	U15		0.1		73	8.3	Friable dark brown sandy CLAY, with fine to medium gravel.
BH04	13.50	U21		0.1		98	8.4	Dark brown firm sandy CLAY with some gravel

Method of Preparation : BS 1377:PART 1:1990:7.5 Preparation of soil for chemical tests BS 1377:PART 3:1990:5.2, 5.3, 5.4 & 9.4

Method of Test : BS 1377:PART 3:1990:5 Determination of the sulphate content of soil and ground water BS 1377:PART 3:1990:9 Determination of the pH value

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

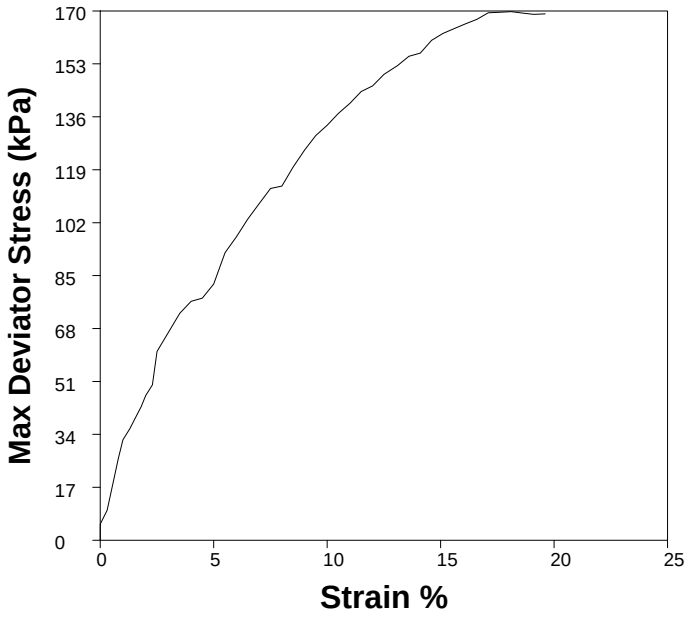
Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITH MULTISTAGE LOADING AND WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Trial Pit	Depth (m)	Sample	Description
BH01	7.50	U9	Soft dark brown sandy CLAY, with fine to medium gravel.



Initial Specimen		
Length of Sample (mm)	450	
Depth from top of sample (mm)	20	
Condition of Sample:	Undisturbed	
Orientation:	Vertical	

Test Type	Multistage
Length of Specimen (mm)	199.2
Diameter of Specimen (mm)	103.1
Moisture Content (%)	14
Bulk Density (Mg/m³)	2.27
Dry Density (Mg/m³)	2.00
Membrane Thickness (mm)	0.3
Membrane Type	latex
Rate of Strain (%/min)	1.99

Test Results				
Measured Cell Pressure (kPa)	75	150	300
Strain at Failure (%)	4.5	8	18.1
Membrane Correction (kPa)	0.3	0.5	1.0
Corrected Deviator Stress (kPa)	77	113	169
Shear Stress (kPa)	**39**	**57**	**84**
Mode of Failure (B/P/C)	**Plastic**		

Method of Preparation :

Method of Test :

Remarks : Membrane Type: latex

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

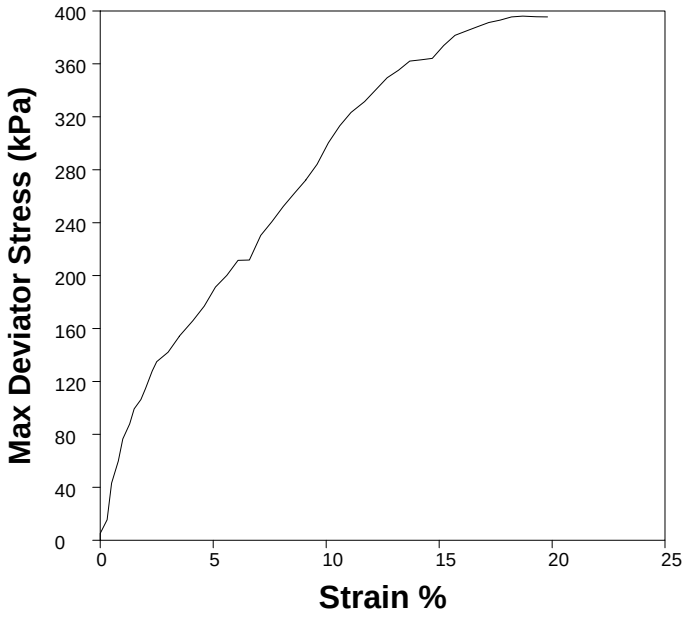
Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITH MULTISTAGE LOADING AND WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Trial Pit	Depth (m)	Sample	Description
BH01	10.50	U15	Firm dark brown CLAY.



Initial Specimen		
Length of Sample (mm)		450
Depth from top of sample (mm)		13
Condition of Sample:		Undisturbed
Orientation:		Vertical

Test Type		Multistage		
Length of Specimen (mm)		197.4		
Diameter of Specimen (mm)		103.4		
Moisture Content (%)		18		
Bulk Density (Mg/m³)		2.19		
Dry Density (Mg/m³)		1.86		
Membrane Thickness (mm)		0.3		
Membrane Type		latex		
Rate of Strain (%/min)		2.01		
Test Results	Measured Cell Pressure (kPa)	100	200	400
	Strain at Failure (%)	6.6	14.7	18.7
	Membrane Correction (kPa)	0.4	0.9	1.0
	Corrected Deviator Stress (kPa)	211	363	395
	Shear Stress (kPa)	**106**	**182**	**198**
	Mode of Failure (B/P/C)	**Brittle**		

Method of Preparation :

Method of Test :

Remarks : Membrane Type: latex

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

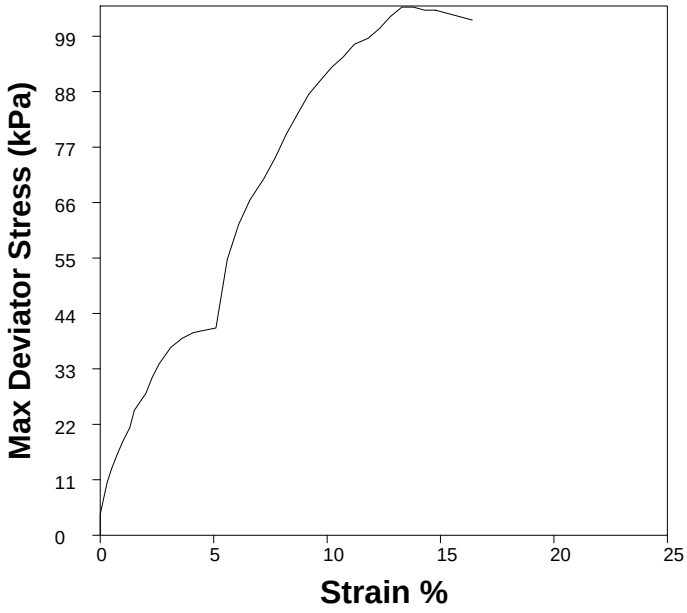
Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITH MULTISTAGE LOADING AND WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Trial Pit	Depth (m)	Sample	Description
BH02	7.50	U16	Soft dark brown sandy CLAY with some gravel



Initial Specimen		
Length of Sample (mm)		450
Depth from top of sample (mm)		25
Condition of Sample:		Undisturbed
Orientation:		Vertical

Test Type		Multistage		
Length of Specimen (mm)		195.6		
Diameter of Specimen (mm)		106.1		
Moisture Content (%)		15		
Bulk Density (Mg/m³)		2.15		
Dry Density (Mg/m³)		1.86		
Membrane Thickness (mm)		0.3		
Membrane Type		latex		
Rate of Strain (%/min)		2.05		
Test Results	**Measured Cell Pressure (kPa)**	75	150	300
	Strain at Failure (%)	2	5.1	13.3
	Membrane Correction (kPa)	0.1	0.3	0.8
	Corrected Deviator Stress (kPa)	28	41	104
	Shear Stress (kPa)	**14**	**20**	**52**
	Mode of Failure (B/P/C)	**Brittle**		

Method of Preparation :

Method of Test :

Remarks : Membrane Type: latex

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

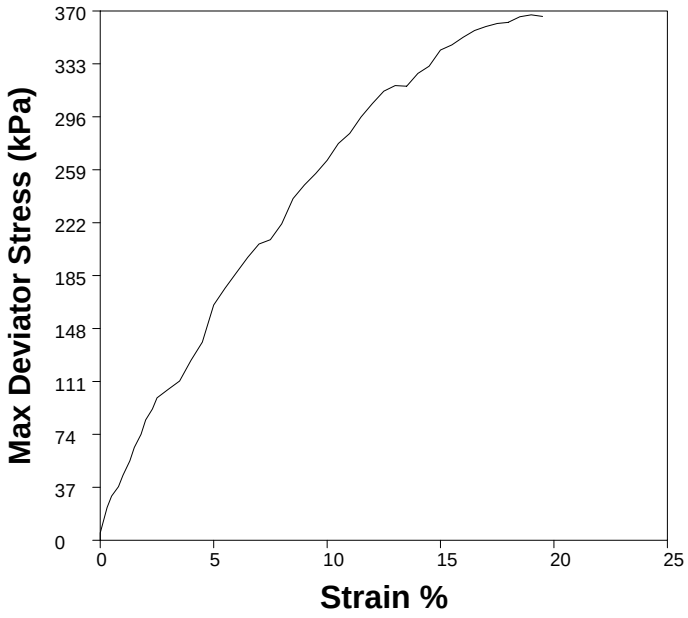
Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITH MULTISTAGE LOADING AND WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Trial Pit	Depth (m)	Sample	Description
BH02	13.50	U27	Firm dark brown sandy CLAY.



Initial Specimen	Length of Sample (mm)			450
	Depth from top of sample (mm)			29
	Condition of Sample:	Undisturbed		
	Orientation:	Vertical		
Test Type		Multistage		
Length of Specimen (mm)		199.8		
Diameter of Specimen (mm)		103.1		
Moisture Content (%)		12		
Bulk Density (Mg/m³)		2.28		
Dry Density (Mg/m³)		2.03		
Membrane Thickness (mm)		0.3		
Membrane Type		latex		
Rate of Strain (%/min)		2.02		
Test Results	Measured Cell Pressure (kPa)	125	250	500
	Strain at Failure (%)	7.5	13	19
	Membrane Correction (kPa)	0.5	0.8	1.1
	Corrected Deviator Stress (kPa)	210	317	366
	Shear Stress (kPa)	**105**	**159**	**183**
	Mode of Failure (B/P/C)	**Plastic**		

Method of Preparation :

Method of Test :

Remarks : Membrane Type: latex

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

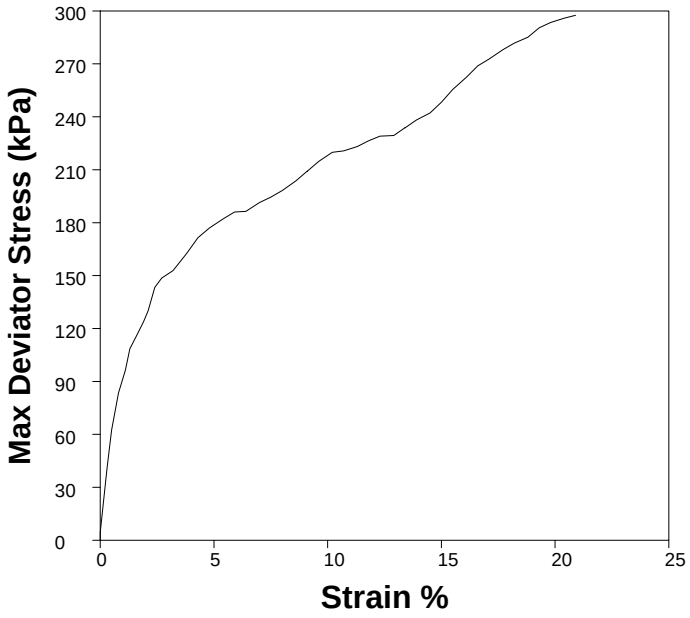
Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITH MULTISTAGE LOADING AND WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Trial Pit	Depth (m)	Sample	Description
BH03	10.50	U15	Firm dark brown sandy CLAY.



Initial Specimen		
Length of Sample (mm)		450
Depth from top of sample (mm)		44
Condition of Sample:	Undisturbed	
Orientation:	Vertical	

Test Type		Multistage		
Length of Specimen (mm)		186.6		
Diameter of Specimen (mm)		103.3		
Moisture Content (%)		15		
Bulk Density (Mg/m³)		2.37		
Dry Density (Mg/m³)		2.06		
Membrane Thickness (mm)		0.3		
Membrane Type		latex		
Rate of Strain (%/min)		2.30		
Test Results	Measured Cell Pressure (kPa)	100	200	400
	Strain at Failure (%)	6.4	12.9	20.9
	Membrane Correction (kPa)	0.4	0.8	1.1
	Corrected Deviator Stress (kPa)	186	229	296
	Shear Stress (kPa)	**93**	**114**	**148**
	Mode of Failure (B/P/C)	**Plastic**		

Method of Preparation :

Method of Test :

Remarks : Membrane Type: latex

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

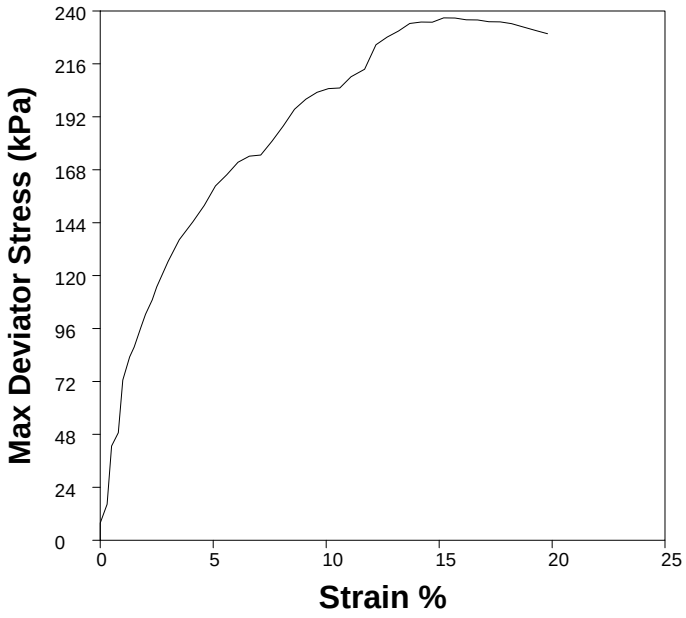
Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITH MULTISTAGE LOADING AND WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Trial Pit	Depth (m)	Sample	Description
BH03	13.50	U21	Firm dark brown CLAY.



Initial Specimen		
Length of Sample (mm)		450
Depth from top of sample (mm)		12
Condition of Sample:		Undisturbed
Orientation:		Vertical

Test Type		Multistage		
Length of Specimen (mm)		197.4		
Diameter of Specimen (mm)		100.4		
Moisture Content (%)		17		
Bulk Density (Mg/m³)		2.13		
Dry Density (Mg/m³)		1.83		
Membrane Thickness (mm)		0.3		
Membrane Type		latex		
Rate of Strain (%/min)		2.03		
Test Results	**Measured Cell Pressure (kPa)**	125	250	500
	Strain at Failure (%)	7.1	10.6	15.2
	Membrane Correction (kPa)	0.5	0.7	0.9
	Corrected Deviator Stress (kPa)	174	204	236
	Shear Stress (kPa)	**87**	**102**	**118**
	Mode of Failure (B/P/C)	**Plastic**		

Method of Preparation :

Method of Test :

Remarks : Membrane Type: latex

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

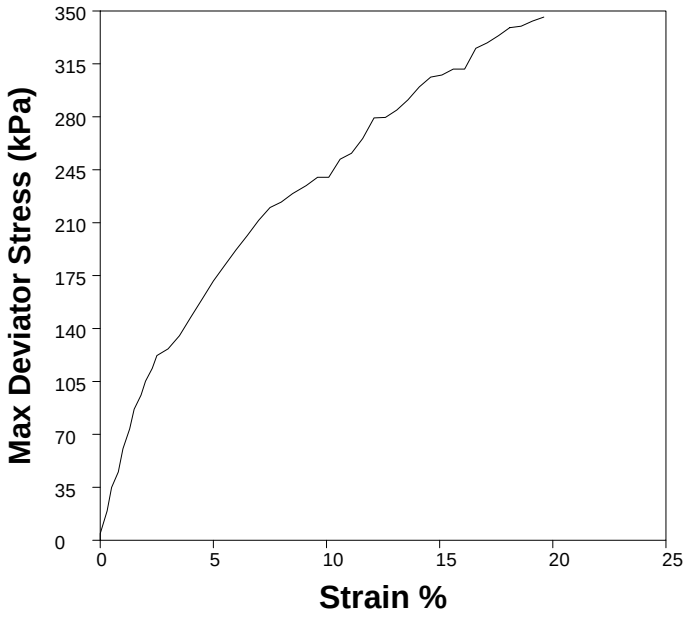
Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITH MULTISTAGE LOADING AND WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Trial Pit	Depth (m)	Sample	Description
BH04	10.50	U15	Friable dark brown sandy CLAY, with fine to medium gravel.



Initial Specimen		
Length of Sample (mm)	450	
Depth from top of sample (mm)	13	
Condition of Sample:	Undisturbed	
Orientation:	Vertical	

Test Type		Multistage		
Length of Specimen (mm)		198.9		
Diameter of Specimen (mm)		102.7		
Moisture Content (%)		14		
Bulk Density (Mg/m³)		2.19		
Dry Density (Mg/m³)		1.92		
Membrane Thickness (mm)		0.3		
Membrane Type		latex		
Rate of Strain (%/min)		2.01		
Test Results	**Measured Cell Pressure (kPa)**	100	200	400
	Strain at Failure (%)	10.1	16.1	19.6
	Membrane Correction (kPa)	0.7	0.9	1.1
	Corrected Deviator Stress (kPa)	239	311	345
	Shear Stress (kPa)	**120**	**155**	**172**
	Mode of Failure (B/P/C)	**Plastic**		

Method of Preparation :

Method of Test :

Remarks : Membrane Type: latex

IAN FARMER ASSOCIATES

Laboratory Test Report - 40323

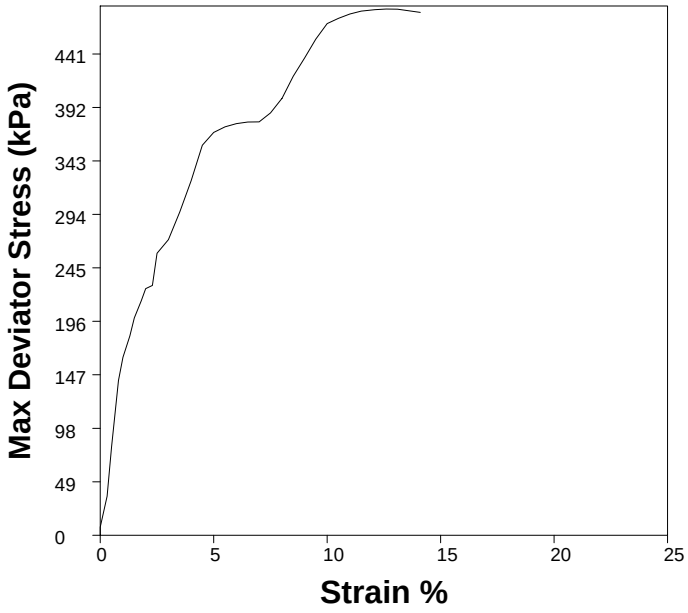
Site : Queens Road, Cheetham Hill, Manchester

Client : L K Group

Job Number 40323

DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITH MULTISTAGE LOADING AND WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Trial Pit	Depth (m)	Sample	Description
BH04	13.50	U21	Dark brown firm sandy CLAY with some gravel



Initial Specimen	Length of Sample (mm)			450
	Depth from top of sample (mm)			35
	Condition of Sample:	Undisturbed		
	Orientation:	Vertical		
Test Type		Multistage		
Length of Specimen (mm)		199.2		
Diameter of Specimen (mm)		102.5		
Moisture Content (%)		9.7		
Bulk Density (Mg/m³)		2.34		
Dry Density (Mg/m³)		2.13		
Membrane Thickness (mm)		0.3		
Membrane Type		latex		
Rate of Strain (%/min)		2.02		
Test Results	Measured Cell Pressure (kPa)	125	250	500
	Strain at Failure (%)	2.3	7	12.6
	Membrane Correction (kPa)	0.2	0.5	0.8
	Corrected Deviator Stress (kPa)	229	378	481
	Shear Stress (kPa)	**114**	**189**	**241**
	Mode of Failure (B/P/C)	**Plastic**		

Method of Preparation :

Method of Test :

Remarks : Membrane Type: latex

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Test Report : **40323**

Site : Queens Road, Cheetham Hill, Manchester
Job Number : 40323
Originating Client : L K Group

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

The following tests contained within this report are not UKAS Accredited.

Date of Issue : 17/05/08

APPENDIX C

LQM GACS TABLE

Summary Table for the Generic Assessment Criteria for Human Health Risk Assessment Land Quality Management (LQM).

The LQM Generic Assessment Criteria (GAC) according to Land use.

		Generic Assessment Criteria (mg/kg) Dry weight soil		
Contaminant	**Soil Organic Matter (SOM)**	**Residential with plant uptake**	**Residential without plant uptake**	**Commercial/ Industrial**
Beryllium	1%	12.1	84.9	1.95E+03
Copper	1%	111	2080	45700
Vanadium	1%	140	150	4250
Zinc	1%	330	8250	188000
Benzo(a)pyrene (BaP)	1%	1.12	1.30	29.7
	2.5%	1.08	1.31	29.7
	5%	1.09	1.32	29.9
Dibenzo(a,h)anthracene	1%	1.14	1.30	29.7
	2.5%	1.13	1.34	29.7
	5%	1.10	1.32	29.9
Fluorene	1%	3.84E+01	2.77E+03	5.90E+04
	2.5%	9.14E+01	2.64E+03	5.94E+04
	5%	1.84E+02	2.70E+03	5.95E+04
Naphthalene	1%	3.47	6.94	290
	2.5%	8.47	17.1	720
	5%	17.0	33.7	1440
Aliphatic				
EC 5-6	1%	2.11 E+00	2.11 E+00	9.53 E+01
EC>6-8	1%	5.37 E+00	5.37 E+00	2.42 E+02
EC>8-10	1%	1.46 E+00	1.46 E+00	6.59 E+01
EC>10-12	1%	8.53 E+00	8.60 E+00	2.99 E+04
EC>12-16	1%	4.07 E+01	4.21 E+01	2.99 E+04
EC>16-21	1%	1.64 E+04	2.76 E+04	6.17 E+05
EC>21-35	1%	1.64 E+04	2.76 E+04	6.17 E+05
EC>35-44	1%	1.64 E+04	2.76 E+04	6.17 E+05
EC 5-6	2.5%	3.72 E+00	3.72 E+00	1.68 E+02
EC>6-8	2.5%	1.19 E+01	1.19 E+01	5.35 E+02
EC>8-10	2.5%	3.55 E+00	3.56 E+00	1.60 E+02
EC>10-12	2.5%	2.08 E+01	2.12 E+01	3.06 E+04
EC>12-16	2.5%	9.34 E+01	1.01 E+02	3.06 E+04
EC>16-21	2.5%	1.64 E+04	2.76 E+04	6.31 E+05
EC>21-35	2.5%	1.64 E+04	2.76 E+04	6.31 E+05
EC>35-44	2.5%	1.64 E+04	2.79 E+04	6.31 E+05
EC 5-6	5%	6.38 E+00	6.39 E+00	2.88 E+02
EC>6-8	5%	2.27 E+01	2.27 E+01	1.02 E+03
EC>8-10	5%	7.00 E+00	7.05 E+00	3.17 E+02
EC>10-12	5%	4.01 E+01	4.17 E+01	3.04 E+04
EC>12-16	5%	1.63 E+02	1.87 E+02	3.04 E+04
EC>16-21	5%	1.63 E+04	2.68 E+04	6.27 E+05
EC>21-35	5%	1.63 E+04	2.68 E+04	6.27 E+05
EC>35-44	5%	1.63 E+04	2.68 E+04	6.27 E+05
Aromatic				
EC5-7(benzene)	1%	5.75 E-01	6.13 E-01	2.69 E+01
EC>7-8(toluene)	1%	6.24 E-01	6.94 E-01	3.04 E+01

EC>8-10	1%	1.09 E+00	2.39 E+00	1.07 E+02
EC>10-12	1%	1.94 E+00	1.42 E+01	6.25 E+02
EC>12-16	1%	2.19 E+00	7.27 E+01	1.22 E+04
EC>16-21	1%	1.15 E+02	2.91 E+02	9.19 E+03
EC>21-35	1%	1.57 E+02	4.17 E+02	9.25 E+03
EC>35-44	1%	1.57 E+02	4.17 E+02	9.25 E+03
EC5-7(benzene)	2.5%	1.33 E+00	1.41 E+00	6.21 E+01
EC>7-8(toluene)	2.5%	1.46 E+00	1.63 E+00	7.11 E+01
EC>8-10	2.5%	2.67 E+00	5.88 E+00	2.63 E+02
EC>10-12	2.5%	4.76 E+00	3.41 E+01	1.45 E+03
EC>12-16	2.5%	5.39 E+00	1.52 E+02	1.25 E+04
EC>16-21	2.5%	1.32 E+02	3.36 E+02	9.40 E+03
EC>21-35	2.5%	1.61 E+02	4.17 E+02	9.46 E+03
EC>35-44	2.5%	1.61 E+02	4.17 E+02	9.46 E+03
EC5-7(benzene)	5%	2.57 E+00	2.75 E+00	1.21 E+02
EC>7-8(toluene)	5%	2.85 E+00	3.18 E+00	1.39 E+02
EC>8-10	5%	5.30 E+00	1.16 E+01	5.13 E+02
EC>10-12	5%	9.44 E+00	6.39 E+01	2.60 E+03
EC>12-16	5%	1.07 E+01	2.35 E+02	1.24 E+04
EC>16-21	5%	1.33 E+02	3.62 E+02	9.35 E+03
EC>21-35	5%	1.57 E+02	4.04 E+02	9.41 E+03
EC>35-44	5%	1.57 E+02	4.04 E+02	9.41 E+03
Aliphatic +Aromatic >EC44	1%	1.74 E+02	4.17 E+02	9.25 E+03
	2.5%	1.79 E+02	4.17 E+02	9.46 E+03
	5%	1.74 E+02	4.04 E+02	9.41 E+03
Chlorobenzene	1%	10.6	32.9	140000
	2.5%	24.8	79.3	143000
	5%	50	155	143000
1,2 Dichloroethane	1%	7.91 E-03	1.18 E-02	5.36 E-01
	2.5%	1.72 E-02	2.56 E-02	1.16 E+00
	5%	3.28 E-02	4.86 E-02	2.2 E+00
Hexachlorobutadiene	1%	4.22 E-03	4.96 E-02	1.98 E+00
	2.5%	1.03 E-02	1.20 E-01	4.72 E+00
	5%	2.06 E-02	2.30 E-01	8.77 E+00
Tetrachloroethane	1%	5.62 E-01	3.60 E+00	1.50 E+02
	2.5%	1.25 E+00	8.05 E+00	3.32 E+02
	5%	2.38 E+00	1.53 E+01	6.20 E+02
Tetrachloroethene	1%	1.01	1.46	63.1
	2.5%	2.32	3.39	146
	5%	4.50	6.58	283
1,1,1 Trichloroethane	1%	1.17 E+01	1.29 E+01	5.52 E+02
	2.5%	2.72 E+01	2.98 E+01	1.28 E+03
	5%	5.31 E+01	5.79 E+01	2.49 E+03
Trichloroethene (TCE)	1%	0.134	0.15	6.42
	2.5%	0.308	0.346	14.8
	5%	0.598	0.673	28.8
Trichloromethane	1%	0.888	1.72	79.4
	2.5%	1.99	3.91	180
	5%	3.86	7.52	345
Vinyl Chloride	1%	9.53 E-04	1.29 E-03	5.87 E-02
	2.5%	1.84 E-03	2.48 E-03	1.13 E-01
	5%	3.29 E-03	4.47 E-03	2.03 E-01
Atrazine	1%	0.0204	7.04	152
	2.5%	0.0489	6.86	157
	5%	0.0984	7.03	157

N.B all GAC are based on Sandy soils with a pH 7.

APPENDIX D

CLR7 STATISTICAL TESTS

Site Name IWHC **LOI /SOM (%)** 5.0

Site Ref No. CL1294 **Site Use** Commercial/Industrial

Data Input By MP 24/04/2008

Analyte	Units	SGV/GAC	Min	Max	x mean	Sx	n	t	US95	T	T crit	Outlier Assessment	Assessment
Arsenic	mg/kg	**500**	**7.1**	**48**	18.45	12.90	8	1.860	**26.93**	1.92	1.91	Outliers Present	No Action Required
Cadmium	mg/kg	**1400**	**0.1**	**5.3**	0.75	1.84	8	1.860	**1.96**	2.47	1.91	Outliers Present	No Action Required
Copper (HH)	mg/kg	**45700**	**33**	**670**	144.63	213.53	8	1.860	**285.05**	2.26	1.91	Outliers Present	No Action Required
Lead	mg/kg	**750**	**39**	**2600**	280.43	3.45	8	1.860	**633.27**	1.80	1.91	No Outliers	No Action Required
Chromium	mg/kg	**5000**	**7.9**	**27**	20.11	5.70	8	1.860	**23.86**	0.91	1.91	No Outliers	No Action Required
Inorganic Mercury	mg/kg	**480**	**0.12**	**8.6**	1.57	2.85	8	1.860	**3.44**	2.10	1.91	Outliers Present	No Action Required
Nickel (HH)	mg/kg	**5000**	**8.7**	**41**	27.21	9.12	8	1.860	**33.21**	1.05	1.91	No Outliers	No Action Required
Selenium	mg/kg	**8000**	**0.2**	**1.2**	0.44	0.32	8	1.860	**0.65**	2.15	1.91	Outliers Present	No Action Required
Zinc (HH)	mg/kg	**188000**	**82**	**620**	231.00	200.15	8	1.860	**362.62**	1.66	1.91	No Outliers	No Action Required
TPH Aliphatic C8-C10	mg/kg	**317**	**0.1**	**15**	1.96	5.27	8	1.860	**5.43**	2.47	1.91	Outliers Present	No Action Required
TPH Aliphatic C10-C12	mg/kg	**30400**	**0.1**	**69**	8.71	24.36	8	1.860	**24.73**	2.47	1.91	Outliers Present	No Action Required
TPH Aliphatic C12-C16	mg/kg	**30400**	**0.1**	**220**	27.59	77.75	8	1.860	**78.71**	2.47	1.91	Outliers Present	No Action Required
TPH Aliphatic C16-C21	mg/kg	**627000**	**0.1**	**250**	31.34	88.35	8	1.860	**89.44**	2.47	1.91	Outliers Present	No Action Required
TPH Aliphatic C21-C35	mg/kg	**627000**	**0.1**	**120**	15.09	42.39	8	1.860	**42.96**	2.47	1.91	Outliers Present	No Action Required
TPH Aromatic EC5-EC7	mg/kg	**121**	**0.1**	**0.4**	0.14	0.11	8	1.860	**0.21**	2.47	1.91	Outliers Present	No Action Required
TPH Aromatic EC7-EC8	mg/kg	**139**	**0.1**	**0.6**	0.16	0.18	8	1.860	**0.28**	2.47	1.91	Outliers Present	No Action Required
TPH Aromatic EC8-EC10	mg/kg	**513**	**0.1**	**280**	35.10	98.95	8	1.860	**100.17**	2.47	1.91	Outliers Present	No Action Required
TPH Aromatic EC10-EC12	mg/kg	**2600**	**0.1**	**100**	20.43	35.24	8	1.860	**43.60**	1.46	1.91	No Outliers	No Action Required
TPH Aromatic EC12-EC16	mg/kg	**12400**	**0.1**	**4600**	658.64	1600.48	8	1.860	**1711.13**	1.54	1.91	No Outliers	No Action Required
TPH Aromatic EC16-EC21	mg/kg	**9350**	**1.1**	**4800**	916.89	1652.73	8	1.860	**2003.74**	1.34	1.91	No Outliers	No Action Required
TPH Aromatic EC21-EC35	mg/kg	**9410**	**0.8**	**2800**	707.10	1009.23	8	1.860	**1370.78**	1.11	1.91	No Outliers	No Action Required
B(a)P	mg/kg	**29.9**	**0.3**	**420**	64.78	144.44	8	1.860	**159.76**	1.71	1.91	No Outliers	Further Action Required
Naphthalene	mg/kg	**1440**	**0.1**	**54**	10.48	18.79	8	1.860	**22.83**	1.51	1.91	No Outliers	No Action Required
Dibenzo(ah)anthracene	mg/kg	**29.9**	**0.1**	**48**	8.31	16.37	8	1.860	**19.07**	1.67	1.91	No Outliers	No Action Required
Copper (phytotoxic)	mg/kg	**130**	**21**	**670**	134.75	217.68	8	1.860	**277.90**	2.17	1.91	Outliers Present	Further Action Required
Nickel (phytotoxic)	mg/kg	**70**	**8.7**	**41**	27.21	9.12	8	1.860	**33.21**	1.05	1.91	No Outliers	No Action Required
Zinc (phytotoxic)	mg/kg	**300**	**82**	**620**	231.00	200.15	8	1.860	**362.62**	1.66	1.91	No Outliers	Further Action Required

Note

SGV	Soil Guideline Value
GAC	LQM Generic Assessment Criteria Value
x mean	Arithmetic mean of measured concentrations for an analyte
Min	Minimum value of measured concentrations for an analyte
Max	Maximum value of measured concentrations for an analyte
Sx	Unbiased analyte standard deviation
n	Number of samples
t	Value for 95th percentile confidence limit based upon number of samples
US95	The Upper 95th percentile bound of sample
T	Outlier test statistic
T crit	Critical T value dependant on n

Site Name	IWHC	**LOI /SOM (%)**	5.0
Site Ref No.	CL1294 **Site Use**	Playing Field	
Data Input By	MP	24/04/2008	

Analyte	Units	SGV/GAC	Min	Max	x mean	Sx	n	t	US95	T	T crit	Outlier Assessment	Assessment
Lead	mg/kg	**450**	**24**	**1400**	489.93	2.76	13	1.761	**804.17**	1.03	2.18	No Outliers	Further Action Required
Aliphatic 10-12	mg/kg	**86**	**0.1**	**230**	17.78	63.76	13	1.761	**48.93**	3.33	2.18	Outliers Present	No Action Required
Aliphatic 12-16	mg/kg	**38**	**0.1**	**820**	63.55	227.29	13	1.761	**174.56**	3.03	2.18	Outliers Present	Further Action Required
B(a)P	mg/kg	**4.56**	**0.5**	**61**	13.90	15.57	13	1.761	**21.50**	1.72	2.18	No Outliers	Further Action Required
D(A,h)A	mg/kg	**4.56**	**0.1**	**9.4**	2.37	2.61	13	1.761	**3.65**	1.60	2.18	No Outliers	No Action Required

Note

SGV	Soil Guideline Value
GAC	LQM Generic Assessment Criteria Value
x mean	Arithmetic mean of measured concentrations for an analyte
Min	Minimum value of measured concentrations for an analyte
Max	Maximum value of measured concentrations for an analyte
Sx	Unbiased analyte standard deviation
n	Number of samples
t	Value for 95th percentile confidence limit based upon number of samples
US95	The Upper 95th percentile bound of sample
T	Outlier test statistic
T crit	Critical T value dependant on n

Site Name	IWHC Park	**LOI /SOM (%)**	5.0
Site Ref No.	CL1294 **Site Use**	Park	
Data Input By	MP	24/04/2008	

Analyte	Units	SGV/GAC	Min	Max	x mean	Sx	n	t	US95	T	T crit	Outlier Assessment	Assessment
Lead	mg/kg	**450**	**66**	**800**	329.92	2.32	10	1.812	**534.99**	1.05	2.04	No Outliers	Further Action Required
Copper (phytotoxic)	mg/kg	**130**	**44**	**1900**	304.80	564.15	10	1.812	**628.06**	2.45	2.04	Outliers Present	Further Action Required
Nickel (phytotoxic)	mg/kg	**70**	**17**	**290**	56.10	82.82	10	1.812	**103.56**	2.62	2.04	Outliers Present	Further Action Required
Zinc (phytotoxic)	mg/kg	**300**	**100**	**3700**	708.00	1084.78	10	1.812	**1329.58**	2.06	2.04	Outliers Present	Further Action Required
Arsenic	mg/kg	**26**	**7.9**	**28**	16.43	7.63	10	1.812	**20.80**	1.33	2.04	No Outliers	No Action Required
Nickel	mg/kg	**100**	**17**	**290**	56.10	82.82	10	1.812	**103.56**	2.62	2.04	Outliers Present	Further Action Required
B(a)P	mg/kg	**1.18**	**0.8**	**23**	9.57	7.84	10	1.812	**14.06**	1.16	2.04	No Outliers	Further Action Required
D(a,h)A	mg/kg	**1.18**	**0.1**	**4.7**	1.55	1.54	10	1.812	**2.43**	1.28	2.04	No Outliers	Further Action Required

Note

SGV	Soil Guideline Value
GAC	LQM Generic Assessment Criteria Value
x mean	Arithmetic mean of measured concentrations for an analyte
Min	Minimum value of measured concentrations for an analyte
Max	Maximum value of measured concentrations for an analyte
Sx	Unbiased analyte standard deviation
n	Number of samples
t	Value for 95th percentile confidence limit based upon number of samples
US95	The Upper 95th percentile bound of sample
T	Outlier test statistic
T crit	Critical T value dependant on n

APPENDIX E

GAS MONITORING RESULTS

Landfill Gas Monitoring on 15th April 2008

Weather: cloudy Surface ground conditions: dry
Monitoring Equipment: GA2000
Ambient concentrations (% Volume) CH4: 0%, CO2: 0%, O2: 20.2%.
Barometric pressure: Start of visit 1013mb, end of visit 1011mb.

ID	DATE	CH4	CO2	O2	BALANCE	CH4 %LEL	PEAKCH4	BARO	REL.PRESSURE	INTERNAL FLOW	CO	H2S	CH4/CO2	Res Nitrogen	Dipmeter	
		%	%	%	%	%	%	mb	mb	l/h	ppm	ppm	%	%		
CP2	15/04/2008 11:11	1.9	6.1	4.7	87.3	38	1.9	1013	-0.06	0	1	0	0.31	69.53	5.2	
WS10	15/04/2008 11:30	0	2.2	10.3	87.5	0	0.1	1013	0	0	7	0	0	48.57	Dry	
WS9	15/04/2008 11:47	4.6	8.8	7.6	79	92	4.6	1013	0.01	0	0	0	0.52	50.27	Dry	
WS8	15/04/2008 12:04	15.5	13.3	2.5	68.7	200	15.8	1013	0.1	0	1	0	1.17	59.25	5	
CP3	15/04/2008 12:23	2.2	3.8	1.3	92.7	44	2.2	1013	0.12	0	4	0	0.58	87.79	Dry	
CP4	15/04/2008 12:39	0	1.2	18.1	80.7	0	0.2	1013	0.15	0	0	0	0	12.28	13	
WS5	15/04/2008 12:54	0	0	21	79	0	0	1013	0.15	0	0	0		0	2.35	Bung removed to remove blockage
CP1	15/04/2008 14:50	0.4	6.5	0.8	92.3	8	0.4	1012	-0.03	0	0	0	0.06	89.28		
WS2	15/04/2008 15:06	0	0.3	20.4	79.3	0	0	1012	0.05	0	0	0	0	2.19	3.75	
WS3	15/04/2008 15:21	0	0.6	20.2	79.2	0	0	1012	0.07	0	0	0	0	2.84	4	
WS4	15/04/2008 15:55	0.3	6.1	0.6	93	6	0.3	1011	-0.03	0.2	0	0	0.05	90.73	4.1	
CP5	15/04/2008 16:14	3.9	3	0.6	92.5	78	3.9	1011	0.01	0	0	0	1.3	90.23		
WS1	gas tap open															
CP6	inaccessible															

Landfill Gas Monitoring on 21st April 2008

Weather: cloudy Surface ground conditions: dry
Monitoring Equipment: GA2000
Ambient concentrations (% Volume) CH4: 0%, CO2: 0%, O2: 20.2%.
Barometric pressure: Start of visit 1000mb, end of visit 999mb.

ID	DATE	CH4	CO2	O2	BALANCE	CH4 %LEL	PEAKCH4	BARO	REL.PRESSURE	INTERNAL FLOW	CO	H2S	CH4/CO2	Res Nitrogen	Dipmeter
		%	%	%	%	%	%	mb	mb	l/h	ppm	ppm	%	%	
CP1	21/04/2008 10:25	0.4	5.9	3.7	90	8	0.3	1000	0.08	0	0	0	0.07	76.01	4.55
WS2	21/04/2008 10:33	0	0.9	18.8	80.3	0	0	1000	0.1	-0.1	0	0	0	9.24	3.5
WS3	21/04/2008 10:44	0	1.4	18.1	80.5	0	0	1000	0.15	0	0	0	0	12.08	Dry
WS10	21/04/2008 10:59	0	1.6	15.7	82.7	0	0	1000	0.15	0	0	0	0	23.35	4.4
WS9	21/04/2008 11:08	0	5.3	13.1	81.6	0	0	1000	0.16	-0.1	0	0	0	32.08	Dry
CP6	21/04/2008 11:16	4.3	13.2	0.4	82.1	86	4.4	1000	0.58	1.3	0	0	0.33	80.59	12.9
WS8	21/04/2008 11:25	15	12.9	3.8	68.3	200	15.1	1000	0.17	0.1	0	0	1.16	53.94	Dry
CP5	21/04/2008 11:36	3.2	3.2	0.1	93.5	64	14.6	1000	0.24	0.1	0	2	1	93.12	
WS5	21/04/2008 11:54	0	1.4	18.4	80.2	0	3.5	1000	0.16	0	0	0	0	10.65	
CP4	21/04/2008 12:08	0	1.9	19	79.1	0	0	999	0.17	0.2	0	0	0	7.28	12.8
WS4	21/04/2008 12:10	0.1	6.7	0.3	92.9	2	0.1	999	0.18		0	0	0.01	91.77	3.95
WS1	Damaged														

Landfill Gas Monitoring on 6th May 2008

Weather: sunny Surface ground conditions: dry
Monitoring Equipment: GA2000
Ambient concentrations (% Volume) CH4: 0%, CO2: 0%, O2: 20.2%.
Barometric pressure: Start of visit 1016mb, end of visit 1016mb.

ID	DATE	CH4	CO2	O2	BALANCE	CH4 %LEL	PEAKCH4	BARO	REL.PRESSURE	INTERNAL FLOW	CO	H2S	CH4/CO2	Res Nitrogen	Dipmeter
		%	%	%	%	%	%	mb	mb	l/h	ppm	ppm	%	%	
CP1	06/05/2008 11:04	0.2	4.7	7	88.1	4	0.2	1016	0.3	0	0	0	0.04	61.64	4.8
WS2	06/05/2008 11:11	0	1.1	18.4	80.5	0	0	1016	0.4	0	0	0	0	10.95	4.1
WS3	06/05/2008 11:19	0	2	16.5	81.5	0	0	1016	0.45	0	0	0	0	19.13	
CP2	06/05/2008 11:39	2	7.5	0.7	89.8	40	2	1016	0.47	0.1	0	0	0.27	87.15	5.2
WS10	06/05/2008 11:48	0	1.4	15.9	82.7	0	0	1017	0.52	-0.1	0	0	0	22.6	Dry
WS9	06/05/2008 11:56	0	1.9	17.9	80.2	0	0	1017	0.58	0	0	0	0	12.54	Dry
CP6	06/05/2008 12:05	16.6	9	9.4	65	200	16.6	1017	-2.02	0	0	0	1.84	29.47	
CP5	06/05/2008 12:14	3.9	2.8	0.8	92.5	78	4	1017	0.59	0.1	0	0	1.39	89.48	9.35
WS8	06/05/2008 13:26	14.1	14.2	1.8	69.9	200	14.1	1016	0.47	0	3	0	0.99	63.1	Dry
CP3	06/05/2008 13:35	0.9	4.1	3.5	91.5	18	13.9	1016	0.54	0	0	0	0.22	78.27	7
CP4	06/05/2008 13:42	0	0.5	19.1	80.4	0	0.1	1016	0.61	0	0	0	0	8.2	7.5
WS5	06/05/2008 13:50	0	2.1	15.7	82.2	0	0	1016	0.66	0	0	0	0	22.85	4.5
WS4	06/05/2008 13:58	0.2	4.7	3.6	91.5	4	0.2	1016	0.7	0	1	0	0.04	77.89	4.3

Landfill Gas Monitoring on 19th May 2008

Weather: sunny Surface ground conditions: dry
Monitoring Equipment: GA2000
Ambient concentrations (% Volume) CH4: 0%, CO2: 0%, O2: 20.2%.
Barometric pressure: Start of visit 101mb, end of visit 1011mb.

ID	DATE	CH4	CO2	O2	BALANCE	CH4 %LEL	PEAKCH4	BARO	REL.PRESSURE	INTERNAL FLOW	CO	H2S	CH4/CO2	Res Nitrogen	Dipmeter
		%	%	%	%	%	%	mb	mb	l/h	ppm	ppm	%	%	
CP1	19/05/2008 11:02	0	3.2	10.9	85.9	0	0	1011	-0.01	0	0	0	0	44.7	4.9
WS2	19/05/2008 11:11	0	1.7	19.1	79.2	0	0	1011	0.03	0	0	0	0	7	
WS2	19/05/2008 11:35	0	0.9	19.6	79.5	0	0	1011	0.06	0	0	0	0	5.41	Dry
CP2	19/05/2008 11:44	0.4	8.5	4.3	86.8	8	0.4	1011	0.08	0	0	0	0.05	70.55	4.52
WS10	19/05/2008 11:55	0	1.5	18.7	79.8	0	0	1011	0.1	0.2	0	0	0	9.11	Dry
CP6	19/05/2008 12:08	11.8	7	13.4	67.8	200	11.8	1011	-0.1	0	0	0	1.69	17.15	13
WS8	19/05/2008 12:15	11.2	13.3	3.9	71.6	8		1011	0.13	0	0	0	2	4.28	Dry
CP3	19/05/2008 13:13	1.2	4.7	2.3	91.8	24	2.7	1011	0.02	0	0	0	0.26	83.11	Dry
CP4	19/05/2008 13:20	0	3.2	13.7	83.1	0	0.7	1011	0.09	0	0	0	0	31.31	13
WS5	19/05/2008 13:35	0	2.4	16.6	81	0	0	1011	0.13	0	0	0	0	18.25	4.4
WS4	19/05/2008 13:38	0.3	6.9	0.2	92.6	6	0.3	1011	0.14	0	0	0	0.04	91.84	4.1
WS9	infested with an ants nest														

Landfill Gas Monitoring on 28th May 2008

Weather: sunny Surface ground conditions: dry
Monitoring Equipment: GA2000
Ambient concentrations (% Volume) CH4: 0%, CO2: 0%, O2: 20.2%.
Barometric pressure: Start of visit 994mb, end of visit 993mb.

ID	DATE	CH4	CO2	O2	BALANCE	CH4 %LEL	PEAKCH4	BARO	REL.PRESSURE	INTERNAL FLOW	CO	H2S	CH4/CO2	Res Nitrogen	Dipmeter
		%	%	%	%	%	%	mb	mb	l/h	ppm	ppm	%	%	
CP1	28/05/2008 10:59	0.4	7.2	1.1	91.3	8	0.4	994	3	0	0	0	0.06	87.14	5
WS2	28/05/2008 11:08	0	4.4	13.5	82.1	0	0.4	994	-0.12	0	0	0	0	31.07	4.3
WS3	28/05/2008 11:18	0	2.5	17.3	80.2	0	0	994	-0.07	0	0	0	0	14.81	Dry
CP2	28/05/2008 11:35	0.1	6.2	8.9	84.8	2	0.1	994	-0.04	0	0	0	0.02	51.16	5.6
WS10	28/05/2008 11:48	0	4.2	6.8	89	0	0	993	-0.04	0	0	0	0	63.3	Dry
WS8	28/05/2008 11:58	11	15.8	0.4	72.6	0		993	-0.03	0	0	0	0	57.76	Dry
CP5	28/05/2008 12:23	3.9	3.2	0.5	92.4	78	5.7	993	-0.02	0	0	0	1.22	90.51	9
WS5	28/05/2008 12:32	0	2.1	17	80.9	0	4	993	-0.02	0	0	0	0	16.64	4.2
WS4	28/05/2008 14:14	0.3	6.8	1.5	91.4	6	0.3	993	-0.17	0	0	0	0.04	85.73	4.15
CP3	28/05/2008 14:23	1.2	4.5	4	90.3	24	1.2	993	-0.13	0	0	0	0.27	75.18	Dry
CP4	28/05/2008 14:30	0	0.1	20.4	79.5	0	0	993	-0.07	0	0	0	0	2.39	12
CP6	Bung removed														
WS9	Infested with ants														

Landfill Gas Monitoring on 18th June 2008

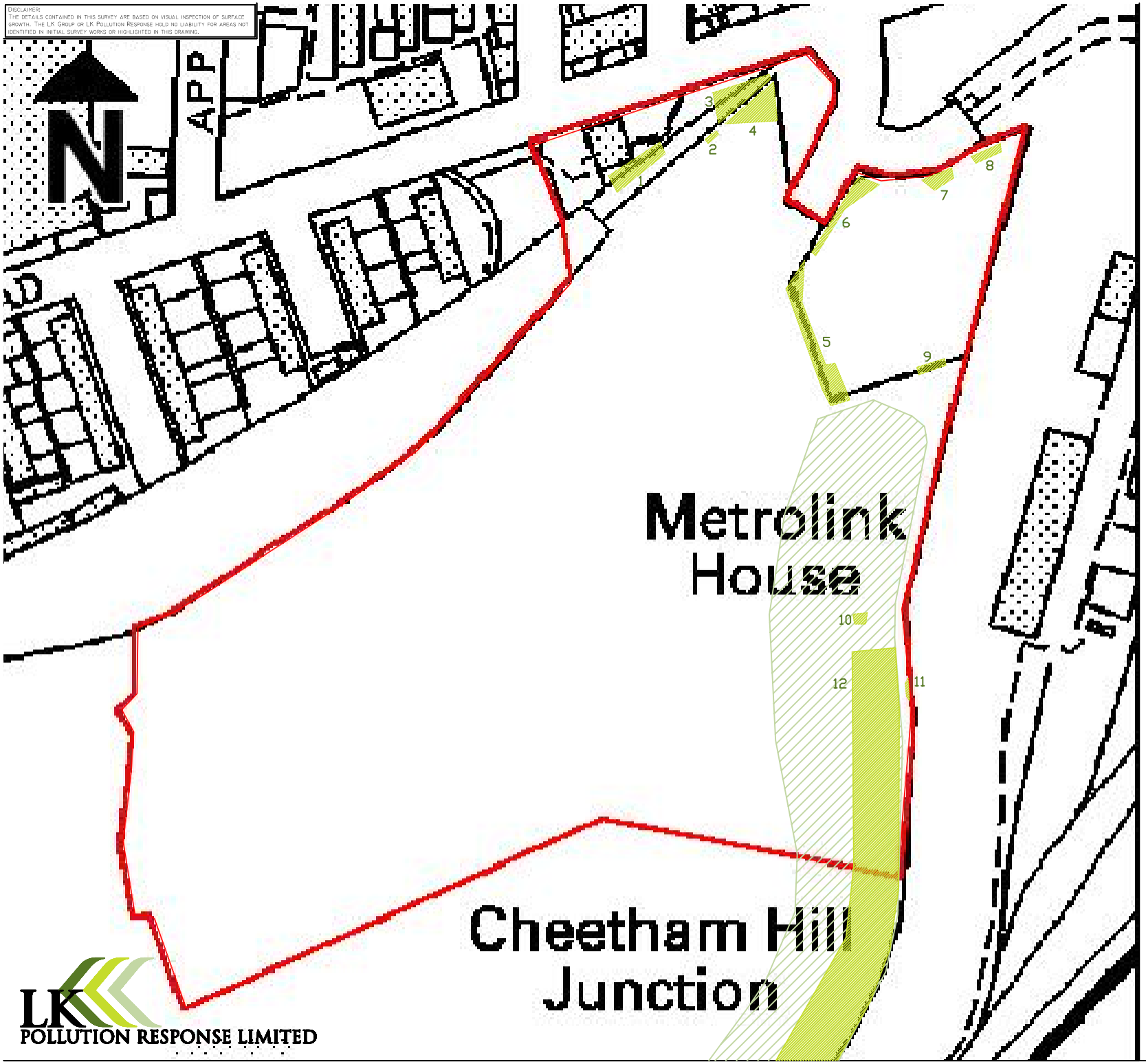
Weather: Raining Surface ground conditions: Wet
Monitoring Equipment: GA2000
Ambient concentrations (% Volume) CH4: 0%, CO2: 0%, O2: 20.2%.
Barometric pressure: Start of visit 997mb, end of visit 997mb.

ID	DATE	CH4	CO2	O2	BALANCE	CH4 %LEL	PEAKCH4	BARO	REL.PRESSURE	INTERNAL FLOW	CO	H2S	CH4/CO2	Res Nitrogen	Dipmeter
		%	%	%	%	%	%	mb	mb	l/h	ppm	ppm	%	%	
CP1	18/06/2008 10:30	0	5.1	5.2	89.7	0	0	997	1.15	0	0	0	0	70.04	5
WS2	18/06/2008 10:37	0	0.9	19.6	79.5	0	0	997	-0.11	-0.2	0	0	0	5.41	4.5
WS3	18/06/2008 10:43	0	0.7	19.8	79.4	0		997	-0.08	0.1	0	0	>>>>	2.49	Dry
CP2	18/06/2008 10:55	1.8	9.3	0.3	88.6	0	1.8	998	-0.03	0	0	0	>>>>	3.44	5.8
WS10	18/06/2008 11:05	0	4.9	8	87.1	0	0	996	-0.01	0	0	0	0	56.86	Dry
WS7	18/06/2008 11:18	4.4	6.5	13.9	75.2	88	4.4	997	-0.04	0	0	0	0.68	22.66	
CP5	18/06/2008 11:38	4.2	3.1	1	91.7	84	7.3	997	-0.09	-0.1	0	0	1.35	87.92	
WS5	18/06/2008 11:47	0	3.3	15.2	81.5	0	0.2	997	-0.03	0	0	0	0	24.04	4.5
WS4	18/06/2008 13:29	0.4	7.1	1.4	91.1	8	0.4	997	-0.17	-0.1	0	0	0.06	85.81	4.45
CP4	18/06/2008 13:37	0	0.2	20.2	79.6	0	0.3	997	-0.12	0	0	0	0	3.24	12.5
CP3	18/06/2008 13:44	0.3	1.7	13.9	84.1	6	0.3	997	-0.08	0.1	0	0	0.18	31.56	Dry

APPENDIX F

JAPANESE KNOTWEED SURVEY PLAN

DISCLAIMER:
THE DETAILS CONTAINED IN THIS SURVEY ARE BASED ON VISUAL INSPECTION OF SURFACE GROWTH. THE LK GROUP OR LK POLLUTION RESPONSE HOLD NO LIABILITY FOR AREAS NOT IDENTIFIED IN INITIAL SURVEY WORKS OR HIGHLIGHTED IN THIS DRAWING.



Site Boundary

Japanese Knotweed

Existing Bund

LK POLLUTION RESPONSE LIMITED

LK GROUP

LIVERPOOL	MANCHESTER	GLASGOW
TEL: 0151 207 0726 FAX: 0871 714 2267	TEL: 0161 703 7200 FAX: 0161 703 7250	TEL: 0141 773 6260 FAX: 0871 263 7015

CLIENT: IWHC

SITE: Queens Road, Cheetham Hill

TITLE: Japanese Knotweed Survey

Job No:	Drawing No:	Scale @ A1:
1294 IWHC	1294 IWHC - JK	NTS

Drawn By:	Checked By:	Authorised:	Date:
SC	CL	CL	09/04/08

LAND AT

IRISH WORLD HERITAGE CENTRE

QUEENS ROAD

CHEETHAM HILL

FURTHER WORK & GROUNDWATER RISK ASSESSMENT REPORT



Prepared for:

The Trustees of the Irish World
Heritage Centre
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Document Verification

Site Address	Irish World Heritage Centre, Queens Road, Cheetham Hill, Manchester		
Job Number	CL1294		
Report Title	Further Works and Groundwater Risk Assessment Report		
Date Issued	22nd May 2009	Document Ref.	CL1294-03
Prepared By	Rebecca McKellar	Signature	
Checked By	Paul Quimby	Signature	

EXECUTIVE SUMMARY

Site Details	The IWHC site is located immediately south of Queens Road (A6010), in the Cheetham Hill area of Manchester at National Grid Reference 384830 400380. The proposed development comprises a two storey new IWHC with associated open space, a 100 bed Hotel, a sports pitch and pavilion, car parking and areas of landscaping
Previous Work & Report Objectives	A Preliminary Risk Assessment report (reference CL1294-01 dated 14th March 2008) and Geoenvironmental Report (reference CL1294-02 dated 21st July 2008) have already been undertaken by LKA on this site and should be read in conjunction with this report. This work was required in response to EA comments. Further site investigation was required within Area A (former petrol station area & proposed hotel) and further controlled waters risk assessment was required within the 'Landfill Area' (Areas B, C and D as described within Report Ref CL1294-02)
Ground Investigation	Six window sample boreholes were drilled to maximum depth of 6.0mbgl within Area A in order to further characterise this area. Two rounds of groundwater monitoring and sampling were undertaken in December 2008 and March 2009. On these occasions river water sampling was also undertaken in the River Irk upstream, midstream and downstream of the study site. Eight soils and 27 water samples collected were analysed for a comprehensive suite of chemical analysis based on the previous uses of the site.
Ground Conditions	Made ground was encountered in all boreholes drilled in Area A to depths of between 3.1mbgl and 6.9mbgl and was not bottomed out at 5.0m and 6.0m in many boreholes. Evidence of hydrocarbon contamination was encountered within the made ground in all boreholes with the exception of WS2, WS206 and CP2. Natural ground was encountered in Area A in WS2, WS204, CP1 and CP2 at depths of 3.1m, 5.9m, 6.9m and 5.5m respectively and comprised firm becoming very stiff clay/ sandy clay. A weathered red/ brown sandstone was encountered within CP2 at 20.5m.
Soil Risk Assessment & Recommendations – AREA A	Elevated levels of contaminants were encountered within the near surface soils in Area A. Remedial measures will be required in soft landscaping areas. Information taken from the previous report also suggests potential risk to potable water supplies has been identified. Advice should be sought from United Utilities. The concentrations of soluble sulphate in the soil when contrasted to BRE Digest 2005 categorise the concrete requirement as DS-2 AC-2 for the Heritage Centre (Area B), no special precautions are required for the Hotel (Area A).
Controlled Water Assessment & Recommendations – AREA A and 'LANDFILL AREA'	The River Irk, the Minor Aquifer and the Major Aquifer beneath the site were identified as potential receptors. A GQRA identified contaminants of concern for each of the receptors. A DQRA was undertaken for each source and receptor. Based on the findings of this risk assessment, LKA does not consider there is a significant risk to the identified receptors from the site (Area A and 'Landfill Area').
Gas Risk Assessment & Recommendations – AREA A and 'LANDFILL AREA'	Information taken from the previous report identified a potential risk to human health and proposed buildings within Area A from ground gases. Gas protection measures are recommended for any new buildings.
Additional Considerations	It is recommended that the risk to human health from contaminated soil is reassessed in Areas B, C and D due to the recent change in the contaminated land regime. Permissions and advice with regard to Waste Framework Directive should be sought from the Environment Agency with regard to re-use of the on-site bund prior to any groundworks commencing on site. LKA recommend that health and safety considerations are employed while the pond area adjacent to the heritage centre building is excavated. Interceptor tanks associated with the former petrol station on the northern part of the site will need to be removed prior to construction of the hotel. Any impacted material associated with the interceptor tank should be removed off-site and validation sampling should be undertaken to ensure that all contamination has been removed. Method Statements and Risk Assessments for the chosen piling option should be forwarded to the Environment Agency once an appropriate technique has been chosen by the contractor, and prior to works commencing on site.

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Appendix D: Photographs of Groundwater Column

Appendix E: Summary of SSVs

Appendix F: Hazard Index Worksheets

Appendix G: Parameters for Remedial Targets Worksheets

1 INTRODUCTION

1.1 Background

Leyden Kirby Associates Ltd (LKA) has been commissioned by the trustees of the Irish World Heritage Centre (IWHC) to carry out a Further Work and Groundwater Risk Assessment for land at Queens Road, Cheetham Hill, Manchester (Figure 1-1).

This work is being undertaken to support future redevelopment of the site into the new Irish World Heritage Centre (IWHC), a hotel and associated areas of open space playing fields. A Preliminary Risk Assessment report (reference CL1294-01 dated 14th March 2008) and Geoenvironmental Report (reference CL1294-02 dated 21st July 2008) have already been undertaken by LKA on this site and should be read in conjunction with this report.

For the purposes of the risk assessment within the previous report the site was divided into four discrete areas based on the proposed site layout comprising the hotel area (Area A), the heritage centre (Area B), the heritage centre park (Area C) and the playing field (Area D) (Figure 1-2). This is due to the likely different receptor behaviour in each of these areas.

For the purposes of the groundwater risk assessment the site has been divided into 'Area A' (former petrol station area) and the 'Landfill Area' (areas B, C and D as shown within Figure 1-2).

1.2 Report Objectives

This report has been undertaken in response to the Environment Agency comments (correspondence dated 14th August 2008, Ref SO/2008/103752/01-L01), and the scope verbally with Lee Beveridge during a telephone conversation. Further work was required in order to;

- Further characterise the former petrol station land adjacent to Queens Road (referred to Area A).
- Undertake further rounds of groundwater monitoring for both Area A (the former petrol station and proposed hotel) and the remaining areas of the site (Areas B to D and referred to as 'Landfill Area').
- Undertake river water sampling up, mid and down stream of the study site.
- Undertake a detailed groundwater risk assessment with the information obtained for the whole site.

1.3 Disclaimer

This report has been prepared by LKA who have exercised such professional skill, care and diligence as may reasonably be expected of a properly qualified and competent consultant experienced in preparing reports of a similar scope.

However, to the extent that the report is based on or relies upon information contained in records, reports or other materials provided to LKA which have not been independently produced or verified, LKA gives no warranty, representation or assurance as to the accuracy or completeness of such information.

This report is issued on the condition that LKA will not be held liable for any loss arising from ground conditions between sampling points (i.e. boreholes/trial pits/hand augers/surface samples) which have not been shown by the sampling points or related

testing carried out during the investigation, nor for any loss arising from conditions below the maximum depth of the investigation. Opinions on such conditions, where given, are for general guidance only.

This report is prepared solely for the benefit of Irish Diaspora Foundation Ltd. It may not be replied upon by, or submitted to a third party for their reliance for the purposes of valuation, mortgage, insurance and regulatory approval, until all invoices have been settled in full.

Those using this information in subsequent assessments or evaluations do so at their own risk.

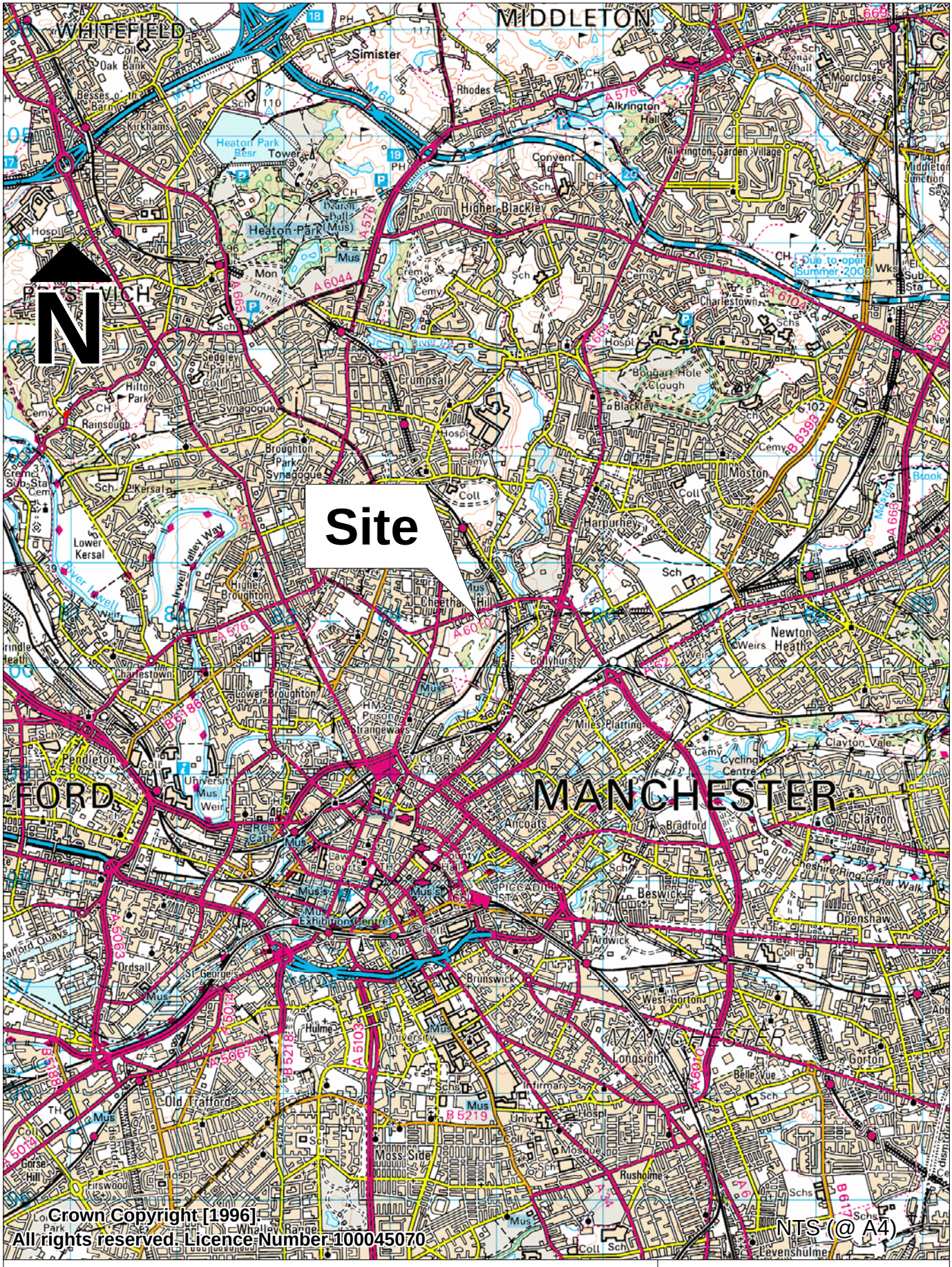

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Figure 1-1: Location Plan, IWHC, Queens Road, Manchester.

Drawn: February 2008

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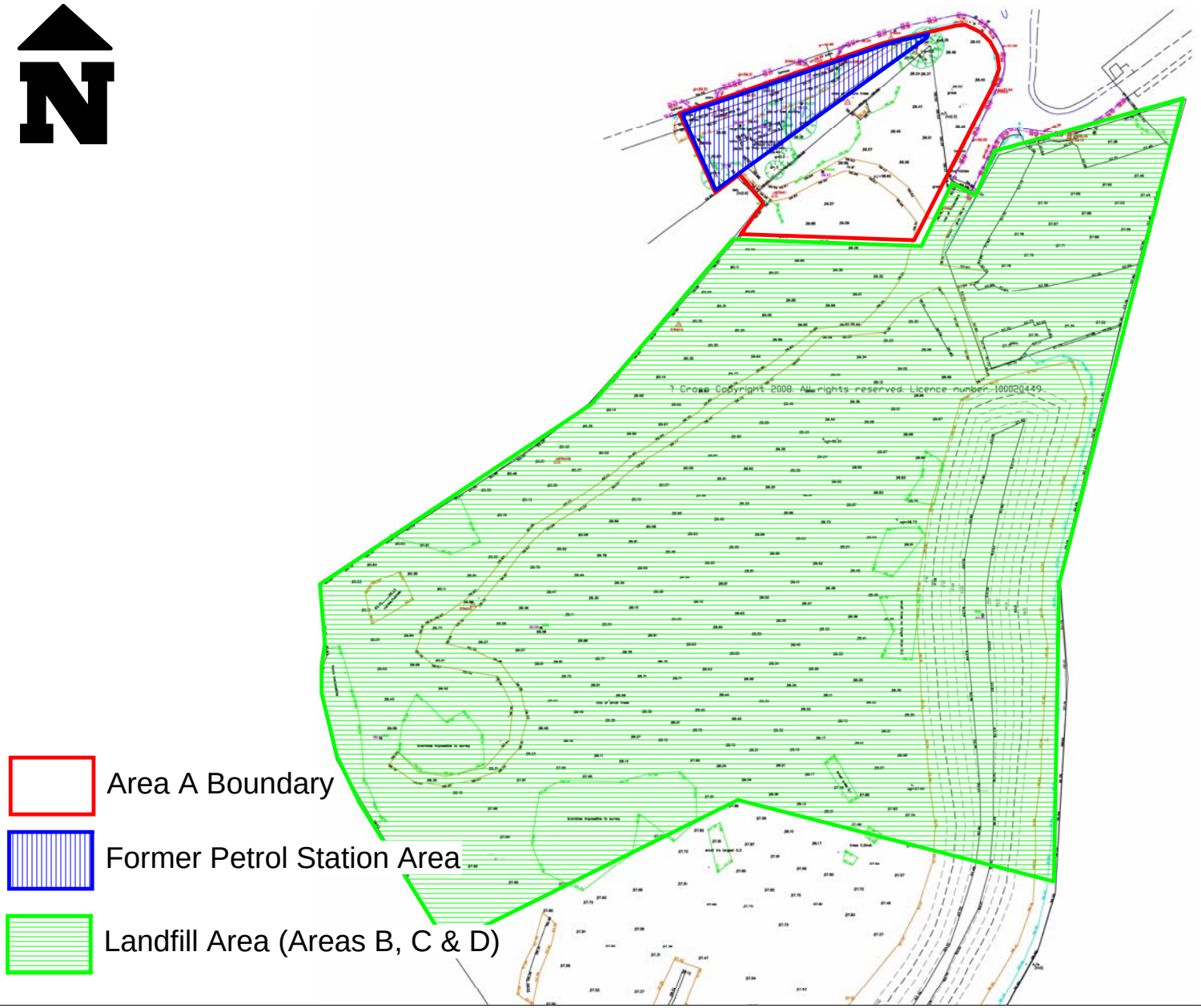

Figure 1-2: Site Areas, Queens Road, Cheetham Hill

Drawn: May 2009

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2 SUMMARY OF THE PRELIMINARY CONCEPTUAL MODEL (AREA A & 'LANDFILL AREA')

The preliminary contamination conceptual model for the IWHC site is illustrated in Table 2-1 below and taken from the previous PRA. The conceptual model identified seven potential pollutant linkages. Each linkage is discussed below along with an assessment of the likelihood of each linkage considering the available data from the previous site investigation, the nature of the development and the comments from the Environment Agency.

Pollutant Linkage No.	Contaminant				Pathway	Receptor
	ACM	Ground Gases	Inorganic	Organic		
1	?	x	✓ (Excl Area B)	✓ (Excl Area B)	- Dermal Contact. - Ingestion of soils. -Inhalation of contaminated soil and dust.	- Future site workers. -Future site construction workers. -Off-site receptor (windblown dust).
2	x	x	x	?	- Inhalation of vapours.	-Future site users. -Future site construction workers. -Off-site receptor (windblown dust).
3	x	✓	x	x	- Ground and hazardous gas migration from infilled areas on and off site.	- Future site users. - Future site workers. - Off-site receptor.
4	x	x	?	?	- Groundwater migration. - Perched water migration.	- Major Aquifer. - Minor Aquifer. - River Irk.
5	x	✓	✓ (Area B only)	x	- Contact with potential hazards	- Site Buildings.
6	x	x	✓	✓	- Ingestion of tainted water supply. - Direct contact and inhalation of dust and vapours.	- Future site users. - Future pipe installers. - Maintenance workers.
7	x	x	✓	x	- Root uptake of phytotoxic contaminants.	- Flora in future landscaping.

Table 2-1: Contamination Conceptual Model for Queens Road, Cheetham Hill (Area A and 'Landfill Area').
Key: ✓ – Pollutant Linkage identified; ? – Pollutant Linkage possible; x – Pollutant Linkage unlikely

Pollutant linkage 1 has been identified for heavy metals and organic compounds for Area A, Area C and Area D. Remedial measures will therefore be required in areas of soft landscaping to mitigate the risk associated with these hazards. Health and safety precautions should be implemented by all construction workers. Further assessment of this linkage is proposed in order that the petrol station area is fully characterised.

Potential pollutant linkage 2 refers to possible inhalation of vapours affecting the future site users and future site construction workers which need to operate in the northern part of the site from potential hydrocarbons. This linkage is considered possible and will be further characterised within the former petrol station area (Area A).

Pollutant linkage 3 refers to the hazardous and ground gas onsite affecting the future site users. The gas monitoring undertaken within the previous site investigation has shown that this pollutant linkage is complete and gas protection measures are required within the proposed buildings. No further work was required to characterise this risk.

Potential pollutant linkage 4 refers to the possible contaminants and the underlying Major and Minor Aquifers and nearby River Irk. Further to the Environment Agency comments,

this linkage is considered possible and requires further assessment within all areas of the study site.

Pollutant linkage 5 has been identified with respect to methane coming into contact with the site buildings. The protection measures used to mitigate Pollutant linkage 3 will also mitigate this pollutant linkage. Sulphate resistant concrete would be required for buildings proposed for Area B.

Pollutant linkage 6 relates to the potential for contaminants on site to permeate potable water supply pipes and for contaminants to affect those installing the pipes. Levels of heavy metals, PAHs and petroleum hydrocarbons are above the pipe line assessment criteria set by United Utilities. Therefore consultation with United Utilities is required, and protective water pipes or a sterile trench were considered likely and no further characterisation is required.

Pollutant linkage 7 refers to the phytotoxic contaminants affecting plant growth. Elevated levels of copper and zinc have been detected in the near surface soils and remedial measures will be necessary in areas of soft landscaping. No further characterisation work was considered necessary.

A summary of the proposed protection measures for pollutant linkages 3, 5 and 6 are provided in Section 9. Further details of the site investigation works undertaken to further characterise and assess Pollutant linkage 1, 2 (Area A) and Pollutant linkage 4 (Area A and 'Landfill Area') are provided in the following Sections.

3 FURTHER GROUND INVESTIGATION AND WATER SAMPLING

3.1 Site Investigation Design and Methodology – Former Petrol Station (Area A)

During the previous site investigation 3 no. window sample boreholes (WS1, WS2 and WS3) and 1 no. trial pit (TP1) were excavated in the former petrol station area. In addition, two deeper cable percussive boreholes (CP1 and CP2) were drilled to the west and south of the former petrol station.

Six further window samples boreholes (WS201-206) were drilled in the former petrol station area on the 20th November 2008 to depths of between 5.0m and 6.0m below ground level. Four boreholes (WS201A-WS201D) were drilled in the area of WS201 to between 0.6m and 1.7mbgl where each one refused on suspected concrete hardstanding before WS201 was able to be extended to 6.0m.

This additional investigation was verbally agreed with by the EA in a telephone conversation.

The borehole locations for Area A are shown in Figure 3-1. All the borehole sample descriptions were carried out in accordance with BS5930[1] by suitably qualified and experienced members of staff. All borehole and trial pit logs for the petrol station area are presented in Appendix A.

3.2 Soil Sample Collection – Former Petrol Station (Area A)

Soil samples of approximately 1Kg were recovered in amber jars and vials. All the samples were labelled and stored in cool boxes prior to being collected by courier for delivery to Chemtest Laboratories in Newmarket. Samples were tracked using appropriate Chain of Custody forms provided by Chemtest. If soil samples could not be sent to the laboratory on the same day they were stored in LKA storage fridge at approximately 4°C.

Eight representative soil samples taken during the site investigation were selected for chemical contamination analysis. All samples were subjected to the following:

- Arsenic, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium, zinc, boron, cyanide, water soluble sulphate, pH, speciated banded TPH (TPH CWG), BTEX compounds, MTBE, USEPA speciated polyaromatic hydrocarbons (PAHs), asbestos screen and organic matter.

Samples from WS203 (4.7m) and WS205 (5.2m) with visual/olfactory evidence of hydrocarbon contamination were additionally subjected to analysis for VOCs and SVOCs.

The majority of the tests are UKAS or MCERTS accredited and further details are given in the certificate of analyses for the soils are presented in Appendix B. A summary of the analytical results is given in Section 5.

3.3 Further Groundwater and River Water Sampling

A round of groundwater sampling was undertaken during the previous investigation of 21st April 2008. Two further groundwater sampling visits have been now undertaken on 10th December 2008 and 24th March 2009. All sampling locations are shown on Figure 3-2.

[1] British Standard (BS5930:1999). "Code of Practice for Site Investigations."

Samples were taken from the following boreholes -

Date	Boreholes Sampled
21st April 2008	WS2, WS5, WS10, CP1, CP4, CP5, CP6
10th December 2008	WS2, WS5, CP1, CP2, CP4, CP5, WS203, WS205
24th March 2008	CP1, CP2, CP4, CP6, WS203, WS205

Table 3-1. Summary of groundwater samples taken at IWHC site, Queens Road, Cheetham Hill.

Sampling from boreholes was not consistent throughout the monitoring period as some boreholes were found to be dry or did not recharge once purged.

Sample collection was undertaken using a dedicated inertia lift Waterra sampling pump and the sample was collected in glass and plastic bottles and a glass vial. The boreholes were purged of all standing water and the sample collected from the recharged water.

In addition, samples were taken from the River Irk upstream midstream and downstream of the study site on two occasions – on the 10th December 2008 and 24th March 2009.

Each water sample was analysed for the following suite of analysis –

- Arsenic, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium, zinc, boron, cyanide, sulphate, pH, speciated banded TPH (TPH CWG), BTEX compounds, MTBE, USEPA speciated polyaromatic hydrocarbons (PAHs), ammonium and hardness.

The majority of the tests are UKAS or MCERTS accredited and further details are given in the certificate of analyses presented in Appendix C. A summary of the analytical results is given in Section 5.

3.4 Groundwater Monitoring

Two groundwater monitoring visits were undertaken at the time of the groundwater sampling on the 10th December 2008 and 24th March 2009. Groundwater depths have also been recorded on a number of occasions since the previous investigation was commenced.

During each monitoring visit a oil-water interface probe was used within each borehole to determine the depth to the water level, depth to the base of the borehole and. to determine the presence/ absence of free product.

On the 15th April 2009 LKA staff visited Area A (the former Petrol Station area). During this time a clear bailer was used within those boreholes with a hydrocarbon odour to remove the groundwater from the boreholes in order to view any evidence of free product. Photographs are provided in Appendix D.

The boreholes monitored were those drilled and installed with monitoring wells during the previous investigation in addition to the new window sample boreholes drilled within the former petrol station area.

All boreholes were instrumented in the made ground with the exception of CP4 and CP6 which were instrumented with response zones within the natural ground only.

The results of the groundwater monitoring are provided in Section 6.

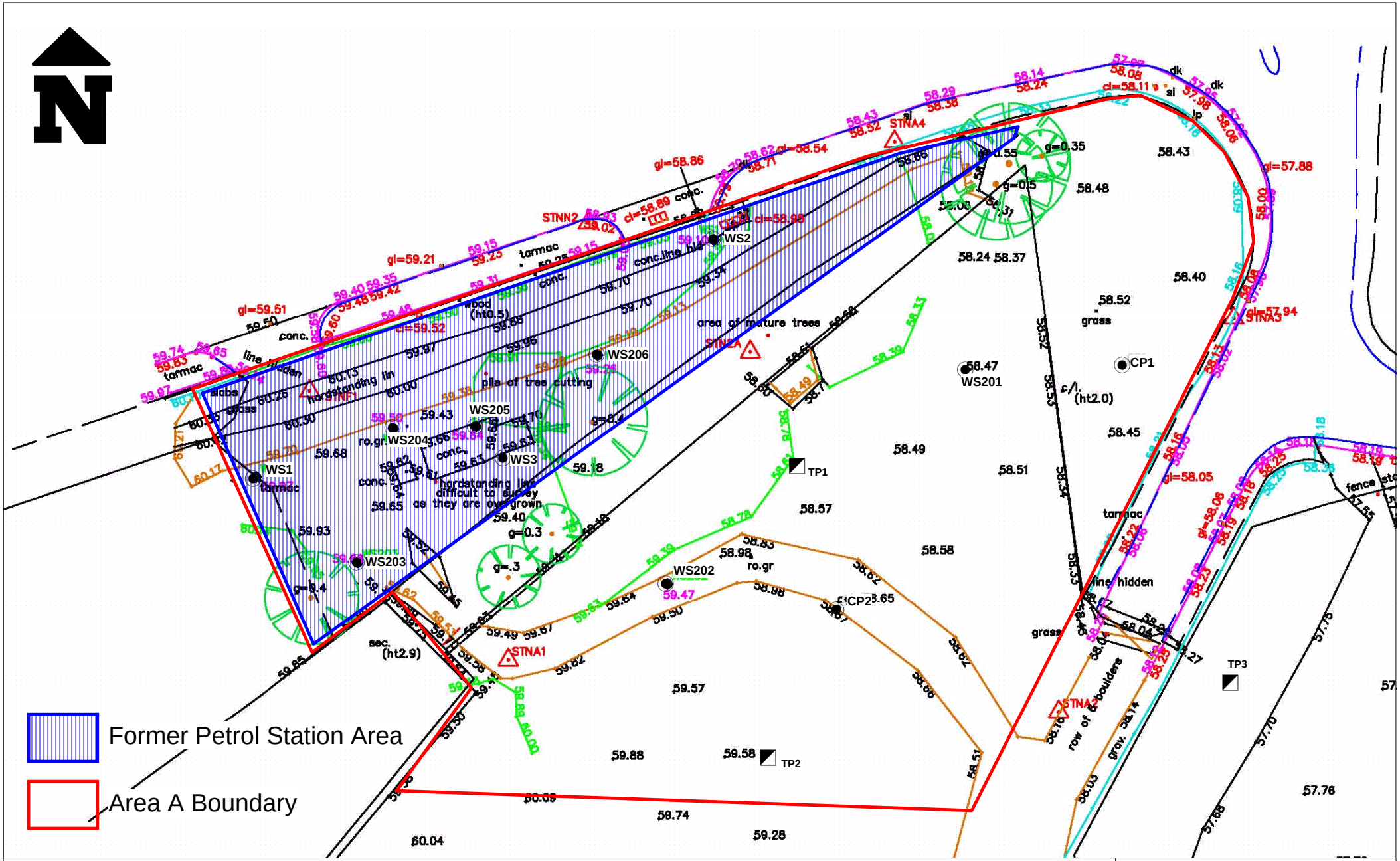

Figure 3-1: Borehole and Trial Pit Location Plan - Area A, Queens Road, Cheetham Hill

Drawn: April 2009

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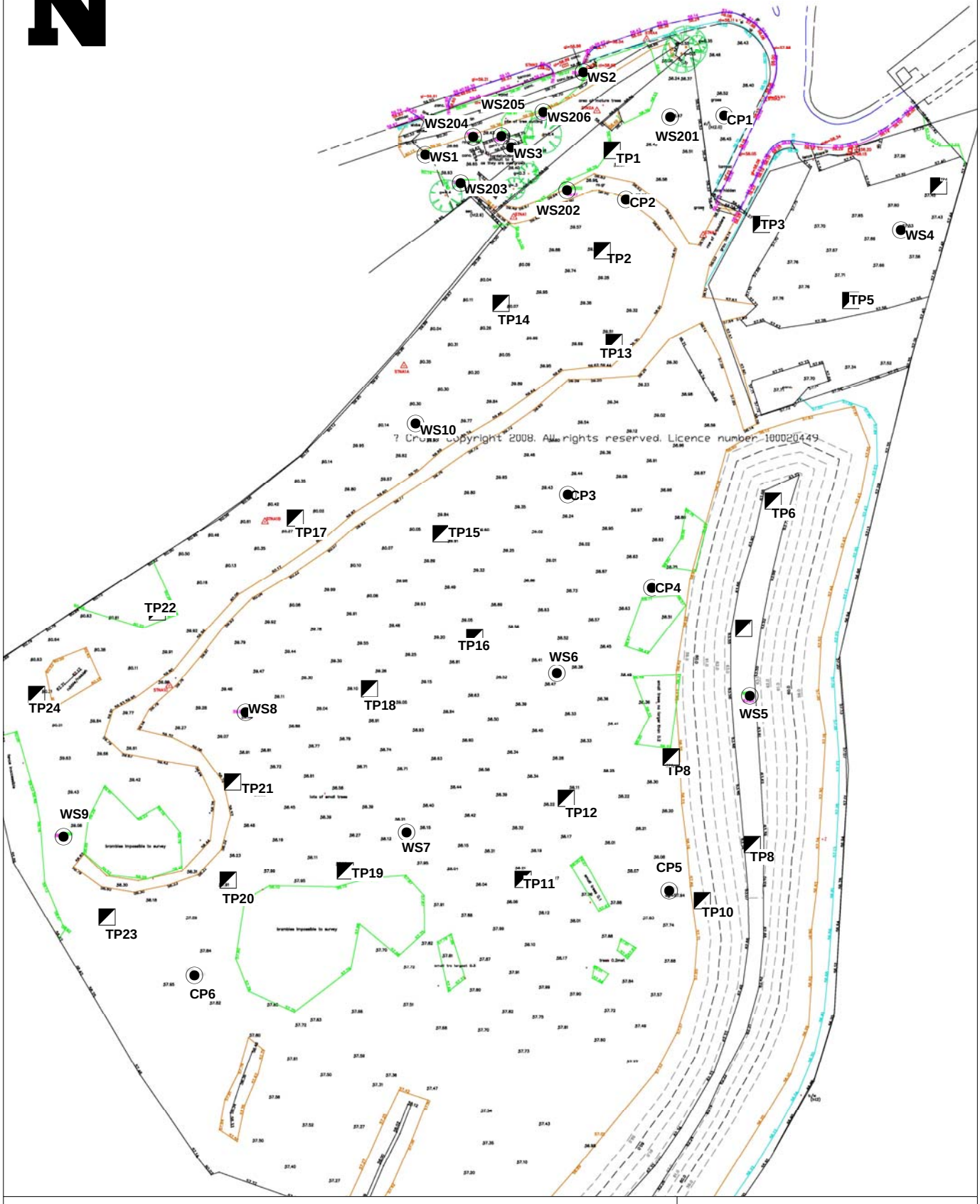

Figure 3-2: All Borehole and Trial Pit Locations, Queens Road.

Drawn: May 2009

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4 GROUND CONDITIONS

4.1 Ground Conditions – Area A (Former Petrol Station)

The ground conditions from all boreholes drilled in and around the former petrol station during both site investigations (WS1 - WS3, WS201 – WS206, CP1 and CP2) have been summarised.

CP1 and CP2 were not located directly in the former petrol station area but were located 40m east and 30m southeast of the boundary respectively and it was therefore considered representative of the deeper ground conditions in the northern site area.

The general ground conditions beneath the former petrol station site comprised of made ground underlain by clay.

4.1.1 Made Ground

Made ground was encountered in all boreholes drilled in the former petrol station to depths of between 3.1m below ground level (bgl) in WS2 to 6.9mbgl in CP1. The made ground was encountered to depths of between 5.0m and 6.0m in the remaining boreholes and not bottomed out.

The made ground was found to comprise reworked clay or sand with brick fragments, tarmac fragments, coarse ash and clinker with occasional glass, wood and plastic.

A summary of where visual & olfactory evidence of hydrocarbon contamination encountered within the made ground is summarised in table 4-1 below.

Borehole Reference	Depth (mbgl)	Description
WS1	From 3.8m	Hydrocarbon odour
WS2	ND	ND
WS3	From 0.1m	Hydrocarbon odour
WS201	From 1.5m	Faint hydrocarbon odour
WS202	1.8m to 2.1m	Faint hydrocarbon odour
	From 4.0m	Faint hydrocarbon odour
WS203	From 5.0m	Wet with visual/olfactory evidence of hydrocarbon odour
WS204	1.0-1.6m	Faint hydrocarbon odour from 3.5m
	From 3.5m	Wet with visual/olfactory evidence of hydrocarbon odour
WS205	From 0.3m	Strong hydrocarbon odour
WS206	ND	ND
CP1	5.0m to 6.9m	Hydrocarbon odour
CP2	ND	ND

Table 4-1. Evidence of hydrocarbons within the made ground within Area A, Queens Road, Cheetham Hill.
ND = No hydrocarbon odour detected

4.1.2 Natural Ground

Natural ground was encountered in WS2, WS204, CP1 and CP2 at depths of 3.1m, 5.9m, 6.9m and 5.5m respectively.

The natural ground comprised a firm becoming very stiff to hard clay/ sandy clay with rare inclusions of sand and gravel. A weathered red/ brown sandstone was encountered within CP2 at 20.5m.

No visual or olfactory evidence of hydrocarbon contamination was encountered within the natural ground.

4.2 Groundwater Monitoring (All Samples)

Groundwater monitoring has been undertaken on up to twelve occasions. An oil-water interface probe (approximately 1cm detection limit) was used to detect the presence of free phase hydrocarbons within each borehole. A clear bailer was used on the 15th April 2009 within the boreholes noted to have a hydrocarbon odour to view the groundwater column. Photographs are provided in Appendix D and all results are summarised in Table 4-1 below.

Furthermore, two rounds of river monitoring did not note any free product.

BH Ref	Depth to top of groundwater (mbgl)			No. Visits	No. Sample Rounds.	Free Product Detected	Hydrocarbon Odours in Groundwater (No. Visits)
	Max	Min	Base				
CP1	5.00	4.50	6.60	12	2	No	0
CP2	5.80	4.50	7.15	10	2	No	0
CP3	DRY	7.10	7.15	12	0	No	0
CP4	13.0	12.0	15.3	12	3	No	0
CP5	DRY	8.15	9.40	7	2	No	0
CP6	13.0	12.5	14.5	5	2	No	0
WS1	DRY	DRY	3.45	2	1*	No	0
WS2	4.50	3.85	4.85	10	2	No	0
WS3	DRY	4.00	4.00	12	0	No	0
WS4	DRY	3.90	4.45	10	0	No	0
WS5	6.00	2.20	5.00	9	2	No	0
WS8	DRY	5.00	5.10	10	1*	No	0
WS9	DRY	DRY	4.50	12	0	No	0
WS10	DRY	4.40	4.70	12	1	No	0
WS201	5.10	5.00	5.15	3	0	No	1
WS202	DRY	DRY	4.85	3	0	No	0
WS203	4.0	3.95	4.55	3	2	No	3
WS204	DRY	DRY	4.50	3	0	No	0
WS205	3.50	3.40	5.40	3	2	No	3
WS206	DRY	DRY	4.30	3	0	No	0

Table 3-1. Summary of groundwater monitoring data (based on all visits), Queens Road, Cheetham Hill.
* NRA Leaching test

The photographs in Appendix D show no free product to have been observed within WS201, WS203 or WS205. A slight odour was noted within WS201 and WS203 and a stronger odour present within WS205.

A large amount of suspended solids were noted particularly within WS201, WS203 and WS205. A very slight hydrocarbon film was only noted on top of the water taken from WS205.

Two contour plots of average groundwater depths and possible flow direction have been created using Surfer based on perched water encountered within the made ground. It should be noted that LKA were not allowed to drill into the Major Aquifer.

Figure 4-1 shows the groundwater depth and flow within the made ground in Area A. The plot shows the approximate flow of ground water is towards the east and southeast (towards the River Irk).

Figure 4-2 shows the groundwater depth and flow within the made ground across the whole of the study site. This generally shows flow to be towards the south and southeast, toward the River Irk. In addition, it is assumed that groundwater may flow in the Major Aquifer to the nearest potable water compliance point 900m south west of the site

4.3 Cross-Sections

A cross section was drawn to establish if there was possible connectivity with similar strata from west to east within Area A and north to south across the landfill mass.

Transect 1-2 (west - east), Transect 3-4 (northeast - southwest) and Transect 5-6 (northwest – southeast) are presented in Figure 4-3.

The cross sectional plans are presented in Figure 4-4, Figure 4-5 and Figure 4-6 respectively.

Based on Cross Section 1-2 there may be some connectivity within Area A in the made ground moving from west to east. This can be supported by the groundwater contours within Area A showing the groundwater flow to be to the east.

Cross Section 3-4 and Cross Section 5-6 do not appear to indicate any connectivity with the main body of the landfill. However, connection is likely through infiltration within permeable strata within the Till deposits and considered a conservative assumption.

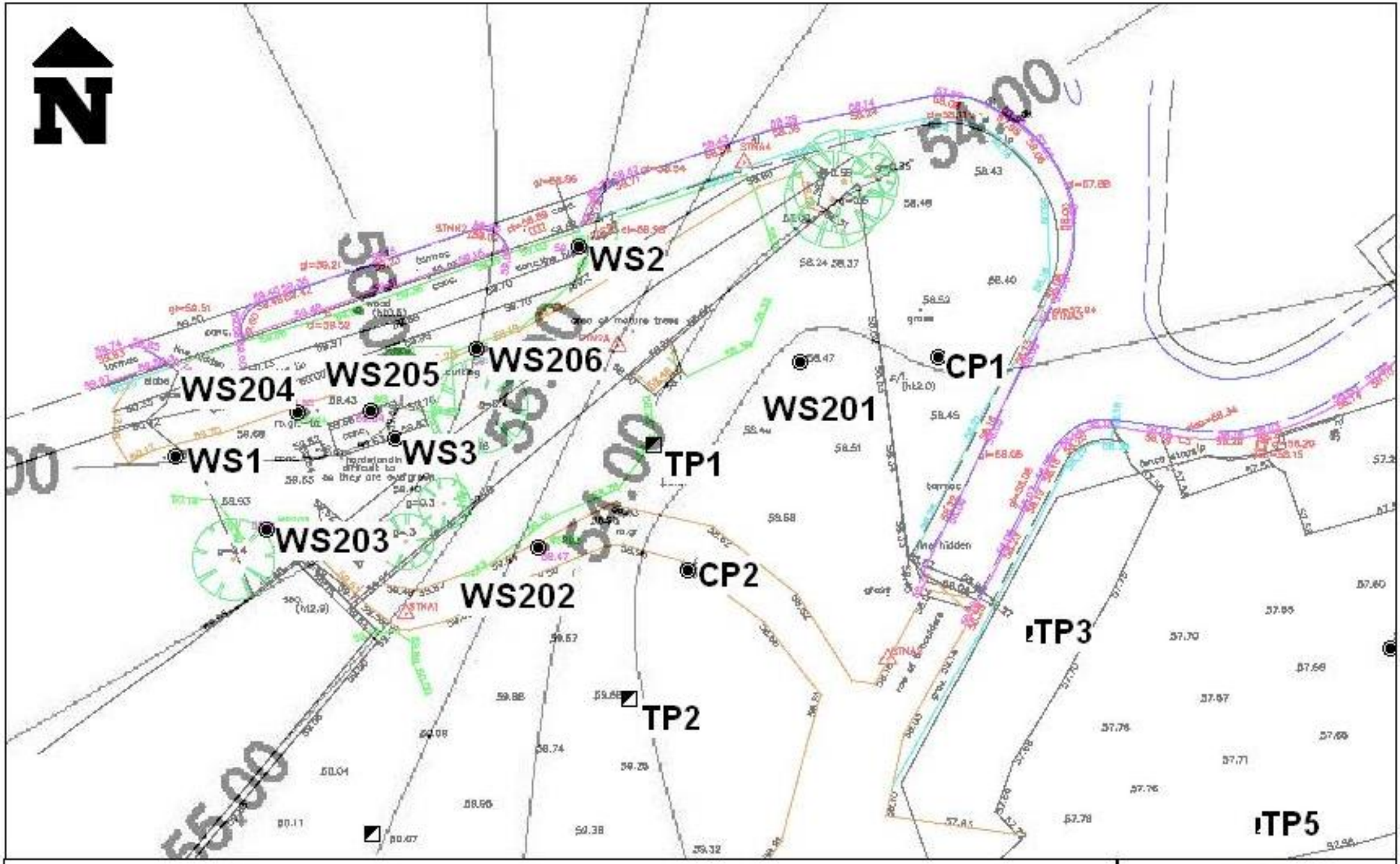

Figure 4-1: Groundwater contours in made ground - Area A

Drawn: May 2009

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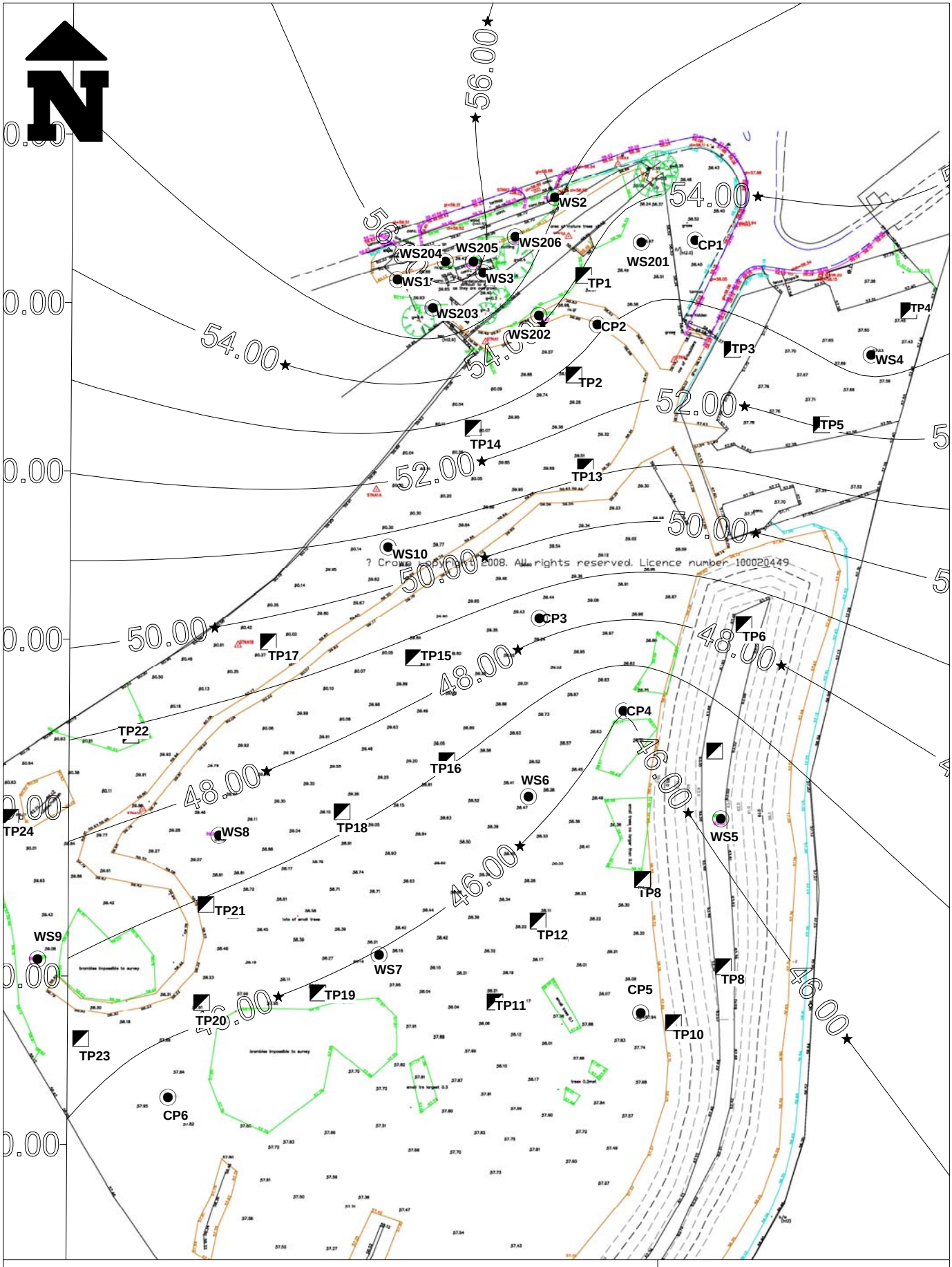

Figure 4-2: Groundwater contours in made ground, Queens Road, Cheetham Hill.

Drawn: May 2009

LK ASSOCIATES LIMITED

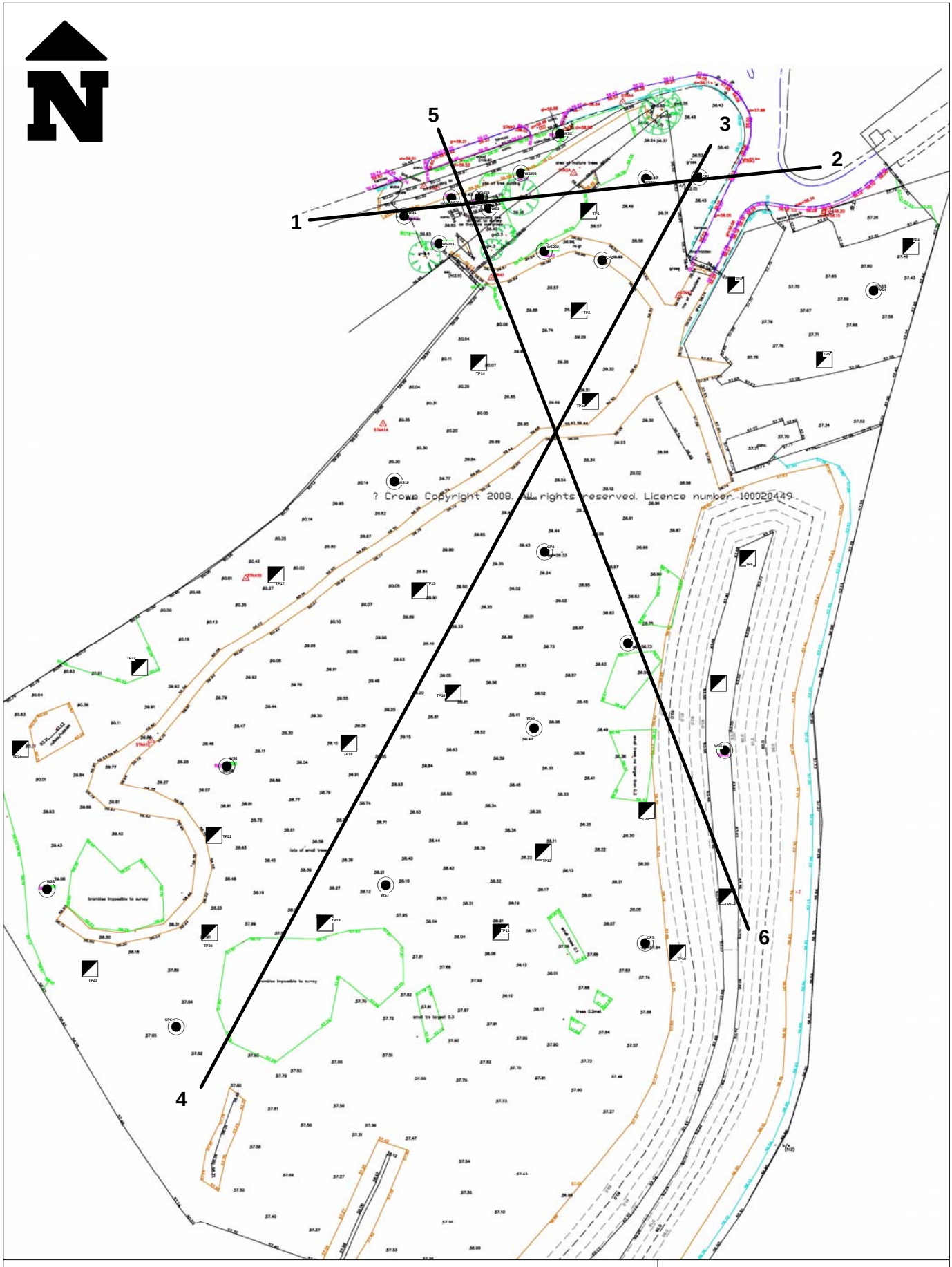

Figure 4-3: Cross -Section Transects, IWHC, Queens Road.

Drawn: April 2009

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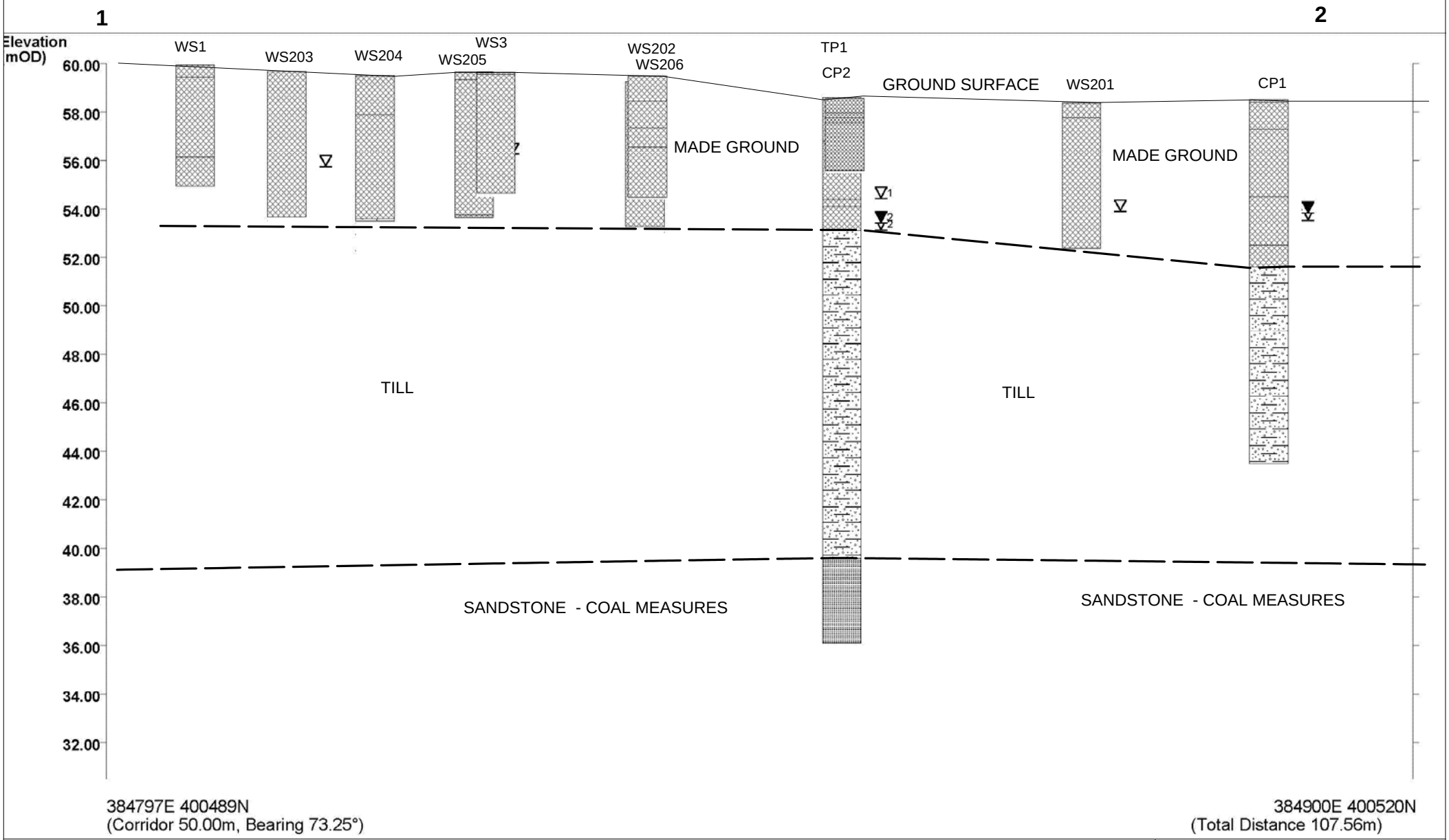

Figure 4-4: Cross Section 1-2, Queens Road.

Drawn: April 2009

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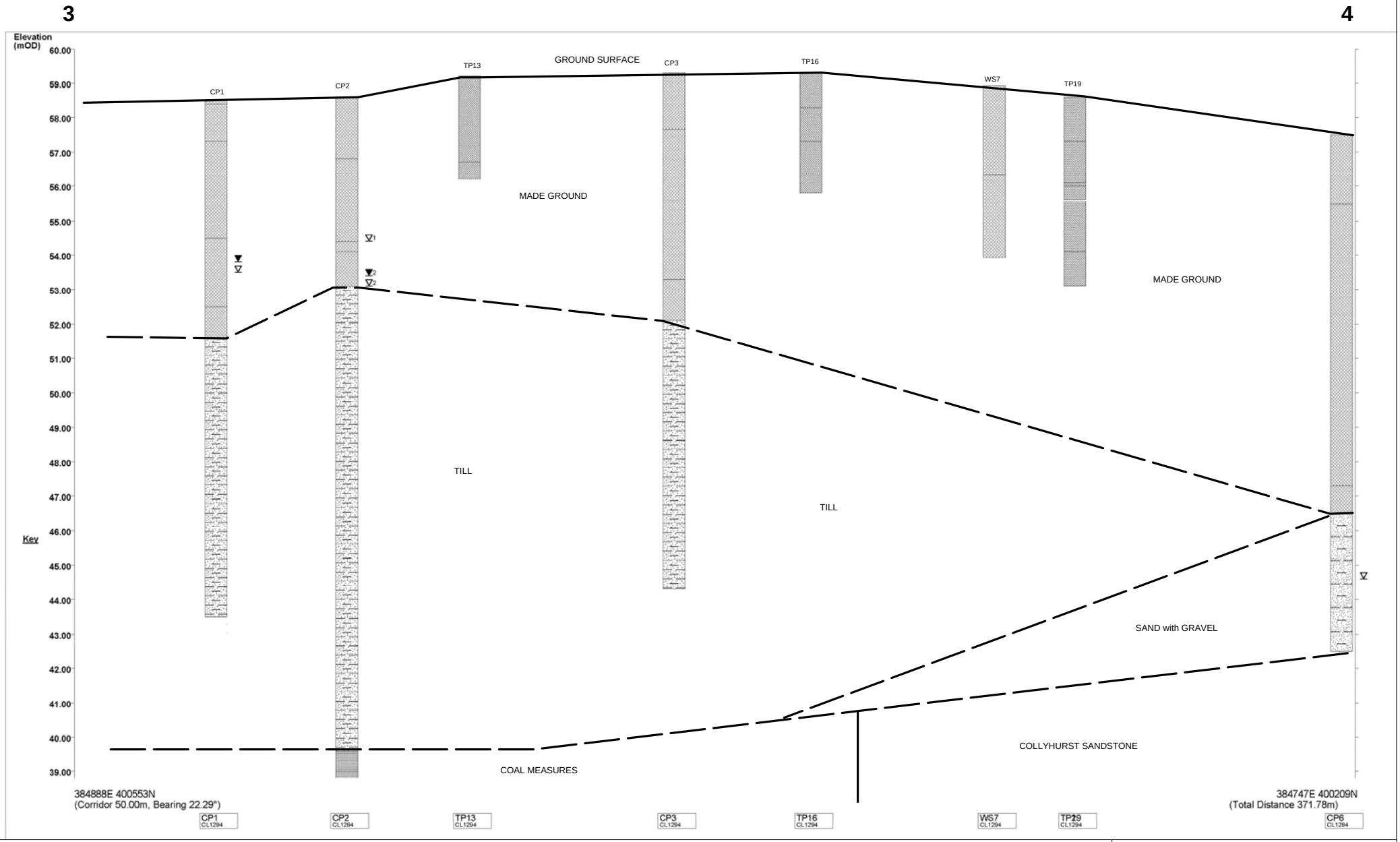

Figure 4-5: Cross Section 3-4, IWHC, Queens Road.

Drawn: April 2009

LK ASSOCIATES LIMITED

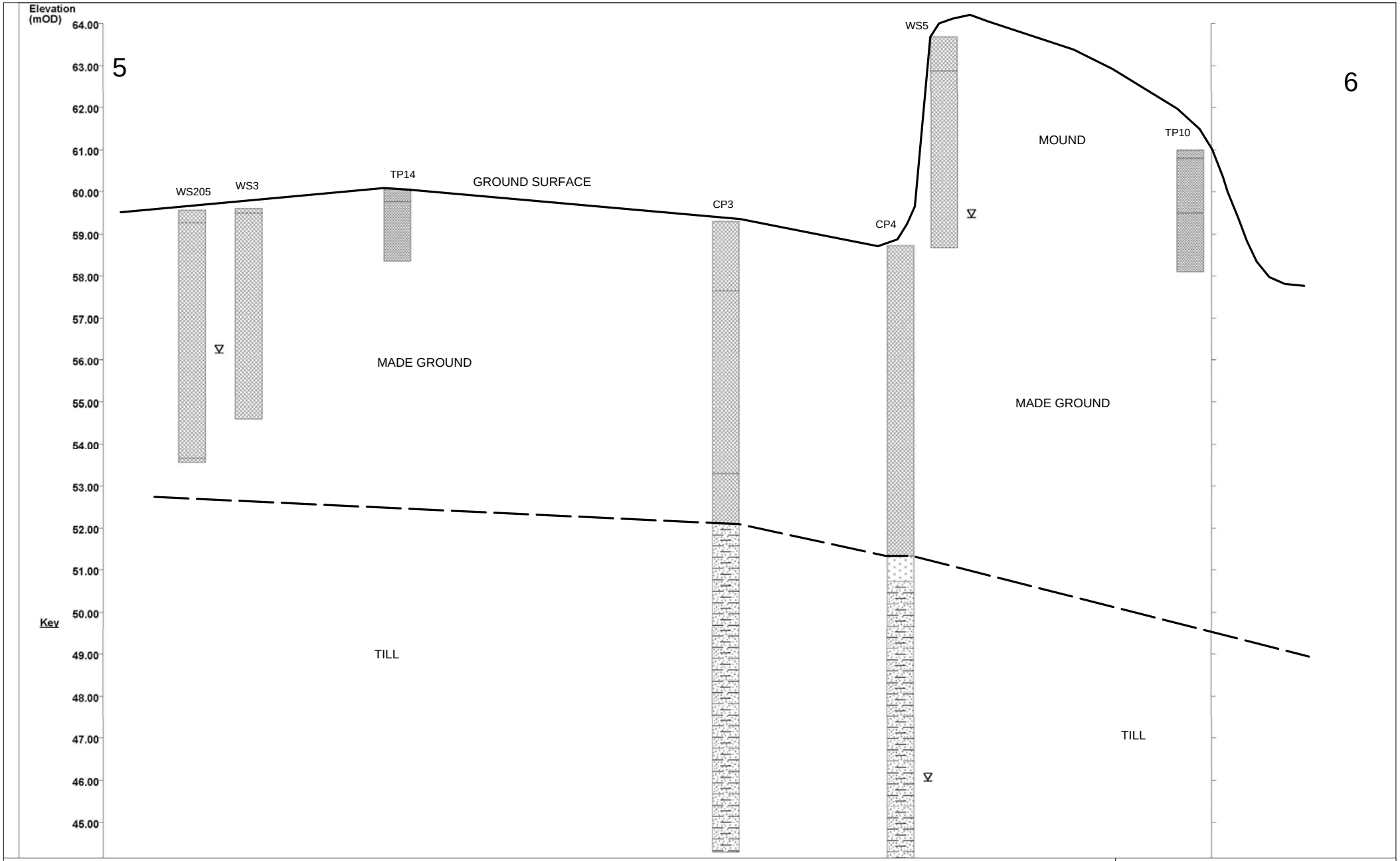

Figure 4-6: Cross Section 5-6, IWHC, Queens Road.

Drawn: April 2009

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5 GENERIC QUANTITATIVE RISK ASSESSMENT (HUMAN HEALTH) – AREA A FORMER PETROL STATION

5.1 Introduction

Current good practice requires that the findings from a site investigation be evaluated on a site specific basis, using a risk based approach. Risk assessment involves identification and evaluation of the hazards presented by the concentrations of contaminants measured, followed by an evaluation of the risks, which are associated with these hazards (CLR11[2]). Information gathered from the risk assessment can then be collated in a revised Conceptual Site Model (see Section 7).

5.2 Soil Risk Assessment – Human Health

The previous report divided the site into four discrete areas. This report will reassess the findings for Area A – the proposed Hotel Area and former petrol station. All samples within Area A have been reviewed (WS1-WS3, TP1, TP2, CP1, CP2 and WS201-WS206). The plan of the Area is presented in Figures 1-2 and 3-1.

At this generic stage of risk assessment new Soil Guideline Values (SGVs) have been used to risk assess the site. Unfortunately, there are only a select number of new SGVs currently available and therefore, where there are no SGVs ATRISK Site Specific Values (SSVs) have been used as screening values. These have been generated using the CLEA V1.04 model[3] based on 6% SOM and although no justification for their derivation has been detailed are considered scientifically robust and conservative. All these criteria now follow current UK methodology[4,5,6,7]. A summary of the SSVs are attached (Appendix E).

For SSVs where contaminants (such as PAHs and petroleum hydrocarbons) are above the lowest aqueous or vapour saturation limits LKA have used the combined SSVs. Even though a very thin (approximately 1mm) film of hydrocarbon has been identified in the groundwater of one borehole (WS205) within the former petrol station. LKA considers using the combined SSVs to be appropriate for this site due to considerations within the CLEA model handbook on the interpretation of the traffic light system (green, amber and red). These are based primarily on the degree that the saturation limit has been exceeded and whether the vapour pathway is an important contributor to exposure. Additional justification is given below:

- Where the vapour saturation limit has been marginally exceeded (<10%, amber), which is the case for many PAHs, then the combined assessment can usually be used and treated as though the saturation limit had not been exceeded (green).
- Most of the refined petroleum hydrocarbons are red, which indicates the assessment criteria exceed the vapour saturation limit by >10%.
- The CLEA model handbook suggests that where vapour is a primary route the exposure is unlikely to reach the derived Health Criteria Value (HCV) and risks are likely to be negligible. This is applicable for petroleum hydrocarbons for fraction <EC16.

[2] Defra (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11
[3] EA (2008). "CLEA Software (Version 1.03 beta) Handbook." Science Report – SC050021/SR4.
[4] EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.
[5] EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.
[6] EA (2008). "A Review of Body Weight and Height Data used within the Contaminated Land Exposure Assessment Model (CLEA)." Project SC050021/Technical Review 1.
[7] EA (2009). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science report SC050021/SR7.

- If free product is identified the CLEA model handbook suggests using other algorithms that deal with free product or NAPL sources, since values generated using the standard vapour model will overestimate the risk[8]. As a precaution LKA attempted to undertake this modelling using the guidance from the USEPA[9] and the NAPL Excel model[10] (adjusting to UK parameters for soil type). This model calculates the equilibrium vapour concentration at the source of emissions for each timestep. First it checks if the mixture (in this case petroleum hydrocarbon fractions) is in a residual (free) phase by calculating the product of the activity coefficient of component in water and the mole fraction of dissolved in soil moisture. If the sum of all the values for all of the components of the mixture is less than 1, the mixture does not contain a residual phase and the model is not applicable. If this is the case then the standard Johnson and Ettinger model should be applied. LKA undertook this modeling but could not generate a theoretically derived indoor vapour concentration due to the mixture not being in a residual phase. Therefore, it suggests that a true free phase was not apparent in the soil samples. This may be due to many of the fuel trace interpretations were in part PAH derived and no evidence of significant free product identified from site monitoring.
- The CLEA handbook indicates that the assessor may wish to use the saturation limit (if red). However, it suggests that using this would be 'highly conservative'.

Based on the above LKA considers using the combined value SSV and not the saturation limit can be used for this site.

The lead SSV has been derived using a threshold substance, which differs from the original SGV blood level model. In the interim before the official SGV for lead has been published LKA will continue to use the original SGV for lead on standard land uses. The default SOM of 6% is considered appropriate for this site based on high organic concentrations identified in the soil samples. The default sandy loam is considered appropriate based on the composition of the made ground identified at this site.

Both the SGVs and ATRISK SSVs are dependent upon the land-use of the proposed development. For the former petrol station all results have been compared to commercial end us, due to the proposed hotel.

LKA consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P), dibenzo(a,h)anthracene (D(a,h)A) and naphthalene. This is due to B(a)P and D(a,h)A possibly being carcinogens and most toxic of the PAHs[11,12] and naphthalene the most volatile and soluble[13]. These determinands will be used to establish the risk from PAHs, although high concentrations of other PAHs will be compared to ATRISK SSVs, where appropriate.

[8] EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.
[9] USEPA (2003). "User's Guide for Evaluating Subsurface Vapour Intrusion into Buildings." Report PN 030224.0001. Washington: US Environmental Protection Agency.
[10] USEPA (2000). "User's Guide for the NAPL-Screen and NAPL-Adv Models for Subsurface Vapour Intrusion Into Buildings." Report PN 050240.0004. Washington: US Environmental Protection Agency.
[11] EA (2002). "Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans. Benzo[a]pyrene." R&D Publication TOX2.
[12] USEPA (1984). "Health Effects Assessment of Polycyclic Aromatic Hydrocarbons (PAHs). EPA 540/1-86-013."
[13] EA (2003). "Review of the Fate and Transport of Selected Contaminants in the Soil Environment." Draft technical report P5-079/TR1.

	Contaminant	Units	No. of samples	Range	No. Exceeded	Assessment Criteria	Source of Criteria
Metals	Lead	mg/kg	14	14-2900$_{(WS203, 4.7m)}$	3	750	CLEA SGV
PAHs	B(a)P	mg/kg	14	0.3-420$_{(WS1, 0.7m)}$	8	22.3	ATRISK SSV
	D(a,h)A	mg/kg	14	0.5-81$_{(WS203,4.7m)}$	4	22.4	ATRISK SSV
General	pH	pH	14	Range: 7.3 to 8.6			
	SOM	%	14	Range: 2.4 to 28			
	Asbestos Screen	-	14	None Detected			

Table 5-1: Summary of analytical results, Area A, Queens Road, Cheetham Hill.
Only results that exceeded SGV/SSVs have been shown and results from all depths are noted. Assumed pH7 and a Soil Organic Matter (SOM) of 6% where those parameters are required.

Elevated levels of B(a)P, Lead and D(a,h)A have been identified across the former petrol station area (Area A). The primary route of entry is from direct contact (ingestion, dermal and inhalation of dust). Statistics have not been undertaken since high concentrations were noted across Area A. Therefore, LKA considers all of Area A is complete with regards to Pollutant Linkage 1 and recommendation discussed previously in the earlier report to mitigate the risk should be undertaken in Area A (see Section 9).

No elevated refined petroleum hydrocarbon concentrations (individual fractions) were noted from the soils, although hydrocarbon odours were noted in some of the logs. To examine the potential additivity of toxicological effects between the petroleum hydrocarbon fractions a Hazard Index (HI) as described by the Environment Agency[14] technical report was undertaken. This should be undertaken when there are no elevated petroleum hydrocarbons and maximum values found on the site (WS203) was used to generate the HI (See Appendix F). The HI was less than 1 at 6% SOM for a commercial development (HI of 0.30), therefore LKA consider there is no significant risk from soil derived petroleum hydrocarbons in Area A and hence pollutant linkage 2 is considered incomplete and no remediation relating to impacted soils is required.

5.3 Groundwater Risk Assessment – Human Health

A thin film of hydrocarbon was identified in WS205 (surface film). However, the water column had a hydrocarbon odour. LKA consider this is related to congealed weathered hydrocarbons as discrete globules or film around the sediment grains. It does not appear to be a true dissolved phase or free product and therefore is difficult to model. As a screening value the water concentrations were compared to the ATRISK SSVs on the assumption that the bulk density is the same as water (conservative assumption) and therefore the mg/L would be equivalent to mg/kg. No values were above generic guidelines for a commercial end use.

As for hydrocarbons in soil the additivity of each fraction in the groundwater was established using the HI based on the highest concentrations. The combined effect of soil and water gave a HI of 0.51, which does not pose a significant risk to site users (see Appendix F).

In addition, groundwater levels did not significantly alter and was at depth (highest groundwater level was 3.85mbgl). This will significantly reduce any risk from groundwater

[14] EA (2005). "The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils." Science Report P5-080/TR3.

vapours. Furthermore, a membrane will be incorporated into the building and validated, therefore providing some protection for any residual vapours.

Therefore, LKA do not consider there is significant risk from groundwater derived vapours.

5.4 Risk Assessment Overview – Human Health (Area A)

Elevated levels of B(a)P, Lead and D(a,h)A have been identified across the former petrol station area (Area A). The primary route of entry is from direct contact (ingestion, dermal and inhalation of dust). Therefore, LKA considers Pollutant Linkage 1 is complete with regards to all of Area A. Therefore, the remedial measures are necessary in the landscaped areas and health and safety precautions are necessary for future construction workers to protect against direct contact, details of which are provided in Section 9.

No elevated refined petroleum hydrocarbons were identified based on the combined assessment ATRISK SSV for a commercial end use. In addition, the additive effect of each hydrocarbon fraction using the Hazard Index (HI) was less than one (HI 0.30 for soil). Furthermore, the risk from hydrocarbon vapours derived from the groundwater is also considered low (combined soil and groundwater HI 0.51). Therefore, the risk from refined petroleum hydrocarbons is not considered significant with regards to human health and pollutant linkage 2 (inhalation of vapours) is incomplete and no specific mitigation is required for this pollutant linkage.

6 CONTROLLED WATER RISK ASSESSMENT

6.1 Introduction

LKA were asked by the Environment Agency to undertake a groundwater risk assessment for the whole site. LKA considers Area A to be outside the area of the landfill, but groundwater flow suggests movement in an easterly direction towards the River Irk. Groundwater within the landfill indicated flow in a south easterly direction towards the River Irk. According to the cross-sections Till intercedes the coal measures (Minor Aquifer) in the north and Collyhurst Sandstone (Major Aquifer) in the south. The thickness of Till is reduced significantly above the Collyhurst Sandstone and overlying strata of Sand and Gravel due to replacement with made ground in the deepest part of landfill.

Based on the above LKA consider there are two primary controlled water receptors comprising the River Irk and the Major Aquifer (specifically the nearest potable water supply approximately 900m southwest). Based on approximated groundwater flow directions Area A and boreholes surrounding this area will likely influence the River Irk (flowing through unconsolidated made ground over Till). The 'Landfill Area' south of Area A will likely influence the Major Aquifer (assuming landfill connectivity from north to south) and the River Irk (through perched waters in the Sand and Gravel overlying the Collyhurst Sandstone).

6.2 Generic Quantitative Risk Assessment (GQRA) - Controlled Waters

A total of twenty one groundwater samples and five solid samples for leaching test analysis were undertaken. In addition, two rounds of sampling (upstream, midstream and downstream) in the River Irk was undertaken (total of six water samples).

At this generic stage of assessment LKA have compared results Environment Agency Values for UK Drinking Water Standards (UKDWS)[15], where the Major Aquifer is the primary receptor. Where the River Irk is the primary receptor results have been compared to freshwater Environmental Quality Standards (EQS) for coarse fish modified by values provided by the Surface Water Abstraction Directive (SWAD)[16] based on A2 treatment or UKDWS if these were not available. The SWAD criteria is considered appropriate because when there are no EQS values water abstraction for drinking (after treatment) would be more realistic criteria. For example the UKDWS for hydrocarbons (dissolved/emulsified) is 10μg/l, whereas it would be 200μg/l using SWAD for normal physical/chemical treatment (A2 treatment).

Furthermore, the risk from List 2 compound (EC Dangerous Substance Directive 76/464/EEC) in a freshwater ecosystem is governed by the hardness of the water. Where applicable the hardness was taken into account for these contaminants.

Comparison to relevant criteria will allow the assessor to determine contaminants of concern (CoC) for each receptor.

6.2.1 GQRA Area A (Receptor – River Irk)

All samples within Area A have been reviewed (WS1-WS3, TP1, TP2, CP1, CP2 and WS201-WS206). The primary receptor identified for this area is considered to be the River

[15] Environment Agency (2001). "Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environment Protection Act 1990, December 2001".
[16] Surface Water Directive (EC 75/440/EEC); Water Supply (Water Quality) Regulations 1989, as modified.

Irk and therefore results were compared to EQS and SWAD values where available. Typical hardness values from this area were greater than 250 mg $CaCO_3$ l^{-1} and therefore contaminants influenced by hardness the higher of the EQS values could be used. Please note Aromatic >EC5-EC7 and Aromatic >EC7-EC8 relates to benzene and toluene respectively, since these are the only compounds in those fractions and the EQS values have been compared to these.

A summary of exceedences are provided in Table 6-1.

Contaminant		Units	No. of samples	Range	No. Exceeded	Assessment Criteria	Source of Criteria
Inorganic	Arsenic	µg/l	12	<1-52 (WS203/05)	2	50	EQS
	Ammonium	mg/l	12	<0.01-6.7 (WS203)	9	0.5	UKDWS
TPH	Aliphatic >EC8-EC10	µg/l	12	<0.1-2800 (WS205)	--	--	--
	Aliphatic >EC10-EC12	µg/l	12	<0.1-49000 (WS205)	--	--	--
	Aliphatic >EC12-EC16	µg/l	12	<0.1-180000 (WS205)	--	--	--
	Aliphatic >EC16-EC21	µg/l	12	<0.1-230000 (WS205)	--	--	--
	Aliphatic >EC21-EC35	µg/l	12	<0.1-22000 (WS205)	--	--	--
	Aromatic >EC8-EC10	µg/l	12	<0.1-3600 (WS205)	--	--	--
	Aromatic >EC10-EC12	µg/l	12	<0.1-29000 (WS205)	--	--	--
	Aromatic >EC12-EC16	µg/l	12	<0.1-23000 (WS205)	--	--	--
	Aromatic >EC16-EC21	µg/l	12	<0.1-23000 (WS205)	--	--	--
	Aromatic >EC21-EC35	µg/l	12	<0.1-6600 (WS205)	--	--	--
	Total TPH	µg/l	12	<10-540000 (WS205)	6	200	SWAD
PAHs	Naphthalene	µg/l	12	<0.01-2900 (WS203)	4	10	SWAD
	PAHs*	µg/l	12	<0.04-1242 (WS205)	3	0.2	SWAD
BTEX	Benzene	µg/l	12	<1-640 (WS203)	3	30	EQS
	Xylene (total)	µg/l	12	<1-169 (WS205)	2	30	EQS
General	Hardness	$CaCO_3$ l^{-1}	9	210-1200			
	pH	pH Unit	12	6.6-7.8			
	Conductivity	µS/cm	2	1100-1300			

Table 6-1: Summary of analytical results for sampling points above Area A, Queens Road, Cheetham Hill.
TPH result based on SWAD value, Individual fractions also compared to this value to identify CoC. Aromatic EC6-EC7 and EC7-EC8 were compared to benzene and toluene respectively.
* Total PAH based on EA guidance on SWAD for six PAHs: benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(123cd)pyrene, benzo(a)pyrene, Fluoranthene and benzo(ghi)perylene.

Elevated petroleum hydrocarbons, PAHs, arsenic and ammonium were above relevant criteria. Large exceedences were identified for the petroleum hydrocarbons above theoretical solubility limits[17], which suggest free product. However, only a surface sheen of free product was identified from the boreholes with the highest groundwater concentrations (WS203 and WS205). These high concentrations are likely related too weathered congealed hydrocarbon globules and/or hydrocarbon film around grains and colloids, which is picked up as a spike by the GC-machine (the trace interpretation identified weathered

[17] TPHCWG (1999). "Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach: Volume 5."

diesel). This then may not be a true residual or dissolve phase. The laboratories did note high sediment content in the water samples. Detectable high PAHs are likely related to high aromatic hydrocarbons.

It is the normal policy of the Environment Agency to remove free product. However, due to the above assessment this does not seem practicable or feasible, in particular the limited free product identified.

The slight arsenic exceedence is not considered a significant risk to the River Irk.

Therefore, LKA consider it prudent to model the CoC for petroleum hydrocarbons, ammonium and naphthalene with regards to the River Irk as the receptor.

6.2.2 GQRA 'Landfill Area' (Receptor River Irk and Major Aquifer)

All samples in the 'Landfill Area' (not including Area A) have been reviewed (WS4-WS10 and CP3-CP6). The primary receptors identified for this area is considered to be the River Irk and the Major Aquifer. Therefore, results have been compared to EQS, SWAD and UKDWS, where appropriate. Typical hardness values from this area were greater than 250 mg $CaCO_3$ l^{-1} and therefore contaminants influenced by hardness the higher of the EQS values could be used for assessing the River Irk as a receptor.

A summary of exceedences are provided in Table 6-2, both assessment criteria are provided for each receptor

Contaminant		Units	No. of samples	Range	No. Exceeded	Assessment Criteria	Source of Criteria
Inorganic	Arsenic	µg/l	14	<1-33$_{(CP6)}$	2/0	10/50	UKDWS/ EQS
	Ammonium	mg/l	14	<0.01-20$_{(CP6)}$	7	0.5	UKDWS
	Chromium	µg/l	14	<1-180$_{(WS6\text{-}LEACH)}$	1/0	50/250	UKDWS/ EQS
	Sulphate	mg/L	14	68-2100$_{(CP6)}$	8/1	250/400	UKDWS/ EQS
PAHs	PAHs*	µg/l	14	<0.04-2.05$_{(CP4)}$	0/2	0.1/0.2	UKDWS/SWAD
General	Hardness	$CaCO_3$ l^{-1}	4	230-1500			
	pH	pH Unit	14	6.9-7.3 (9.2 from leach (WS6)			
	Conductivity	µS/cm	5	1300-2100			

Table 6-2: Summary of analytical results for sampling points in the 'Landfill Area', Queens Road, Cheetham Hill.
* Total PAH based on EA guidance on UKDWS for four PAHs: benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(123cd)pyrene and benzo(ghi)perylene. SWAD additionally has benzo(a)pyrene and Fluoranthene.

Elevated arsenic, chromium, ammonium, sulphate and PAHs have been identified in the 'Landfill Area'.

Detectible acenaphthylene, pyrene and fluoranthene likely relate to the heavier end aromatics (>EC12-21) detected in the TPHCWG analysis. These were not above drinking water standards of 10µ/l for hydrocarbons and therefore PAHs are not considered CoC.

The one elevated total chromium result was based upon a leaching sample. Chromium VI was below detection limits (<50µg/l), which assumed to derive the risk for chromium. Therefore, chromium is not considered a CoC.

Further assessment will be required on the CoC to determine the risk to the Minor Aquifer at a suitable compliance point and the River Irk.

LKA considers the CoCs for the Major Aquifer are arsenic, ammonium and sulphate

LKA considers the CoCs for the River Irk are ammonium and sulphate.

6.2.3 River

Two rounds of river water sampling were undertaken in December 2008 and March 2009 (upstream, midstream and downstream). Results were compared to EQS and SWAD values where available. Typical hardness values ranged from 160 to 240 mg $CaCO_3$ l^{-1} and results were adjusted accordingly.

No values were above the relevant criteria. However, it should be noted that pyrene was detected in all samples on the second visit (range 1.1µg/l to 2.5µg/l). This may indicate a potential point source upstream of the site, since the first sampling visit concentrations were below detection limits.

According to the Environmental Agency water quality for the area it is graded 'Fair' upstream of the site and graded 'Poor' downstream of the site. The effect on the river grade is likely due to the inputs of Moston Brook, which confluences downstream of the site and is rated 'Bad'. The midstream and downstream river samples taken by LKA were below the Moston Brook confluence and LKA considers this 'Bad' grade Moston Brook will influence this stretch of the River Irk.

6.2.4 Contaminants of Concern

Based on the above GQRA LKA considers the following CoC (Table 6-3). The concentrations are considered representative of site conditions, based on up to three separate sampling visits. These contaminants will be used in the Detailed Quantitative Risk Assessment (DQRA).

Contaminants of Concern		
Area A (Receptor -River Irk)	**'Landfill Area' (Receptor - Major Aquifer to Nearest Potable Water Supply)**	**'Landfill Area' (Receptor - River Irk)**
Aliphatic >EC8-EC10	Arsenic	Ammonium
Aliphatic >EC10-EC12	Ammonium	Sulphate
Aliphatic >EC12-EC16	Sulphate	
Aliphatic >EC16-EC21		
Aliphatic >EC21-EC35		
Aromatic >EC5-EC7 (benzene)		
Aromatic >EC8-EC10		
Aromatic >EC10-EC12		
Aromatic >EC12-EC16		
Aromatic >EC16-EC21		
Aromatic >EC21-EC35		
Xylene (total)		
Naphthalene		
Ammonium		

Table 6-3: Contaminants of Concern for Queens Road, Cheetham Hill

6.3 Detailed Quantitative Risk Assessment (DQRA) - Controlled Waters

LKA have used the Environment Agency remedial target methodology[18] using the remedial target worksheet V3.1. Site Specific Target Levels (SSTLs) have been generated for each CoC.

The Tier 3 groundwater assessment was considered appropriate for this site and considered conservative, since site concentrations are assumed to have reached the aquifer (Minor-perched or Major) and only attenuation (sorption onto soil particles) and degradation (microbial breakdown for some contaminants) down gradient of the source to the relevant compliance point has been modelled.

The contaminant sources are considered constant sources, rather than depleting sources and modelling is assumed to follow first order kinetics, where equilibrium has been reached.

Full justification for all parameters and remedial target worksheets are presented in Appendix G

6.3.1 DQRA Area A (Receptor – River Irk)

The compliance point is assumed to be the River Irk from the point of the highest concentration identified in Area A (WS203 and WS205 - 480m). The assumption is that groundwater will be moving through the made ground and perched above the Till. Therefore, soil/strata type is considered non-cohesive made ground and typically a sandy silty clay composition and sandy clay loam parameters have been used in the model. A summary of generated SSTLS for Area A is presented in Table 6-4.

Contaminant	Unit	Max Site Value	Groundwater SSTL	Assessment Criteria	Approximate Distance Criteria Achieved	Pass/Fail
Aliphatic >EC8-EC10	mg/l	2.80	2.28E110	0.01*	<10m	PASS
Aliphatic >EC10-EC12	mg/l	49	4.26E+200	0.01*	<10m	PASS
Aliphatic >EC12-EC16	mg/l	180	No impact	0.01*	No impact	PASS
Aliphatic >EC16-EC21	mg/l	230	No impact	0.01*	No impact	PASS
Aliphatic >EC21-EC35	mg/l	22	No impact	0.01*	No impact	PASS
Aromatic >EC5-EC7 (benzene)	mg/l	0.64	6.43E+03	0.03	70m	PASS
Aromatic >EC8-EC10	mg/l	3.60	4.12E+22	0.01*	20m	PASS
Aromatic >EC10-EC12	mg/l	29	4.25E+17	0.01*	75m	PASS
Aromatic >EC12-EC16	mg/l	23	9.96E+25	0.01*	50m	PASS
Aromatic >EC16-EC21	mg/l	23	1.12E+29	0.01*	30m	PASS
Aromatic >EC21-EC35	mg/l	6.60	1.10E+87	0.01*	<10m	PASS
Xylene (total)	mg/l	0.169	2.61E+64	30	<10m	PASS
Naphthalene	mg/l	2.90	1.80E+76	0.01	<10m	PASS
Ammonium	mg/l	6.7	43.4	0.5	150m	PASS

Table 6-4: Generated SSTLs for Area A (Receptor – River Irk), Queens Road, Cheetham Hill
* Assumed UKDWS for individual Hydrocarbon Fractions

No values exceed SSTLs. High remedial targets for heavier end petroleum hydrocarbon fractions relate, in part to high Koc values (high partition coefficients). This value along with the organic content determines the retardation/attenuation factor for the contaminant. The high values indicate reduced migration of these contaminants.

[18] EA (2006). "Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination."

Lower concentration in CP1, approximately 70m-80m from WS205 and WS203 respectively, suggests migration of the plume is limited and concentrations have reduced (assuming connectivity to the former petrol station). This is indicated in the approximate distances where the criteria are achieved (especially for the aromatics) and suggests that the modelled criteria are appropriate.

6.3.2 DQRA 'Landfill Area' (Receptor – River Irk)

The compliance point is assumed to be the River Irk from the point of the highest concentration identified in the 'Landfill Area' (CP6 - 320m). The assumption is that groundwater will be moving through the made ground in the landfill to the silty Sand layer above the Major Aquifer in the south. Therefore, strata type is considered to be a conservative Sand and Gravel and these parameters have been used in the model. A summary of generated SSTLS for the 'Landfill Area' is presented in Table 6-5.

Contaminant	Unit	Max Site Value	Groundwater SSTL	Assessment Criteria	Approximate Distance Criteria Achieved	Pass/Fail
Ammonium	mg/l	20	3.47	0.5	Impacted	**FAIL**
Sulphate	mg/l	2100	3140	400	220m	PASS

Table 6-5: Generated SSTLs for 'Landfill Area' (Receptor – River Irk), Queens Road, Cheetham Hill

Elevated ammonium above groundwater SSTL were identified for CP5 (range 1.6mg/l - 9mg/l) and CP6 (range 10mg/l – 20mg/l). High ammonium concentrations are not surprising in a landfill, in particular with likely reducing conditions. Concentrations were variable in these boreholes from each sampling visits, suggesting variations in conditions during each sampling visit (either in the landfill or oxidation of the sample after sampling).

Impact of ammonium in the River Irk was not encountered on any of the sampling visits, which suggests that either the impacted waters have not reached the river, oxidation of ammonium in the river and/or the highly conservative assumption that Sand and Gravels are in continuity to the river (considering Till intercedes part of the pathway to the river). The latter may be why breakthrough had not been observed in the River Irk, since the assessment criteria of 0.5mg/l was observed in 'sandy clay loam' in Section 6.3.1 at 150m, which may be more indicative of the composition of material overlying the Major Aquifer. In addition, the Tier 3 model assumed no dilution and that the identified site concentrations were indicative of actual aquifer concentrations.

Based upon all these potential factors and concentrations encountered in the River Irk LKA do not consider the River Irk to be at significant risk from the Landfill.

6.3.3 DQRA 'Landfill Area' (Receptor – Major Aquifer and flow to Potable Water Supply)

The compliance point is assumed to be the potable water supply 900m southwest (compliance point assumed 450m). The assumption is that concentrations identified in the perched waters is indicative of concentrations in the Major Aquifer and will migrate to the southwest. This is considered unlikely since perched waters were flowing to the River Irk, however this has been modelled as a precaution. Therefore, strata type is considered Sandstone and these parameters have been used in the model. It should be noted that LKA were not allowed to drill in the Major Aquifer and a conservative hydraulic gradient has been used in the model.

A summary of generated SSTLS for the 'Landfill Area' is presented in Table 6-6

Contaminant	Unit	Max Site Value	Groundwater SSTL	Assessment Criteria	Approximate Distance Criteria Achieved	Pass/Fail
Ammonium	mg/l	20	261	0.5	210m	PASS
Sulphate	mg/l	2100	1.63E+05	250	90m	PASS
Arsenic	mg/l	0.033	3270	0.01	70m	PASS

Table 6-6: Generated SSTLs for 'Landfill Area' (Receptor - potable water supply), Queens Road, Cheetham Hill

No values exceed SSTLs and therefore LKA do not consider the potable water supply to be at significant risk from the Landfill. In addition, LKA consider it more likely the groundwater flow is towards the River Irk.

6.4 Risk Assessment Overview – Controlled Waters

LKA considers one primary receptor from Area A as the River Irk. LKA considers two primary receptors from the 'Landfill Area' as the River Irk and Major Aquifer (potable water supply 900m west).

The GQRA for controlled waters identified a potential risk from the former petrol station (Area A) to the River Irk from petroleum hydrocarbons, xylene, naphthalene and ammonium. The GQRA for the 'Landfill Area' identified a potential risk from ammonium and sulphate to the River Irk and ammonium, sulphate and arsenic to the potable water supply. All these were considered CoC for the DQRA.

LKA undertook a DQRA using remedial target worksheet V3.1. Site Specific Target Levels (SSTLs) have been generated for each CoC and for each receptor. The Tier 3 groundwater assessment was considered appropriate for this site and considered conservative, since site concentrations are assumed to have reached the aquifer (Minor-perched or Major) and only attenuation (sorption onto soil particles) and degradation (microbial breakdown for some contaminants) down gradient of the source has been modelled.

Ammonium SSTL of 3.47mg/l (maximum value 20mg/l) was exceeded for migrating perched waters in the landfill to the River Irk receptor. Impact of ammonium in the River Irk was not encountered on any of the sampling visits, which suggests that either the impacted waters have not reached the river, oxidation of ammonium in the river and/or the highly conservative assumption that Sand and Gravels are in continuity to the river (considering Till intercedes part of the pathway to the river). Based upon all these potential factors and concentrations encountered in the River Irk LKA do not consider the River Irk to be at significant risk from the Landfill.

Based on the above LKA does not consider there is a significant risk to the identified receptors from the site (Area A and 'Landfill Area') and therefore Pollutant Linkage 3 is considered incomplete and no further remediation is required in respect to this linkage.

7 REVISED CONCEPTUAL SITE MODEL (AREA A & 'LANDFILL AREA')

A revised conceptual model may be undertaken for Area A and 'Landfill Area' using all available data from this and previous reports. Only pollutant linkages that possibly still exist and were determined from the site investigation are shown. A description of the likelihood for the pollutant linkage to exist is summarised below.

Pollutant Linkage No.	Contaminant					
	ACM	Ground Gases	Inorganic	Organic	Pathway	Receptor
1	x	x	✓ (Excl Area B)	✓ (Excl Area B)	- Dermal Contact. - Ingestion of soils. -Inhalation of contaminated soil and dust.	- Future site workers. -Future site construction workers. -Off-site receptor (windblown dust).
3	x	✓	x	x	- Ground and hazardous gas migration from infilled areas on and off site.	- Future site users. - Future site workers. - Off-site receptor.
5	x	✓	✓ (Area B only)	x	- Contact with potential hazards	- Site Buildings.
6	x	x	✓	✓	- Ingestion of tainted water supply. - Direct contact and inhalation of dust and vapours.	- Future site users. - Future pipe installers. - Maintenance workers.
7	x	x	?	x	- Root uptake of phytotoxic contaminants.	- Flora in future landscaping.

Table 2-1: Contamination Conceptual Model for Area A and 'Landfill Area', Queens Road, Cheetham Hill.
Key: ✓ – Pollutant Linkage identified; ? – Pollutant Linkage possible; x – Pollutant Linkage unlikely

Pollutant linkage 1 has been identified for heavy metals and organic contaminants in Area A and Landfill Area (with the exception of Area B). Remedial measures will therefore be required in areas of soft landscaping to mitigate the risk associated with these hazards. Health and safety precautions should be implemented by all construction workers.

Pollutant linkage 3 refers to the hazardous and ground gas onsite affecting the future site users. The gas monitoring undertaken within the previous site investigation has shown that this pollutant linkage is complete and gas protection measures are required within the proposed buildings.

Pollutant linkage 5 has been identified with respect to methane coming into contact with the site buildings. The protection measures used to mitigate Pollutant linkage 3 will also mitigate this pollutant linkage.

Pollutant linkage 6 relates to the potential for contaminants on site to permeate potable water supply pipes and for contaminants to affect those installing the pipes. Levels of heavy metals, PAHs and petroleum hydrocarbons are above the pipe line assessment criteria set by United Utilities. Therefore consultation with United Utilities is required, and protective water pipes or a sterile trench were considered likely.

Pollutant linkage 7 refers to the phytotoxic contaminants affecting plant growth. Elevated levels of copper and zinc compared to ICRCL 59/83[19] as a conservative screen for phytotoxicity have been detected in the near surface soils and remedial measures may be required in all areas of soft landscaping, although is it dependent upon the flora proposed to be grown in those areas.

[19] ICRCL 59/83 (1987). "Guidance on the assessment and redevelopment of contaminated land". 2nd edition

Recommendations are provided in Section 9 detailing all remediation work required for the whole site.

8 CONCLUSIONS

Further site investigation works have been undertaken within Area A (the former petrol station and proposed hotel area) with respect to soils and for the entire site with respect to risks to controlled waters.

The findings of this additional work and risk assessment within Area A were that elevated levels of B(a)P, D(a,h)A, and lead were encountered within the near surface soils. Remedial measures will therefore be required within the landscaped areas, as described within previous report.

With regard to controlled waters, no significant impact was identified to the Minor Aquifer, Major Aquifer or River Irk receptors from contaminated soils and perched waters encountered on the study site.

The previous risk assessment undertaken across the whole Queens Road site with regard to regard to future users of the development, future construction workers, potable water supply and on site buildings in relation to contaminated soils, groundwaters and ground gas remain as described within the previous risk assessment report (CL1294-02 dated 21st July 2008) and require remediation or precautionary construction practices.

Based on the available data, LKA consider the site may be safely developed with recourse to standard remedial measures and precautionary construction practices.

Outline remedial recommendations and precautions are summarised in Section 9 below.

9 RECOMMENDATIONS

The recommendations provided below are a summary of the recommendations from all investigation work undertaken.

9.1 Soil Contamination (Pollutant Linkages 1 and 7)

9.1.1 Site Users / Residents

Pollutant linkage 1 has been identified for B(a)P, D(a,h)A and lead in Area A; B(a)P, D(a,h)A, nickel and lead in Area C and B(a)P, D(a,h)A, lead and TPH in Area D. In addition, phytotoxic contamination was identified across all areas of the site.

However, with regard to human health, the contaminated land regime has recently changed with the publication of a new risk assessment model. As such the previous report, undertaken in July 2008 may not represent current guidance. It is therefore recommended that the risk assessment with respect to direct contact and inhalation of vapours (Pollutant linkage 1 and 2) is reassessed for Areas B, C and D in line with current guidance.

With regard to phytotoxicity (pollutant linkage 7), the assessment is based upon the old ICRCL guidance and depending upon the planting regime for the site, in areas of soft landscaping, may not necessarily be a significant phytotoxic risk. For example turfed landscaped areas with minimal planting are unlikely to be significantly effected.

In order to mitigate the risk to human health from direct contact within Area A, LKA recommend the implementation of a clean cover system in soft landscaped areas to mitigate the risk associated with the identified on-site contamination. The capping layer should be 300mm thick comprising 100mm physical and capillary break layer (for example MOT type 1 and/or geotextile) at the base of the cover overlain by a minimum 200mm of chemically suitable soil (300m of soil if geotextile is used). Photographic evidence of the depth of the cover system should be taken.

The depth of the cover layer required across the site may vary depending on the planting regime proposed for the landscaped areas. This should be agreed in writing with Manchester City Council once a landscape plan is available for the study site.

Depending on proposed site levels the capping layer may be placed directly on existing soils or may be accommodated by excavation and removal off-site of an appropriate depth of soil.

The capping layer thickness and a rate of validation sampling for imported topsoil (typically 1 sample per 50m^3 of soil) is the general requirement of Manchester City Council.

9.1.2 Construction / landscaping workers

Across the whole site appropriate health and safety considerations should be adopted during site works to prevent direct contact of contamination to site workers. These should include as a minimum:

- Ensuring wind blow is minimised by dampening down exposed surfaces.
- Ensuring all vehicles leaving the site are clean and if necessary have used a wheel wash.

- Limiting unauthorised access to the site to prevent exposure to contaminated materials.
- The provision and use of washing facilities for site staff, requirement for high standards of personal hygiene to be adopted by all site staff, particularly before and during meals.

9.2 Hazardous Gas (Pollutant Linkage 3 and Pollutant linkage 5 with respect to methane)

The results of the gas monitoring to date places the site within Characteristic Situation 2 which requires the following protection measures:

- Ventilation of confined spaces within the building.
- Well-constructed floor slab.
- Sub floor void vented to the atmosphere.
- Low permeable membrane such as 2000g, fitted by a professional contactor and validated by a third party.
- Minimum penetration of ground slab by services, with sufficient lapped and taped joints.

The installation of the gas membrane should be undertaken by a suitably competent contractor and quality assurance and control information should be collected. For example photographic evidence of ground joints, welds and service entry seals.

LKA would advise that the foundation design follow BRE 414[20] and drawings are provided to the Local Authority for approval. In addition, specifications of the proprietary gas membrane should be sent to the Local Authority for their approval.

9.3 Site Buildings (Pollutant Linkage 5)

The concentrations of soluble sulphate in the soil when contrasted to BRE Digest 2005 categorise the concrete requirement as DS-2 AC-2 for the Heritage Centre (Area B), no special precautions are required for the Hotel (Area A).

9.4 Potable Water Supply (Pollutant Linkage 6)

Potential risk to potable water supplies has been identified and LKA would advise consulting with United Utilities about suitable protection for water supplies. If pipes are to be installed in the made ground then all pipework should be protectaline or cast iron and installed in sterile trenches.

9.5 Remediation Verification & Site Completion Report

It is strongly recommended that any remediation carried out on the site is validated by a third party and suitable documentary evidence provided in a Site Completion Report, such as photographs, consignment documents and soil depth measurements. This should include as a minimum:

- Verification of all imported soil for soft landscaping. The sampling suite and regime should follow local authority guidance. A typical sampling regime would be 1 per $50m^3$ (or a minimum of 3 samples). Typical composite samples would be tested for

[20] BRE (2001). "Protective Measures for Housing on Gas-Contaminated Land." BRE 414.

metals, speciated PAHs, petroleum hydrocarbons and asbestos. The depth of the capping layer should also be validated.

- Consultation with United Utilities and information on the installation of protective pipes and/or sterile trenches.

- Validation information should be collected on the installation of the gas protection measures.

The Site Completion Report will assist the local authority in the discharge of any future relevant planning condition.

This report should be sent to Manchester City Council and the Environment Agency for their comments prior to works commencing on site.

10 FURTHER CONSIDERATIONS

10.1 Reassessment of Risks from Contaminated Soil in 'Landfill Area'

With regard to human health, the contaminated land regime has recently changed with the publication of a new risk assessment model. As such the previous report, undertaken in July 2008 may not represent current guidance. It is therefore recommended that the risk assessment with respect to direct contact and inhalation of vapours is reassessed for Areas B, C and D in line with current guidance.

With regard to phytotoxicity, the assessment is based upon the old ICRCL guidance and depending upon the planting regime for the site, in areas of soft landscaping, may not necessarily be a significant phytotoxic risk. For example turfed landscaped areas with minimal planting are unlikely to be significantly effected.

10.2 The Bund

It is understood that the bund present on the eastern part of the site will need to be excavated in order to accommodate the proposed development. LKA understands that this material may also be required for levelling the site along its southern boundary. Permissions and advice should be sought from the Environment Agency prior to any groundworks of this nature commencing on-site.

10.3 The Water Feature

A water feature is proposed adjacent to the heritage centre building. LKA understand that the pond will be fully lined. LKA recommend that health and safety considerations are employed while the area is excavated to accommodate the pond.

10.4 The Interceptor Tanks

Interceptor tanks associated with the former petrol station on the northern part of the site will need to be removed prior to construction of the hotel. Any impacted material associated with the interceptor tank should be removed off-site and validation sampling should be undertaken to ensure that all contamination has been removed.

10.5 Considerations for Piling in Contaminated Land.

LKA have reviewed the Environment Agency guidance document with respect to piling on contaminated land and the prevention of pollution[21]. LKA considers that the most appropriate piling option would be via a non-displacement technique. This technique involved the coring and removal of the material from that area to be occupied by the pile. The material is brought to the surface as arisings. The excavated hole is then cased and replaced with the pile. This technique minimises the displacement of contaminated material and prevent such material being "dragged" downwards into the underlying aquifer.

[21] Environment Agency (2001). Piling and Penetrative Ground Improvement Methods on Land affected by Contamination: Guidance on Pollution Prevention. Bristol

Method Statements and Risk Assessments for the chosen piling option should be forwarded to the Environment Agency once an appropriate technique has been chosen by the contractor, and prior to works commencing on site.

APPENDIX A

BOREHOLE AND TRIAL PIT LOGS – AREA A

IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP01

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 12.00m		L K Group	40323
	Location	**Dates** 03/04/2008-04/04/2008	**Engineer** L K Group	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.20	B1					(0.10) 0.10	Grass over MADE GROUND: Topsoil (driller's description).			
						(1.10)	MADE GROUND: Soft, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including brick, sandstone, mudstone and siltstone with rare ash and organic material.			
1.20-1.65 1.20-1.65	CPT N=37 B2	1.20	DRY	4,7/8,8,12,9		1.20	MADE GROUND: Loose, dark brown, sandy, angular to subangular, fine to coarse GRAVEL with pockets of clay and some ash. Gravel includes brick, concrete, limestone and sandstone.			
2.00-2.45 2.00-2.45	CPT N=8 B3	1.50	DRY	3,4/3,2,1,2		(2.80)				
3.00-3.45 3.00-3.45	CPT N=13 B4	3.00	DRY	1,2/5,3,2,3			Below 3.00m: medium dense.			
4.00-4.45 4.00-4.45	CPT N=8 B5	4.00	DRY	2,1/2,2,3,1		4.00	MADE GROUND: Very soft, brown/grey, sandy, gravelly CLAY. Gravel is angular to subangular, fine to coarse including brick, concrete and sandstone with some ash.			
						(1.00)			▼1	
5.00-5.45	B6			Water strike(1) at 5.00m, rose to 4.70m in 20 mins, sealed at 7.30m.		5.00	MADE GROUND: Medium dense, dark grey, clayey, sandy, subangular to angular, fine to coarse GRAVEL including brick, concrete and sandstone with some ash. Hydrocarbon odour noted.		▽1	
5.00-5.45	CPT N=12	4.50	4.70	1,1/2,4,3,3						
6.00-6.45 6.00-6.45	CPT N=10 B7	6.00	5.50	1,2/2,3,2,3		(1.90)				
7.00-7.50	B8					6.90	Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and siltstone.			
7.50-7.95	U9 0.45	7.50	DRY	60 blows						
8.00 8.00-8.50	D10 B11						Below 8.00m: stiff.			
9.00-9.45 9.00-9.45 9.00-9.45	SPT N=25 D13 B12	9.00	DRY	2,3/4,6,7,8						

Remarks
Excavating from 0.00m to 1.20m for 1.00 hour.

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH01

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP01

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 12.00m		L K Group	40323
	Location	**Dates** 03/04/2008-04/04/2008	**Engineer** L K Group	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.50	B14									
10.50-10.95	U15 0.45	10.50	DRY	90 blows						
11.00	D16						Below 11.00m: laminations of silt.			
11.00-11.50	B17									
12.00-12.45	SPT N=36	12.00	DRY	3,5/7,8,10,11			Below 12.00m: very stiff.			
12.00-12.45	B18									
12.00-12.45	D19					(8.10)				
13.00-13.50	B20									
13.50-13.95	U21 0.45	12.00	DRY	110 blows						
14.00	D22						Below 14.00m: no gravel. Thin bands of sand.			
14.00-14.50	B23									
15.00-15.45	SPT 50/295	12.00	DRY	4,6/8,11,14,17		15.00				
15.00-15.45	D24						Complete at 15.00m			

Remarks
Chiselling from 12.60m to 12.80m for 0.50 hours.

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH01

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP02

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 21.00m		L K Group	40323
	Location	**Dates** 02/04/2008-03/04/2008	**Engineer** L K Group	**Sheet** 1/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.20	B1					(1.80)	Grass over MADE GROUND: Loose, dark brown, clayey, gravelly, fine to coarse SAND with pockets of clay. Gravel is angular to subangular, fine to coarse including brick, concrete and limestone with some ash and wood.			
1.20-1.65 1.20-1.65	CPT N=9 B2	1.20	DRY	1,1/2,2,3,2		1.80				
2.00-2.45	U3 0.45	1.50	DRY	65 blows			MADE GROUND: Firm, locally soft, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and siltstone.			
2.50 2.50-3.00	D4 B5									
3.00-3.45 3.00-3.45	SPT N=12 D6	3.00	DRY	1,2/2,3,3,4		(2.40)				
3.50-4.00	B7									
4.00-4.45	U8 0.45	4.00	DRY	50 blows		4.20			▽1	
				slight seepage(1) at 4.20m.		(0.30)	MADE GROUND: Loose, dark brown, clayey, gravelly, fine to coarse SAND with pockets of clay. Gravel is angular to subangular, fine to coarse including brick, concrete and sandstone with some ash and wood.			
4.50 4.50-5.00	D9 B10					4.50				
5.00-5.45 5.00-5.45	SPT N=10 D11	4.50	DRY	1,1/2,2,3,3		(1.00)	MADE GROUND: Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse including brick, ceramics, sandstone, mudstone and siltstone with rare ash.		▼2	
5.50-6.00	B12			Water strike(2) at 5.50m, rose to 5.20m in 20 mins, sealed at 7.50m.		5.50			▽2	
6.00-6.45 6.00-6.45	SPT N=17 D13	6.00	5.50	1,2/7,4,3,3		(1.50)	Very soft, brown, sandy, gravelly CLAY with some ash and cobbles of brick. Gravel is angular to subangular, fine to coarse including brick and concrete.			
6.50-7.00	B14									
7.00-7.50	B15					7.00	Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and siltstone.			
7.50-7.95	U16 0.45	7.50	DRY	65 blows						
8.00 8.00-8.50	D17 B18						Below 8.00m: stiff.			
9.00-9.45 9.00-9.45 9.00-9.45	SPT N=28 B19 D20	9.00	DRY	2,4/5,6,8,9			Below 9.00m: lenses of silt.			

Remarks
Excavating from 0.00m to 1.20m for 1.00 hour.

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH02

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP02

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 21.00m		L K Group	40323
	Location	**Dates** 02/04/2008-03/04/2008	**Engineer** L K Group	**Sheet** 2/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.50-10.95	U21 0.45	10.50	DRY	95 blows						
11.00	D22									
11.00-11.50	B23									
12.00-12.45	SPT N=36	12.00	DRY	3,5/7,9,10,10			Below 12.00m: very stiff.			
12.00-12.45	B24									
12.00-12.45	D25									
13.00-13.50	B26						Below 13.00m: occasional thin bands of sand.			
13.50-13.95	U27 0.25	13.50	DRY	120 blows						
14.00	D28									
14.00-14.50	B29									
15.00-15.37	SPT 50/220	15.00	DRY	4,7/11,17,22		(13.50)				
15.00-15.45	B30									
15.00-15.45	D31									
16.00-16.50	B32						Below 16.00m: no gravel.			
16.50-16.95	U33 0.30	15.00	DRY	120 blows						
17.00	D34						Below 17.00m: thin laminations of silt.			
17.00-17.50	B35									
18.00-18.32	SPT 50/170	15.00	DRY	3,6/8,10,32			Below 18.00m: sandy.			
18.00-18.45	B36									
18.00-18.45	D37									
19.00-19.50	B38									
19.50-19.80	SPT 50/145	19.50	DRY	9,16/24,26						
19.50-19.80	D39									

Remarks

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH02

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IAN FARMER ASSOCIATES

Site	Borehole Number
Queens Road, Cheetham Hill, Manchester	CP02

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm to 21.00m		L K Group	40323
	Location	**Dates** 02/04/2008-03/04/2008	**Engineer** L K Group	**Sheet** 3/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
20.00-20.50	B40					(13.50)				
						20.50	Highly weathered, red brown SANDSTONE, recovered as very stiff, sandy, slightly gravelly clay. Gravel is subangular to subrounded, fine to coarse of sandstone.			
21.00-21.29	SPT 50/140	21.00	DRY	8,15/23,27						
21.00-21.30	D43									
21.00-21.30	B41					(2.00)				
22.00-22.50	B44									
						22.50	Complete at 22.50m			

Remarks
Chiselling from 22.30m to 22.50m for 1.00 hour.

Scale (approx)	Logged By
1:50	OJ

Figure No. 40323.BH02

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LEYDEN KIRBY ASSOCIATES LTD
Bury Business Centre, Kay Street, Bury, Lancashire, BL9 6BU
Tel: 0161 763 7200 Fax: 0161 763 7318 web: www.leydenkirby.co.uk

Site	Number
Irish World Heritage Centre	**WS1**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.70 0.70 0.70	V T J				(0.50) 0.50 (3.30) 3.80 (1.20) 5.00	MADE GROUND. Grass underlain by mid brown sandy topsoil with much fine to medium angular gravel, occasional brick, coal and clinker fragments and rootlets. MADE GROUND. Compacted black ash, clinker, coal, tarmac, fine to coarse angular gravel, cobbles and hydrocarbon odour. Inclusions of reworked sandy clay with ash, coal and gravel were present at 1.6m to 2.0m, 2.4m to 2.5m and 2.8m to 3.0m. MADE GROUND. Reworked mid brown clay with ash, occasional brick fragments, coal, fine to coarse angular and sub-rounded gravel, wood and hydrocarbon odour. Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS1

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LEYDEN KIRBY ASSOCIATES LTD
Bury Business Centre, Kay Street, Bury, Lancashire, BL9 6BU
Tel: 0161 763 7200 Fax: 0161 763 7318 web: www.leydenkirby.co.uk

Site	Number
Irish World Heritage Centre	**WS2**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 02/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.60)	MADE GROUND. Grass underlain by mid brown sandy topsoil with rootlets, fine to medium angular gravel, occasional brick fragments and rare clinker.			
0.60	T				0.60				
0.60	V					MADE GROUND. Ash, clinker, fine to coarse angular gravel, coal, brick fragments and cobbles, inclusion of builder's sand and some inclusions of clay.			
0.60	J				(1.40)				
					2.00				
						MADE GROUND. Reworked light brown stiff sandy clay with brick fragments and cobbles, coarse angular gravel and coal fragments.			
					(1.10)				
					3.10				
						Stiff mid brown sandy CLAY with occasional fine coal fragments and small inclusions of sand and rare fine gravel.			
3.50	T								
3.50	V								
3.50	J								
4.00-4.45	SPT N=12		1,2/2,3,3,4		(2.35)				
5.00-5.45	SPT N=15		2,2/3,4,4,4						
					5.45				
						Complete at 5.45m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS2

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LK ASSOCIATES LTD

Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com

Site	Trial Pit Number
Irish World Heritage Centre	TP1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.60)	MADE GROUND. Light brown very clayey sandy topsoil with occasional brick fragments, some coal and rare wood.		
0.60-0.80	V				0.60			
0.60-0.80	T				(0.20)	MADE GROUND. Light grey fine to coarse sand with much ash and clinker and some brick and coal fragments.		
0.60-0.80	J				0.80			
					(0.20)	MADE GROUND. Light brown coarse sand.		
1.00-1.00	V				1.00			
1.00-1.00	T					MADE GROUND. Dark grey coarse sand and fine to coarse gravel, many cobbles and large pieces of clinker, occasional brick, rare tarmacadam, glass and pottery.		
1.00-1.00	J				(2.00)			
					3.00	Complete at 3.00m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	CL1294.TP1

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LK ASSOCIATES LTD
Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com

Site	Trial Pit Number
Irish World Heritage Centre	TP2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Volvo ECR 88			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 03/04/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.30	V				(1.30)	MADE GROUND. Brown sandy clay with much fine sub-angular gravel, many fragments of brick, coal, ash, clinker, wood and concrete and rare metal.		
0.00-1.30	T							
0.00-1.30	J							
					1.30			
					(1.20)	MADE GROUND. Dark grey dense clayey sand with much fine angular gravel, much brick and coal, and rare glass.		
					2.50			
					(0.10)	MADE GROUND. Brown and orange coarse sand and medium sub-angular gravel with much ash, clinker, metal and plastic.		
2.60-3.00	V				2.60			
2.60-3.00	T							
2.60-3.00	J				(0.40)	MADE GROUND. Light brown clay with frequent fine angular gravel, some fragments of brick, clinker and coal.		
					3.00			
						Complete at 3.00m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	BR	CL1294.TP2

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LK ASSOCIATES LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.leydenkirby.co.uk	Site Irish World Heritage Centre	Number **WS201**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler		58.37	Trustees of the Irish World Heritage Centre	CL1294
	Location 384870.68 E 400518.06 N	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.60)	MADE GROUND. Mid-brown reworked clay with brick fragments and cobbles, fine to coarse angular gravel and some ash and clinker.			
0.50	S			57.77	0.60	MADE GROUND. Ash, clinker, fine to coarse angular gravel, tarmac fragments, coal fragments and rare sand.			
1.50	S					Faint hydrocarbon odour from 1.5m.			
						Some inclusions of clay and sand and some cobbles from 2.5m.			
					(5.40)				
						Wood fragments from 3.5m.			
						Moist from 4.0m.			
			Water strike(1) at 4.50m.					▽1	
						Wet from 5.0m.			
				52.37	6.00				
						Complete at 6.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No.
CL1294.WS201

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LK ASSOCIATES LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.leydenkirby.co.uk		**Site** Irish World Heritage Centre	**Number** **WS201A**
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Trustees of the Irish World Heritage Centre	**Job Number** CL1294
	Location	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40) 0.40	MADE GROUND. Grass underlain by grey/brown reworked sandy clay with brick cobbles and fragments, some ash, coal fragments and rootlets.		
					(1.30) 1.70	MADE GROUND. Ash, brick fragments and cobbles, clinker, glass, plastic, fine to coarse angular gravel, coal fragments, rare clay and sand inclusions.		
			Borehole refused at 1.7m			Complete at 1.70m		

Remarks	**Scale (approx)** 1:50	**Logged By** MP
	Figure No. CL1294.WS201A	

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LK ASSOCIATES LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.leydenkirby.co.uk	**Site** Irish World Heritage Centre		**Number** **WS201B**
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Trustees of the Irish World Heritage Centre	**Job Number** CL1294
	Location	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40) 0.40	MADE GROUND. Grass underlain by grey/brown reworked sandy clay with brick cobbles and fragments, some ash, coal fragments and rootlets.		
					(1.20) 1.60	MADE GROUND. Ash, brick fragments and cobbles, clinker, glass, plastic, fine to coarse angular gravel, coal fragments, rare clay and sand inclusions.		
			Borehole refused at 1.6m			Complete at 1.60m		

Remarks	Scale (approx)	Logged By
	1:50	MP
	Figure No. CL1294.WS201A	

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LK ASSOCIATES LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.leydenkirby.co.uk	Site Irish World Heritage Centre	Number WS201C

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40) 0.40	MADE GROUND. Grass underlain by mid-brown reworked clay with brick fragments, fine to coarse angular gravel, coal fragments and ash.		
					(0.20) 0.60	MADE GROUND. Sandstone cobbles.		
					(1.10)	MADE GROUND. Ash, clinker, brick fragments, fine to coarse angular gravel and cobbles, coal and tarmac fragments.		
			Borehole refused at 1.7m.		1.70	Complete at 1.70m		

Remarks	Scale (approx)	Logged By
	1:50	MP
	Figure No. CL1294.WS201C	

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LK ASSOCIATES LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.leydenkirby.co.uk	Site Irish World Heritage Centre	Number WS201D

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Trustees of the Irish World Heritage Centre	CL1294
	Location	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
			Borehole refused at 0.6m.		(0.50) 0.50 (0.10) 0.60	MADE GROUND. Reworked brown clay with brick fragments, ash and fine to coarse angular gravel. MADE GROUND. Ash, clinker, brick fragments and fine to coarse angular gravel. Complete at 0.60m		

Remarks	Scale (approx)	Logged By
	1:50	MP
	Figure No. CL1294.WS201D	

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LK ASSOCIATES LTD
Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.leydenkirby.co.uk

Site	Number
Irish World Heritage Centre	**WS202**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler		59.47	Trustees of the Irish World Heritage Centre	CL1294
	Location 384840 E 400496 N	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.30	S				(1.00)	MADE GROUND. Mid-brown reworked sandy clay with brick fragments, occasional fine to coarse angular gravel, rootlets, ash and clinker and rare glass fragments.			
				58.47	1.00				
					(1.10)	MADE GROUND. Ash and clinker with occasional fine to coarse angular gravel, rare cobble, rare glass fragments and rare brick fragments. Faint hydrocarbon odour from 1.8 to 2.1m.			
1.90	S			57.37	2.10				
					(0.80)	MADE GROUND. Mid-brown reworked sandy clay with brick fragments, occasional fine to coarse angular gravel, rootlets, ash and clinker and rare glass fragments.			
				56.57	2.90				
					(2.10)	MADE GROUND. Ash and clinker with occasional fine to coarse angular gravel, rare cobble, rare brick fragments and fragments of clay pipe. Faint hydrocarbon odour from 4.0m.			
			Borehole refused at 5.0m	54.47	5.00				
						Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS202

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LK ASSOCIATES LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.leydenkirby.co.uk	**Site** Irish World Heritage Centre		**Number** **WS203**
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)** 59.66	**Client** Trustees of the Irish World Heritage Centre	**Job Number** CL1294
	Location 384808.27 E 400498.37 N	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20	S				(6.00)	MADE GROUND. Ash, clinker, tarmac fragments, fine to coarse angular gravel, some inclusions of clay, rare glass fragments and hydrocarbon odour. Brick fragments present from 0 to 0.5m.			
			Water strike(1) at 3.95m.					▽1	
4.70	S					Moist with wood fragments from 4.6m. Wet with visual evidence of hydrocarbons from 5.0m.			
				53.66	6.00	Complete at 6.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No.
CL1294.WS203

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LK ASSOCIATES LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.leydenkirby.co.uk	**Site** Irish World Heritage Centre		**Number** **WS204**
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)** 59.50	**Client** Trustees of the Irish World Heritage Centre	**Job Number** CL1294
	Location 384811.8 E 400511.9 N	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(1.60)	MADE GROUND. Steel reinforced concrete underlain by ash, clinker, fine to coarse angular and sub-rounded gravel, occasional brick fragments and rare pottery fragments. Faint hydrocarbon odour from 1 to 1.6m.			
1.60	S			57.90	1.60	MADE GROUND. Mid-brown reworked very sandy clay with brick fragments, ash and fine to coarse angular gravel.			
						Moist from 3.0m.			
3.50	S				(4.30)	Inclusions of ash and cliner with diesel type odour from 3.5m.			
			Water strike(1) at 4.00m.			Wet with visual evidence of hydrocarbons from 4.0m.		▽1	
						Water has a green tinge from 5.0m.			
5.20	S								
				53.60	5.90				
				53.50	(0.10)	Light brown sandy CLAY.			
					6.00	Complete at 6.00m			

Remarks	Scale (approx)	Logged By
	1:50	MP
	Figure No. CL1294.WS204	

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LK ASSOCIATES LTD
Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.leydenkirby.co.uk

Site	Number
Irish World Heritage Centre	**WS205**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler		59.64	Trustees of the Irish World Heritage Centre	CL1294
	Location 384820.18 E 400512.32 N	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
				59.34	(0.30) 0.30	MADE GROUND. Tarmac underlain by fine to coarse gravel, ash and tarmac fragments.			
0.60	S					MADE GROUND. Ash, clinker, fine to coarse angular gravel, tarmac fragments. Strong hydrocarbon odour and rare brick fragments from 1.0m.			
1.20	S								
			Water strike(1) at 3.40m.		(5.60)			▽1	
				53.74	5.90				
				53.64	(0.10) 6.00	MADE GROUND. Moist reworked mid brown clay with brick and coal fragments.			
						Complete at 6.00m			

Remarks

Scale (approx)	Logged By
1:50	MP

Figure No. CL1294.WS205

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LK ASSOCIATES LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.leydenkirby.co.uk	Site Irish World Heritage Centre	Number WS206

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler		59.26	Trustees of the Irish World Heritage Centre	CL1294
	Location 384832.71 E 400519.5 N	**Dates** 20/11/2008	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20	S				(2.20)	MADE GROUND. Grass underlain by ash, clinker, brick fragments and cobbles, fine to coarse angular gravel, tarmac fragments, pottery and plastic fragments and rare cobbles.			
				57.06	2.20	MADE GROUND. Reworked mid-brown sandy clay with fine to coarse angular gravel, brick fragments and some ash. No return 5.0 to 6.0m			
					(3.80)				
				53.26	6.00	Complete at 6.00m			

Remarks	Scale (approx)	Logged By
	1:50	MP
	Figure No. CL1294.WS206	

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APPENDIX B

ANALYTICAL RESULTS – SOILS – AREA A

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R,McKellar

LABORATORY TEST REPORT

Results of analysis of 8 samples
received 24 November 2008

I.W.H.C. - CL1294

Chemtest

Report Date
28 November 2008

Login Batch No					92886							
Chemtest LIMS ID					AD66165	AD66168	AD66169	AD66170	AD66171	AD66172	AD66173	AD66174
Sample ID					WS201	WS202	WS203	WS203	WS204	WS205	WS205	WS206
Sample No												
Depth					0.5	1.9	0.2	4.7	5.2	0.6	1.2	0.2
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*								
2120	Boron (hot water soluble)	7440428	mg kg-¹	U	0.6	2.7	0.6	2	0.9	1	1.6	0.9
	Sulfate (2:1 water soluble)	14808798	g l-¹	M	0.03	<0.01	<0.01	0.83	0.13	0.12	0.62	0.06
2300	Cyanide (free)	57125	mg kg-¹	M	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
	Cyanide (total)	57125	mg kg-¹	M	< 0.5	< 0.5	0.6	2.9	12.0	10.0	3.1	0.5
2450	Arsenic	7440382	mg kg-¹	M	17	15	24	24	30	15	20	40
	Cadmium	7440439	mg kg-¹	M	0.68	0.28	1.1	0.28	0.25	0.25	1.8	0.49
	Chromium	7440473	mg kg-¹	M	26	26	32	15	35	16	17	26
	Copper	7440508	mg kg-¹	M	72	130	85	120	120	120	98	91
	Mercury	7439976	mg kg-¹	M	0.39	2.5	1.2	2.0	0.62	0.33	0.87	0.83
	Nickel	7440020	mg kg-¹	M	31	61	43	15	41	40	29	33
	Lead	7439921	mg kg-¹	M	190	91	370	2900	760	83	180	520
	Selenium	7782492	mg kg-¹	M	0.25	0.73	0.50	<0.2	0.43	0.48	0.41	0.44
	Zinc	7440666	mg kg-¹	M	170	280	170	160	110	55	210	130
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
2625	Organic matter		%	M	6.4	21	9.8	22	9.1	24	24	15
2675	TPH aliphatic >C5-C6		mg kg-¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C6-C8		mg kg-¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C8-C10		mg kg-¹	N	< 0.1	< 0.1	< 0.1	140	54	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C10-C12		mg kg-¹	N	< 0.1	< 0.1	< 0.1	1300	290	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C12-C16		mg kg-¹	N	< 0.1	< 0.1	< 0.1	6400	1900	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C16-C21		mg kg-¹	N	< 0.1	< 0.1	< 0.1	6800	1600	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C21-C35		mg kg-¹	N	< 0.1	< 0.1	< 0.1	2900	360	< 0.1	< 0.1	< 0.1
	TPH aromatic >C5-C7		mg kg-¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C7-C8		mg kg-¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C8-C10		mg kg-¹	N	< 0.1	< 0.1	< 0.1	110	45	< 0.1	< 0.1	< 0.1
	TPH aromatic >C10-C12		mg kg-¹	N	< 0.1	61	29	680	130	9.2	110	7.9
	TPH aromatic >C12-C16		mg kg-¹	N	13	340	140	1600	400	100	460	48
	TPH aromatic >C16-C21		mg kg-¹	N	2.4	1000	410	2000	320	480	1500	120
	TPH aromatic >C21-C35		mg kg-¹	N	11	1300	790	1000	100	600	2100	190
	Total Petroleum Hydrocarbons		mg kg-¹	N	26	2800	1400	23000	5200	1200	4200	370

All tests undertaken between 24-Nov-2008 and 28-Nov-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R,McKellar

LABORATORY TEST REPORT

Results of analysis of 8 samples
received 24 November 2008

I.W.H.C. - CL1294

Chemtest

Report Date
28 November 2008

					92886							
					AD66165	AD66168	AD66169	AD66170	AD66171	AD66172	AD66173	AD66174
					WS201	WS202	WS203	WS203	WS204	WS205	WS205	WS206
					0.5	1.9	0.2	4.7	5.2	0.6	1.2	0.2
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Naphthalene	91203	mg kg-1	M	1.5	51	21			18	190	16
	Acenaphthylene	208968	mg kg-1	M	0.3	2.9	13			6.5	8.4	2.9
	Acenaphthene	83329	mg kg-1	M	2.4	65	19			35	190	8.5
	Fluorene	86737	mg kg-1	M	1.6	61	29			28	140	9.6
	Phenanthrene	85018	mg kg-1	M	10	460	220			210	980	54
	Anthracene	120127	mg kg-1	M	2.7	98	49			50	250	12
	Fluoranthene	206440	mg kg-1	M	9.7	440	220			230	960	49
	Pyrene	129000	mg kg-1	M	8.7	380	240			220	860	48
	Benzo[a]anthracene	56553	mg kg-1	M	4.2	160	100			95	380	23
	Chrysene	218019	mg kg-1	M	5.1	190	120			110	430	32
	Benzo[b]fluoranthene	205992	mg kg-1	M	4	150	91			89	300	26
	Benzo[k]fluoranthene	207089	mg kg-1	M	3.4	100	63			71	290	14
	Benzo[a]pyrene	50328	mg kg-1	M	4.4	170	110			100	390	24
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	0.5	25	19			22	62	3.8
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	M	2.4	130	69			77	260	10
	Benzo[g,h,i]perylene	191242	mg kg-1	M	3	100	75			77	240	4.8
	Total (of 16) PAHs		mg kg-1	M	64	2600	1500			1400	5900	340
2750	Fuel Type (soils)			N	pah	pah	pah	w. diesel, pah	w. diesel, pah	pah	pah	pah
2760	Benzene	71432	µg kg-1	M	1.8	4.3	5.4			4.3	8.9	2.9
	Toluene	108883	µg kg-1	M	2.1	5.1	9.7			6.3	19	2.9
	Ethyl benzene	100414	µg kg-1	M	<1	3.3	5.7			3.2	11	1.1
	m- & p-Xylene	1330207	µg kg-1	M	2.0	7.8	21			6.9	32	2.9
	o-Xylene	95476	µg kg-1	M	<1	6.0	33			4.4	23	1.4
	Methyl tert-butyl ether	1634044	µg kg-1	N	<1	<1	<1			<1	<1	<1
	Dichlorodifluoromethane	75718	µg kg-1	U				<1	<1			
	Chloromethane	74873	µg kg-1	M				<1	<1			
	Vinyl chloride	75014	µg kg-1	M				<1	<1			
	Bromomethane	74839	µg kg-1	U				<20	<20			
	Chloroethane	75003	µg kg-1	U				<2	<2			
	Trichlorofluoromethane	75694	µg kg-1	U				<1	<1			
	1,1-Dichloroethene	75354	µg kg-1	U				<1	<1			

All tests undertaken between 24-Nov-2008 and 28-Nov-2008

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Leyden Kirby Associates
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Kay Street
Bury, Lancashire
BL9 6BU

FAO R,McKellar

LABORATORY TEST REPORT

Results of analysis of 8 samples
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I.W.H.C. - CL1294

Chemtest

Report Date
28 November 2008

					92886							
					AD66165	AD66168	AD66169	AD66170	AD66171	AD66172	AD66173	AD66174
					WS201	WS202	WS203	WS203	WS204	WS205	WS205	WS206
					0.5	1.9	0.2	4.7	5.2	0.6	1.2	0.2
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Dichloromethane	75092	µg kg⁻¹	U				ne	ne			
	trans-1,2-Dichloroethene	156605	µg kg⁻¹	M				<1	<1			
	1,1-Dichloroethane	75343	µg kg⁻¹	M				<1	<1			
	cis-1,2-Dichloroethene	156592	µg kg⁻¹	M				<1	<1			
	Bromochloromethane	74975	µg kg⁻¹	U				<1	<1			
	Trichloromethane	67663	µg kg⁻¹	M				<1	<1			
	1,1,1-Trichloroethane	71556	µg kg⁻¹	M				<1	<1			
	Tetrachloromethane	56235	µg kg⁻¹	M				<1	<1			
	1,1-Dichloropropene	563586	µg kg⁻¹	U				<1	<1			
	Benzene	71432	µg kg⁻¹	M				14	170			
	1,2-Dichloroethane	107062	µg kg⁻¹	M				<2	<2			
	Trichloroethene	79016	µg kg⁻¹	N				<1	<1			
	1,2-Dichloropropane	78875	µg kg⁻¹	U				<1	<1			
	Dibromomethane	74953	µg kg⁻¹	U				<10	<10			
	Bromodichloromethane	75274	µg kg⁻¹	U				<5	<5			
	cis-1,3-Dichloropropene	10061015	µg kg⁻¹	U				<10	<10			
	Toluene	108883	µg kg⁻¹	M				33	<1			
	trans-1,3-Dichloropropene	10061026	µg kg⁻¹	U				<10	<10			
	1,1,2-Trichloroethane	79005	µg kg⁻¹	M				<10	<10			
	Tetrachloroethene	127184	µg kg⁻¹	M				<1	<1			
	1,3-Dichloropropane	142289	µg kg⁻¹	U				<2	<2			
	Dibromochloromethane	124481	µg kg⁻¹	U				<10	<10			
	1,2-Dibromoethane	106934	µg kg⁻¹	U				<5	<5			
	Chlorobenzene	108907	µg kg⁻¹	M				<1	<1			
	1,1,1,2-Tetrachloroethane	630206	µg kg⁻¹	M				<2	<2			
	Ethylbenzene	100414	µg kg⁻¹	M				100	8.4			
	m- & p-Xylene	1330207	µg kg⁻¹	M				160	270			
	o-Xylene	95476	µg kg⁻¹	M				130	12			
	Styrene	100425	µg kg⁻¹	U				<1	<1			
	Tribromomethane	75252	µg kg⁻¹	U				<10	<10			
	Isopropylbenzene	98828	µg kg⁻¹	U				47	<1			

All tests undertaken between 24-Nov-2008 and 28-Nov-2008

* Accreditation status

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Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R,McKellar

LABORATORY TEST REPORT

Results of analysis of 8 samples
received 24 November 2008

I.W.H.C. - CL1294

Chemtest

Report Date
28 November 2008

					92886							
					AD66165	AD66168	AD66169	AD66170	AD66171	AD66172	AD66173	AD66174
					WS201	WS202	WS203	WS203	WS204	WS205	WS205	WS206
					0.5	1.9	0.2	4.7	5.2	0.6	1.2	0.2
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2760	Bromobenzene	108861	µg kg⁻¹	U				<1	<1			
	1,1,2,2-Tetrachloroethane	79345	µg kg⁻¹	M				<10	<10			
	1,2,3-Trichloropropane	96184	µg kg⁻¹	U				<50	<50			
	n-Propylbenzene	103651	µg kg⁻¹	U				39	170			
	2-Chlorotoluene	95498	µg kg⁻¹	U				<1	<1			
	1,3,5-Trimethylbenzene	108678	µg kg⁻¹	U				120	320			
	4-Chlorotoluene	106434	µg kg⁻¹	U				<1	<1			
	tert-Butylbenzene	98066	µg kg⁻¹	U				<1	<1			
	1,2,4-Trimethylbenzene	95636	µg kg⁻¹	U				390	1300			
	sec-Butylbenzene	135988	µg kg⁻¹	U				61	160			
	1,3-Dichlorobenzene	541731	µg kg⁻¹	U				<1	<1			
	4-Isopropyltoluene	99876	µg kg⁻¹	U				23	70			
	1,4-Dichlorobenzene	106467	µg kg⁻¹	U				<1	<1			
	n-Butylbenzene	104518	µg kg⁻¹	U				<1	<1			
	1,2-Dichlorobenzene	95501	µg kg⁻¹	U				<1	<1			
	1,2-Dibromo-3-chloropropane	96128	µg kg⁻¹	U				<50	<50			
	1,2,4-Trichlorobenzene	120821	µg kg⁻¹	U				<1	<1			
	Hexachlorobutadiene	87683	µg kg⁻¹	U				<1	<1			
	1,2,3-Trichlorobenzene	87616	µg kg⁻¹	U				<2	<2			
2790	N-Nitrosodimethylamine	62759	mg kg⁻¹	N				<0.5	<0.5			
	Phenol	108952	mg kg⁻¹	N				<0.5	<0.5			
	bis(2-Chloroethyl)ether	111444	mg kg⁻¹	N				<0.5	<0.5			
	2-Chlorophenol	95578	mg kg⁻¹	N				<0.5	<0.5			
	1,3-Dichlorobenzene	541731	mg kg⁻¹	N				<0.5	<0.5			
	1,4-Dichlorobenzene	106467	mg kg⁻¹	N				<0.5	<0.5			
	1,2-Dichlorobenzene	95501	mg kg⁻¹	N				<0.5	<0.5			
	2-Methylphenol	95487	mg kg⁻¹	N				<0.5	<0.5			
	bis(2-Chloroisopropyl)ether	108601	mg kg⁻¹	N				<0.5	<0.5			
	4-Methylphenol	106445	mg kg⁻¹	N				<0.5	<0.5			
	N-Nitrosodi-n-propylamine	621647	mg kg⁻¹	N				<0.5	<0.5			
	Hexachloroethane	67721	mg kg⁻¹	N				<0.5	<0.5			

All tests undertaken between 24-Nov-2008 and 28-Nov-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R,McKellar

LABORATORY TEST REPORT

Results of analysis of 8 samples
received 24 November 2008

I.W.H.C. - CL1294

Chemtest

Report Date
28 November 2008

					92886							
					AD66165	AD66168	AD66169	AD66170	AD66171	AD66172	AD66173	AD66174
					WS201	WS202	WS203	WS203	WS204	WS205	WS205	WS206
					0.5	1.9	0.2	4.7	5.2	0.6	1.2	0.2
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Nitrobenzene	98953	mg kg⁻¹	N				<0.5	<0.5			
	Isophorone	78591	mg kg⁻¹	N				<0.5	<0.5			
	2-Nitrophenol	88755	mg kg⁻¹	N				<0.5	<0.5			
	2,4-Dimethylphenol	105679	mg kg⁻¹	N				<0.5	<0.5			
	bis(2-Chloroethoxy)methane	111911	mg kg⁻¹	N				<0.5	<0.5			
	2,4-Dichlorophenol	120832	mg kg⁻¹	N				<0.5	<0.5			
	1,2,4-Trichlorobenzene	120821	mg kg⁻¹	N				<0.5	<0.5			
	Naphthalene	91203	mg kg⁻¹	N				130	4.8			
	4-Chloroaniline	106478	mg kg⁻¹	N				<0.5	<0.5			
	Hexachlorobutadiene	87683	mg kg⁻¹	N				<0.5	<0.5			
	4-Chloro-3-methylphenol	59507	mg kg⁻¹	N				<0.5	<0.5			
	2-Methylnaphthalene	91576	mg kg⁻¹	N				95	20			
	Hexachlorocyclopentadiene	77474	mg kg⁻¹	N				<0.5	<0.5			
	2,4,6-Trichlorophenol	88062	mg kg⁻¹	N				<0.5	<0.5			
	2,4,5-Trichlorophenol	95954	mg kg⁻¹	N				<0.5	<0.5			
	2-Chloronaphthalene	91587	mg kg⁻¹	N				<0.5	<0.5			
	2-Nitroaniline	88744	mg kg⁻¹	N				<0.5	<0.5			
	Dimethylphthalate	131113	mg kg⁻¹	N				<0.5	<0.5			
	2,6-Dinitrotoluene	606202	mg kg⁻¹	N				<0.5	<0.5			
	Acenaphthylene	208968	mg kg⁻¹	N				2.3	<0.5			
	3-Nitroaniline	99092	mg kg⁻¹	N				<0.5	<0.5			
	Acenaphthene	83329	mg kg⁻¹	N				100	8.0			
	Dibenzofuran	132649	mg kg⁻¹	N				64	4.5			
	2,4-Dinitrotoluene	121142	mg kg⁻¹	N				<0.5	<0.5			
	Diethylphthalate	84662	mg kg⁻¹	N				<0.5	<0.5			
	Fluorene	86737	mg kg⁻¹	N				77	8.0			
	4-Chlorophenylether	7005723	mg kg⁻¹	N				<0.5	<0.5			
	4-Nitroaniline	100016	mg kg⁻¹	N				<0.5	<0.5			
	2-Methyl-4,6-dinitrophenol	534521	mg kg⁻¹	N				<0.5	<0.5			
	Azobenzene	103333	mg kg⁻¹	N				<0.5	<0.5			
	4-Bromophenylphenylether	101553	mg kg⁻¹	N				<0.5	<0.5			

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LABORATORY TEST REPORT

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I.W.H.C. - CL1294

Chemtest

Report Date
28 November 2008

FAO R,McKellar

					92886							
					AD66165	AD66168	AD66169	AD66170	AD66171	AD66172	AD66173	AD66174
					WS201	WS202	WS203	WS203	WS204	WS205	WS205	WS206
					0.5	1.9	0.2	4.7	5.2	0.6	1.2	0.2
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2790	Hexachlorobenzene	118741	mg kg⁻¹	N				<0.5	<0.5			
	Pentachlorophenol	87865	mg kg⁻¹	N				<0.5	<0.5			
	Phenanthrene	85018	mg kg⁻¹	N				290	46			
	Anthracene	120127	mg kg⁻¹	N				85	14			
	Carbazole	86748	mg kg⁻¹	N				32	5.3			
	Di-n-butylphthalate	84742	mg kg⁻¹	N				<0.5	<0.5			
	Fluoranthene	206440	mg kg⁻¹	N				200	43			
	Pyrene	129000	mg kg⁻¹	N				190	39			
	Butylbenzylphthalate	85687	mg kg⁻¹	N				<0.5	<0.5			
	Benzo[a]anthracene	56553	mg kg⁻¹	N				88	18			
	Chrysene	218019	mg kg⁻¹	N				80	18			
	bis(2-Ethylhexyl)phthalate	117817	mg kg⁻¹	N				<0.5	<0.5			
	Di-n-octylphthalate	117840	mg kg⁻¹	N				<0.5	<0.5			
	Benzo[b]fluoranthene	205992	mg kg⁻¹	N				87	19			
	Benzo[k]fluoranthene	207089	mg kg⁻¹	N				30	5.5			
	Benzo[a]pyrene	50328	mg kg⁻¹	N				81	17			
	Indeno[1,2,3-cd]pyrene	193395	mg kg⁻¹	N				33	8.0			
	Dibenzo[a,h]anthracene	53703	mg kg⁻¹	N				13	2.9			
	Benzo[g,h,i]perylene	191242	mg kg⁻¹	N				40	9.2			
2920	Phenols (total)		mg kg⁻¹	N	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	1.1	<0.3
2010	pH		-	M	8.6	8.1	7.9	8.0	8.1	7.8	7.8	7.4
2030	Moisture		%	n/a	16.5	18.4	13.2	23.1	24.7	11.7	11.4	16.4
	Stone content (as received)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2140	Soil colour			n/a	brown	brown	brown	brown	brown	brown	brown	brown
	Soil texture			n/a	clay	clay	clay	sand	clay	clay	clay	clay
	Other material			n/a	none	none	none	none	none	none	none	none
2186	Asbestos (ACMs - presence/absence)		-	N	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected

All tests undertaken between 24-Nov-2008 and 28-Nov-2008

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APPENDIX C

ANALYTICAL RESULTS – GROUNDWATERS

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO B.Rouse

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

Login Batch No					**47045**							
Chemtest LIMS ID					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
Sample ID					WS2	CP1	WS10	CP4	WS5	CP5	CP6
Sample No											
Depth											
Matrix					*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓	*							
1010	pH	PH	-	U	7.3	7.0	6.9	6.9	7.1	7.1	6.9
1020	Electrical Conductivity	EC	µS cm-¹	U	1100	1300	1500	1600	1300	1300	2100
1300	Cyanide (total)	57125	mg l-¹	U	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1310	Cyanide (free)	57125	mg l-¹	U	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1420	Ammonium	14798039	mg l-¹	U	0.73	1.2	3.3	0.24	1.9	9.0	20
1120	Sulfate	14808798	mg l-¹	U	270	190	410	350	420	390	2100
1220	Chloride	16887006	mg l-¹	N	32	33	19	27	47	60	24
	Nitrate	14797558	mg l-¹	N	0.61	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Nitrite	14797650	mg l-¹	N	0.089	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1450	Arsenic	7440382	µg l-¹	U	<1	2.0	<1	<1	<1	<1	<1
	Boron	7440428	µg l-¹	U	65	90	90	220	48	170	<20
	Cadmium	7440439	µg l-¹	U	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chromium	7440473	µg l-¹	U	<1	<1	<1	<1	<1	<1	<1
	Copper	7440508	µg l-¹	U	1.0	<1	<1	<1	<1	<1	<1
	Lead	7439921	µg l-¹	U	<1	2.5	1.1	<1	<1	<1	<1
	Mercury	7439976	µg l-¹	U	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Nickel	7440020	µg l-¹	U	4.5	4.2	4.5	11	6.5	3.0	5.5
	Selenium	7782492	µg l-¹	U	<1	<1	<1	<1	2.2	<1	<1
	Zinc	7440666	µg l-¹	U	5	18	4.5	24	5	1.9	1.6
1490	Chromium (hexavalent)	18540299	µg l-¹	N	<50	<50	<50	<50	<50	<50	<50
1675	TPH aliphatic >C5-C6		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C16-C21		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C21-C35		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C6-C7		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

All tests undertaken between 27-Apr-2008 and 7-May-2008

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Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO B.Rouse

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1675	TPH aromatic >C10-C12		µg l⁻¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C12-C16		µg l⁻¹	N	<0.1	4.3	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C16-C21		µg l⁻¹	N	<0.1	6.2	11	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C21-C35		µg l⁻¹	N	<0.1	5.3	6.9	<0.1	<0.1	<0.1	<0.1
	Total Petroleum Hydrocarbons		µg l⁻¹	N	<10	16	18	<10	<10	<10	<10
1700	Naphthalene	91203	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Acenaphthylene	208968	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Acenaphthene	83329	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Fluorene	86737	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Phenanthrene	85018	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Anthracene	120127	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Fluoranthene	206440	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Pyrene	129000	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[a]anthracene	56553	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Chrysene	218019	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[b]fluoranthene	205992	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[k]fluoranthene	207089	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[a]pyrene	50328	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Dibenzo[a,h]anthracene	53703	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Benzo[g,h,i]perylene	191242	µg l⁻¹	N	<0.01			<0.01	<0.01	<0.01	<0.01
	Total (of 16) PAHs		µg l⁻¹	N	<0.2			<0.2	<0.2	<0.2	<0.2
1750	Fuel Type (waters)			n/a	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1760	Benzene	71432	µg l⁻¹	U	<1			<1	<1	<1	<1
	Dichlorodifluoromethane	75718	µg l⁻¹	U		<1	<1				
	Chloromethane	74873	µg l⁻¹	U		<1	<1				
	Toluene	108883	µg l⁻¹	U	<1			<1	<1	<1	<1
	Ethyl benzene	100414	µg l⁻¹	U	<1			<1	<1	<1	<1
	Vinyl chloride	75014	µg l⁻¹	U		<1	<1				
	Bromomethane	74839	µg l⁻¹	U		<20	<20				
	m- & p-Xylene	1330207	µg l⁻¹	U	<1			<1	<1	<1	<1

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LABORATORY TEST REPORT

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IWHC

Chemtest

Report Date
07 May 2008

					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1760	Chloroethane	75003	µg l-1	U		<2	<2				
	o-Xylene	95476	µg l-1	U	<1			<1	<1	<1	<1
	Methyl tert-buty ether	1634044	µg l-1	U	<1			<1	<1	<1	<1
	Trichlorofluoromethane	75694	µg l-1	U		<1	<1				
	1,1-Dichloroethene	75354	µg l-1	U		<1	<1				
	Dichloromethane	75092	µg l-1	U		ne	ne				
	trans-1,2-Dichloroethene	156605	µg l-1	U		<1	<1				
	1,1-Dichloroethane	75343	µg l-1	U		<1	<1				
	cis-1,2-Dichloroethene	156592	µg l-1	U		<1	<1				
	Bromochloromethane	74975	µg l-1	U		<1	<1				
	Trichloromethane	67663	µg l-1	U		<1	<1				
	1,1,1-Trichloroethane	71556	µg l-1	U		<1	<1				
	Tetrachloromethane	56235	µg l-1	U		<1	<1				
	1,1-Dichloropropene	563586	µg l-1	U		<1	<1				
	Benzene	71432	µg l-1	U		<1	<1				
	1,2-Dichloroethane	107062	µg l-1	U		<2	<2				
	Trichloroethene	79016	µg l-1	U		<1	<1				
	1,2-Dichloropropane	78875	µg l-1	U		<1	<1				
	Dibromomethane	74953	µg l-1	U		<10	<10				
	Bromodichloromethane	75274	µg l-1	U		<5	<5				
	cis-1,3-Dichloropropene	10061015	µg l-1	U		<10	<10				
	Toluene	108883	µg l-1	U		<1	<1				
	trans-1,3-Dichloropropene	10061026	µg l-1	U		<10	<10				
	1,1,2-Trichloroethane	79005	µg l-1	U		<10	<10				
	Tetrachloroethene	127184	µg l-1	U		<1	<1				
	1,3-Dichloropropane	142289	µg l-1	U		<2	<2				
	Dibromochloromethane	124481	µg l-1	U		<10	<10				
	1,2-Dibromoethane	106934	µg l-1	U		<5	<5				
	Chlorobenzene	108907	µg l-1	U		<1	<1				
	1,1,1,2-Tetrachloroethane	630206	µg l-1	U		<2	<2				
	Ethylbenzene	100414	µg l-1	U		<1	<1				

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					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1760	m- & p-Xylene	1330207	µg l-¹	U		<1	<1				
	o-Xylene	95476	µg l-¹	U		<1	<1				
	Styrene	100425	µg l-¹	U		<1	<1				
	Tribromomethane	75252	µg l-¹	U		<10	<10				
	Isopropylbenzene	98828	µg l-¹	U		<1	<1				
	Bromobenzene	108861	µg l-¹	U		<1	<1				
	1,1,2,2-Tetrachloroethane	79345	µg l-¹	U		<10	<10				
	1,2,3-Trichloropropane	96184	µg l-¹	U		<50	<50				
	n-Propylbenzene	103651	µg l-¹	U		<1	<1				
	2-Chlorotoluene	95498	µg l-¹	U		<1	<1				
	1,3,5-Trimethylbenzene	108678	µg l-¹	U		<1	<1				
	4-Chlorotoluene	106434	µg l-¹	U		<1	<1				
	tert-Butylbenzene	98066	µg l-¹	U		<1	<1				
	1,2,4-Trimethylbenzene	95636	µg l-¹	U		<1	<1				
	sec-Butylbenzene	135988	µg l-¹	U		<1	<1				
	1,3-Dichlorobenzene	541731	µg l-¹	U		<1	<1				
	4-Isopropyltoluene	99876	µg l-¹	U		<1	<1				
	1,4-Dichlorobenzene	106467	µg l-¹	U		<1	<1				
	n-Butylbenzene	104518	µg l-¹	U		<1	<1				
	1,2-Dichlorobenzene	95501	µg l-¹	U		<1	<1				
	1,2-Dibromo-3-chloropropane	96128	µg l-¹	U		<50	<50				
	1,2,4-Trichlorobenzene	120821	µg l-¹	U		<1	<1				
	Hexachlorobutadiene	87683	µg l-¹	U		<1	<1				
	1,2,3-Trichlorobenzene	87616	µg l-¹	U		<2	<2				
1790	N-Nitrosodimethylamine	62759	µg l-¹	N		<0.05	<0.05				
	Phenol	108952	µg l-¹	N		<0.05	<0.05				
	bis(2-Chloroethyl)ether	111444	µg l-¹	N		<0.05	<0.05				
	2-Chlorophenol	95578	µg l-¹	N		<0.05	<0.05				
	1,3-Dichlorobenzene	541731	µg l-¹	N		<0.05	<0.05				
	1,4-Dichlorobenzene	106467	µg l-¹	N		<0.05	<0.05				
	1,2-Dichlorobenzene	95501	µg l-¹	N		<0.05	<0.05				

All tests undertaken between 27-Apr-2008 and 7-May-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO B.Rouse

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1790	2-Methylphenol	95487	µg l-¹	N		<0.05	<0.05				
	bis(2-Chloroisopropyl)ether	108601	µg l-¹	N		<0.05	<0.05				
	4-Methylphenol	106445	µg l-¹	N		<0.05	<0.05				
	N-Nitrosodi-n-propylamine	621647	µg l-¹	N		<0.05	<0.05				
	Hexachloroethane	67721	µg l-¹	N		<0.05	<0.05				
	Nitrobenzene	98953	µg l-¹	N		<0.05	<0.05				
	Isophorone	78591	µg l-¹	N		<0.05	<0.05				
	2-Nitrophenol	88755	µg l-¹	N		<0.05	<0.05				
	2,4-Dimethylphenol	105679	µg l-¹	N		<0.05	<0.05				
	bis(2-Chloroethoxy)methane	111911	µg l-¹	N		<0.05	<0.05				
	2,4-Dichlorophenol	120832	µg l-¹	N		<0.05	<0.05				
	1,2,4-Trichlorobenzene	120821	µg l-¹	N		<0.05	<0.05				
	Naphthalene	91203	µg l-¹	N		<0.05	<0.05				
	4-Chloroaniline	106478	µg l-¹	N		<0.05	<0.05				
	Hexachlorobutadiene	87683	µg l-¹	N		<0.05	<0.05				
	4-Chloro-3-methylphenol	59507	µg l-¹	N		<0.05	<0.05				
	2-Methylnaphthalene	91576	µg l-¹	N		<0.05	<0.05				
	Hexachlorocyclopentadiene	77474	µg l-¹	N		<0.05	<0.05				
	2,4,6-Trichlorophenol	88062	µg l-¹	N		<0.05	<0.05				
	2,4,5-Trichlorophenol	95954	µg l-¹	N		<0.05	<0.05				
	2-Chloronaphthalene	91587	µg l-¹	N		<0.05	<0.05				
	2-Nitroaniline	88744	µg l-¹	N		<0.05	<0.05				
	Dimethylphthalate	131113	µg l-¹	N		<0.05	<0.05				
	2,6-Dinitrotoluene	606202	µg l-¹	N		<0.05	<0.05				
	Acenaphthylene	208968	µg l-¹	N		<0.05	<0.05				
	3-Nitroaniline	99092	µg l-¹	N		<0.05	<0.05				
	Acenaphthene	83329	µg l-¹	N		2.9	1.8				
	Dibenzofuran	132649	µg l-¹	N		0.2	0.1				
	2,4-Dinitrotoluene	121142	µg l-¹	N		<0.05	<0.05				
	Diethylphthalate	84662	µg l-¹	N		<0.05	<0.05				
	Fluorene	86737	µg l-¹	N		0.2	0.1				

All tests undertaken between 27-Apr-2008 and 7-May-2008

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FAO B.Rouse

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 23 April 2008

IWHC

Chemtest

Report Date
07 May 2008

					47045						
					AC96921	AC96922	AC96923	AC96924	AC96925	AC96926	AC96927
					WS2	CP1	WS10	CP4	WS5	CP5	CP6
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1790	4-Chlorophenylether	7005723	µg l⁻¹	N		<0.05	<0.05				
	4-Nitroaniline	100016	µg l⁻¹	N		<0.05	<0.05				
	2-Methyl-4,6-dinitrophenol	534521	µg l⁻¹	N		<0.05	<0.05				
	Azobenzene	103333	µg l⁻¹	N		<0.05	<0.05				
	4-Bromophenylphenylether	101553	µg l⁻¹	N		<0.05	<0.05				
	Hexachlorobenzene	118741	µg l⁻¹	N		<0.05	<0.05				
	Pentachlorophenol	87865	µg l⁻¹	N		<0.05	<0.05				
	Phenanthrene	85018	µg l⁻¹	N		0.1	0.2				
	Anthracene	120127	µg l⁻¹	N		1.0	2.5				
	Carbazole	86748	µg l⁻¹	N		6.6	<0.05				
	Di-n-butylphthalate	84742	µg l⁻¹	N		<0.05	<0.05				
	Fluoranthene	206440	µg l⁻¹	N		0.3	0.9				
	Pyrene	129000	µg l⁻¹	N		0.1	0.6				
	Butylbenzylphthalate	85687	µg l⁻¹	N		<0.05	<0.05				
	Benzo[a]anthracene	56553	µg l⁻¹	N		<0.05	<0.05				
	Chrysene	218019	µg l⁻¹	N		<0.05	<0.05				
	bis(2-Ethylhexyl)phthalate	117817	µg l⁻¹	N		<0.05	<0.05				
	Di-n-octylphthalate	117840	µg l⁻¹	N		<0.05	<0.05				
	Benzo[b]fluoranthene	205992	µg l⁻¹	N		<0.05	<0.05				
	Benzo[k]fluoranthene	207089	µg l⁻¹	N		<0.05	<0.05				
	Benzo[a]pyrene	50328	µg l⁻¹	N		<0.05	<0.05				
	Indeno[1,2,3-cd]pyrene	193395	µg l⁻¹	N		<0.05	<0.05				
	Dibenzo[a,h]anthracene	53703	µg l⁻¹	N		<0.05	<0.05				
	Benzo[g,h,i]perylene	191242	µg l⁻¹	N		<0.05	<0.05				
1920	Phenols (total)		mg l⁻¹	N	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03

All tests undertaken between 27-Apr-2008 and 7-May-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R McKellar

AMENDED LABORATORY TEST REPORT

Results of analysis of 11 samples
received 11 December 2008

CL1294 - Queens Road

Chemtest

Report Date
14 April 2009

Login Batch No					102140							
Chemtest LIMS ID					AD70414	AD70415	AD70416	AD70417	AD70418	AD70419	AD70420	AD70421
Sample ID					CP1	CP2	CP4	CP5	WS2	WS5	WS205	UP
Sample No												
Depth												
Matrix					*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓	*								
1010	pH	PH	-	U	7.3	7.1	7.2	6.9	6.9	6.9	6.6	7.3
1220	Sulfate	14808798	mg l-1	U	110	120	310	68	96	120	< 1.0	44
1270	Hardness	HARD_TO	mg CaCO3 l-1	U	290	300	430	230	310	320	210	170
1300	Cyanide (total)	57125	mg l-1	U	< 0.05	< 0.05	0.17	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1310	Cyanide (free)	57125	mg l-1	U	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1420	Ammonium	14798039	mg l-1	U	1.4	1.0	0.16	1.6	< 0.01	0.81	1.3	0.45
1450	Arsenic	7440382	µg l-1	U	20	15	1.0	4.2	<1	2.6	52	2.2
	Boron	7440428	µg l-1	U	370	320	640	370	140	120	210	61
	Cadmium	7440439	µg l-1	U	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chromium	7440473	µg l-1	U	6.6	3.8	5.9	6.2	2.3	2.8	5.0	1.5
	Copper	7440508	µg l-1	U	<1	<1	1.8	3.4	4.0	3.2	<1	3.5
	Lead	7439921	µg l-1	U	1.8	3.0	<1	<1	<1	3.6	5.5	<1
	Mercury	7439976	µg l-1	U	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Nickel	7440020	µg l-1	U	8.6	7.5	14	9.7	4.3	6.3	5.0	3.8
	Selenium	7782492	µg l-1	U	<1	<1	1.2	3.8	4.3	1.6	<1	<1
	Zinc	7440666	µg l-1	U	11	11	16	6.8	2.4	14	<1	13
1490	Chromium (hexavalent)	18540299	µg l-1	N	<50	<50	<50	<50	<50	<50	<50	<50
1675	TPH aliphatic >C5-C6		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	49000	<0.1
	TPH aliphatic >C12-C16		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	180000	<0.1
	TPH aliphatic >C16-C21		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	230000	<0.1
	TPH aliphatic >C21-C35		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20000	<0.1
	TPH aromatic >C6-C7		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	310	<0.1
	TPH aromatic >C7-C8		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3600	<0.1
	TPH aromatic >C10-C12		µg l-1	N	11	<0.1	<0.1	<0.1	<0.1	<0.1	29000	<0.1
	TPH aromatic >C12-C16		µg l-1	N	82	<0.1	<0.1	<0.1	<0.1	<0.1	22000	<0.1
	TPH aromatic >C16-C21		µg l-1	N	88	<0.1	<0.1	<0.1	<0.1	<0.1	8200	<0.1

All tests undertaken between 12-Dec-2008 and 16-Dec-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R McKellar

AMENDED LABORATORY TEST REPORT

Results of analysis of 11 samples
received 11 December 2008

CL1294 - Queens Road

Chemtest

Report Date
14 April 2009

Login Batch No					**102140**		
Chemtest LIMS ID					AD70422	AD70423	AD70424
Sample ID					MID	DOWN	WS203
Sample No							
Depth							
Matrix					*WATER*	*WATER*	*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓				
1010	pH	PH	-	U	7.2	7	7.2
1220	Sulfate	14808798	mg l-¹	U	45	47	u/s
1270	Hardness	HARD_TO	mg CaCO3 l-¹	U	160	170	230
1300	Cyanide (total)	57125	mg l-¹	U	< 0.05	< 0.05	u/s
1310	Cyanide (free)	57125	mg l-¹	U	< 0.05	< 0.05	u/s
1420	Ammonium	14798039	mg l-¹	U	0.45	0.50	u/s
1450	Arsenic	7440382	µg l-¹	U	2.5	2.5	57
	Boron	7440428	µg l-¹	U	69	66	430
	Cadmium	7440439	µg l-¹	U	<0.5	<0.5	<0.5
	Chromium	7440473	µg l-¹	U	1.7	1.6	6.9
	Copper	7440508	µg l-¹	U	4.8	4.2	<1
	Lead	7439921	µg l-¹	U	<1	<1	25
	Mercury	7439976	µg l-¹	U	<0.5	<0.5	<0.5
	Nickel	7440020	µg l-¹	U	4.1	3.9	9.6
	Selenium	7782492	µg l-¹	U	<1	<1	1.1
	Zinc	7440666	µg l-¹	U	16	15	2.3
1490	Chromium (hexavalent)	18540299	µg l-¹	N	<50	<50	<50
1675	TPH aliphatic >C5-C6		µg l-¹	N	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		µg l-¹	N	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		µg l-¹	N	<0.1	<0.1	150
	TPH aliphatic >C10-C12		µg l-¹	N	<0.1	<0.1	3800
	TPH aliphatic >C12-C16		µg l-¹	N	<0.1	<0.1	8800
	TPH aliphatic >C16-C21		µg l-¹	N	<0.1	<0.1	6800
	TPH aliphatic >C21-C35		µg l-¹	N	<0.1	<0.1	3700
	TPH aromatic >C6-C7		µg l-¹	N	<0.1	<0.1	640
	TPH aromatic >C7-C8		µg l-¹	N	<0.1	<0.1	34
	TPH aromatic >C8-C10		µg l-¹	N	<0.1	<0.1	150
	TPH aromatic >C10-C12		µg l-¹	N	<0.1	<0.1	3800
	TPH aromatic >C12-C16		µg l-¹	N	<0.1	<0.1	8800
	TPH aromatic >C16-C21		µg l-¹	N	<0.1	<0.1	6800

All tests undertaken between 12-Dec-2008 and 16-Dec-2008

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Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
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FAO R McKellar

AMENDED LABORATORY TEST REPORT

Results of analysis of 11 samples
received 11 December 2008

CL1294 - Queens Road

Chemtest

Report Date
14 April 2009

					102140							
					AD70414	AD70415	AD70416	AD70417	AD70418	AD70419	AD70420	AD70421
					CP1	CP2	CP4	CP5	WS2	WS5	WS205	UP
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1675	TPH aromatic >C21-C35		µg l⁻¹	N	17	<0.1	<0.1	<0.1	<0.1	<0.1	1500	<0.1
	Total Petroleum Hydrocarbons		µg l⁻¹	N	200	<10	<10	<10	<10	<10	540000	<10
1700	Naphthalene	91203	µg l⁻¹	N	3.1	<0.01	<0.01	<0.01	<0.01	<0.01	290	<0.01
	Acenaphthylene	208968	µg l⁻¹	N	0.21	<0.01	<0.01	<0.01	<0.01	<0.01	2200	<0.01
	Acenaphthene	83329	µg l⁻¹	N	29	<0.01	<0.01	<0.01	<0.01	<0.01	1400	<0.01
	Fluorene	86737	µg l⁻¹	N	10	<0.01	<0.01	<0.01	<0.01	<0.01	960	<0.01
	Phenanthrene	85018	µg l⁻¹	N	24	<0.01	<0.01	<0.01	<0.01	<0.01	1800	<0.01
	Anthracene	120127	µg l⁻¹	N	10	<0.01	<0.01	<0.01	<0.01	<0.01	610	<0.01
	Fluoranthene	206440	µg l⁻¹	N	14	<0.01	<0.01	<0.01	<0.01	<0.01	860	<0.01
	Pyrene	129000	µg l⁻¹	N	12	<0.01	<0.01	<0.01	<0.01	<0.01	790	<0.01
	Benzo[a]anthracene	56553	µg l⁻¹	N	3.9	<0.01	<0.01	<0.01	<0.01	<0.01	210	<0.01
	Chrysene	218019	µg l⁻¹	N	14	<0.01	<0.01	<0.01	<0.01	<0.01	190	<0.01
	Benzo[b]fluoranthene	205992	µg l⁻¹	N	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	110	<0.01
	Benzo[k]fluoranthene	207089	µg l⁻¹	N	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	83	<0.01
	Benzo[a]pyrene	50328	µg l⁻¹	N	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	120	<0.01
	Dibenzo[a,h]anthracene	53703	µg l⁻¹	N	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	62	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l⁻¹	N	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	18	<0.01
	Benzo[g,h,i]perylene	191242	µg l⁻¹	N	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	51	<0.01
	Total (of 16) PAHs		µg l⁻¹	N	120.2	<0.2	<0.2	<0.2	<0.2	<0.2	9754	<0.2
1750	Fuel Type (waters)			n/a	pah	n/a	n/a	n/a	n/a	n/a	w.diesel, gaso	n/a
1920	Phenols (total)		mg l⁻¹	N	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03

All tests undertaken between 12-Dec-2008 and 16-Dec-2008

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R McKellar

AMENDED LABORATORY TEST REPORT

Results of analysis of 11 samples
received 11 December 2008

CL1294 - Queens Road

Chemtest

Report Date
14 April 2009

					102140		
					AD70422	AD70423	AD70424
					MID	DOWN	WS203
					WATER	*WATER*	*WATER*
1675	TPH aromatic >C21-C35		µg l-¹	N	<0.1	<0.1	3700
	Total Petroleum Hydrocarbons		µg l-¹	N	<10	<10	47000
1700	Naphthalene	91203	µg l-¹	N	<0.01	<0.01	2900
	Acenaphthylene	208968	µg l-¹	N	<0.01	<0.01	210
	Acenaphthene	83329	µg l-¹	N	<0.01	<0.01	650
	Fluorene	86737	µg l-¹	N	<0.01	<0.01	390
	Phenanthrene	85018	µg l-¹	N	<0.01	<0.01	1100
	Anthracene	120127	µg l-¹	N	<0.01	<0.01	310
	Fluoranthene	206440	µg l-¹	N	<0.01	<0.01	600
	Pyrene	129000	µg l-¹	N	<0.01	<0.01	530
	Benzo[a]anthracene	56553	µg l-¹	N	<0.01	<0.01	170
	Chrysene	218019	µg l-¹	N	<0.01	<0.01	260
	Benzo[b]fluoranthene	205992	µg l-¹	N	<0.01	<0.01	100
	Benzo[k]fluoranthene	207089	µg l-¹	N	<0.01	<0.01	73
	Benzo[a]pyrene	50328	µg l-¹	N	<0.01	<0.01	110
	Dibenzo[a,h]anthracene	53703	µg l-¹	N	<0.01	<0.01	55
	Indeno[1,2,3-cd]pyrene	193395	µg l-¹	N	<0.01	<0.01	17
	Benzo[g,h,i]perylene	191242	µg l-¹	N	<0.01	<0.01	45
	Total (of 16) PAHs		µg l-¹	N	<0.2	<0.2	7520
1750	Fuel Type (waters)			n/a	n/a	n/a	pah, w. diesel
1920	Phenols (total)		mg l-¹	N	<0.03	<0.03	1.2

All tests undertaken between 12-Dec-2008 and 16-Dec-2008

This report should be interpreted in conjunction with the notes on the accompanying cover page

Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R McKellar

LABORATORY TEST REPORT

Results of analysis of 9 samples
received 26 March 2009

I.W.H.C. - CL1294

Chemtest
The right chemistry to deliver results

Report Date
03 April 2009

Login Batch No					**94194**								
	Chemtest LIMS ID				AD92350	AD92351	AD92352	AD92353	AD92354	AD92355	AD92356	AD92357
	Sample ID				WS203	WS205	CP1	CP2	CP4	CP6	Upstream	Midstream
	Sample No											
	Depth											
	Matrix				*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓	*								
1010	pH	PH	-	U	7.3	7.0	7.0	7.1	7.1	7.0	7.5	7.6
1220	Sulfate	14808798	mg l-1	U	6.4	7.0	77	120	350	270	63	63
1270	Hardness	HARD_TO	mg CaCO3 l-1	U	1200	680	1000	830	1400	1500	230	220
1300	Cyanide (total)	57125	mg l-1	U	< 0.05	< 0.05	< 0.05	< 0.05	0.19	< 0.05	< 0.05	< 0.05
1310	Cyanide (free)	57125	mg l-1	U	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1420	Ammonium	14798039	mg l-1	U	6.7	0.90	1.1	1.0	0.06	10	0.38	0.44
1450	Arsenic	7440382	µg l-1	U	52	34	17	15	2.2	33	3.6	3.7
	Boron	7440428	µg l-1	U	530	190	360	390	860	1200	120	120
	Cadmium	7440439	µg l-1	U	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chromium	7440473	µg l-1	U	15	7.9	8.6	7.2	11	14	6.0	11
	Copper	7440508	µg l-1	U	2.2	2.2	<1	<1	3.5	8.7	4.8	4.2
	Lead	7439921	µg l-1	U	34	32	4.3	2.7	1.3	<1	<1	<1
	Mercury	7439976	µg l-1	U	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Nickel	7440020	µg l-1	U	15	5.1	9.5	9.8	19	18	11	11
	Selenium	7782492	µg l-1	U	2.5	<1	1.3	<1	1.8	2.0	<1	<1
	Zinc	7440666	µg l-1	U	6.9	4.1	12	8.7	28	12	20	24
1490	Chromium (hexavalent)	18540299	µg l-1	N	<50	<50	<50	<50	<50	<50	<50	<50
1675	TPH aliphatic >C5-C6		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C6-C8		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C8-C10		µg l-1	N	78	2800	25	4.7	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C10-C12		µg l-1	N	44	9800	13	29	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C12-C16		µg l-1	N	260	32000	94	150	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C16-C21		µg l-1	N	490	32000	140	190	<0.1	<0.1	<0.1	<0.1
	TPH aliphatic >C21-C35		µg l-1	N	420	22000	220	190	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C5-C7		µg l-1	N	0.9	190	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C7-C8		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C8-C10		µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C10-C12		µg l-1	N	160	7600	39	4.2	<0.1	<0.1	<0.1	<0.1
	TPH aromatic >C12-C16		µg l-1	N	320	23000	96	11	5.0	4.4	6.8	2.8
	TPH aromatic >C16-C21		µg l-1	N	180	23000	83	6.7	5.8	4.8	7.2	2.7
	TPH aromatic >C21-C35		µg l-1	N	60	6600	7.9	3.2	6.7	3.8	3.4	3.0

All tests undertaken between 26-Mar-2009 and 3-Apr-2009

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Leyden Kirby Associates
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO R McKellar

LABORATORY TEST REPORT

Results of analysis of 9 samples
received 26 March 2009

I.W.H.C. - CL1294

Report Date
03 April 2009

Login Batch No					**94194**
Chemtest LIMS ID					AD92358
Sample ID					Downstream
Sample No					
Depth					
Matrix					*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓	*	
1010	pH	PH	-	U	7.5
1220	Sulfate	14808798	mg l-¹	U	66
1270	Hardness	HARD_TO	mg CaCO3 l-¹	U	240
1300	Cyanide (total)	57125	mg l-¹	U	< 0.05
1310	Cyanide (free)	57125	mg l-¹	U	< 0.05
1420	Ammonium	14798039	mg l-¹	U	0.29
1450	Arsenic	7440382	µg l-¹	U	4.5
	Boron	7440428	µg l-¹	U	130
	Cadmium	7440439	µg l-¹	U	<0.5
	Chromium	7440473	µg l-¹	U	21
	Copper	7440508	µg l-¹	U	5.8
	Lead	7439921	µg l-¹	U	<1
	Mercury	7439976	µg l-¹	U	<0.5
	Nickel	7440020	µg l-¹	U	12
	Selenium	7782492	µg l-¹	U	<1
	Zinc	7440666	µg l-¹	U	34
1490	Chromium (hexavalent)	18540299	µg l-¹	N	<50
1675	TPH aliphatic >C5-C6		µg l-¹	N	<0.1
	TPH aliphatic >C6-C8		µg l-¹	N	<0.1
	TPH aliphatic >C8-C10		µg l-¹	N	<0.1
	TPH aliphatic >C10-C12		µg l-¹	N	<0.1
	TPH aliphatic >C12-C16		µg l-¹	N	<0.1
	TPH aliphatic >C16-C21		µg l-¹	N	<0.1
	TPH aliphatic >C21-C35		µg l-¹	N	<0.1
	TPH aromatic >C5-C7		µg l-¹	N	<0.1
	TPH aromatic >C7-C8		µg l-¹	N	<0.1
	TPH aromatic >C8-C10		µg l-¹	N	<0.1
	TPH aromatic >C10-C12		µg l-¹	N	<0.1
	TPH aromatic >C12-C16		µg l-¹	N	4.4
	TPH aromatic >C16-C21		µg l-¹	N	6.3
	TPH aromatic >C21-C35		µg l-¹	N	7.2

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Chemtest
The right chemistry to deliver results

Report Date
03 April 2009

					94194							
					AD92350	AD92351	AD92352	AD92353	AD92354	AD92355	AD92356	AD92357
					WS203	WS205	CP1	CP2	CP4	CP6	Upstream	Midstream
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1675	Total Petroleum Hydrocarbons		µg l-1	N	2000	160000	720	590	18	13	17	8.5
1700	Naphthalene	91203	µg l-1	N	21		3.7	2.1	3.3	2.4	1.5	0.76
	Acenaphthylene	208968	µg l-1	N	7.5		0.93	3.6	<0.01	0.66	<0.01	<0.01
	Acenaphthene	83329	µg l-1	N	77		49	2.8	2.2	0.33	<0.01	0.85
	Fluorene	86737	µg l-1	N	33		7.8	1.7	<0.01	0.36	0.17	<0.01
	Phenanthrene	85018	µg l-1	N	18		0.93	0.5	<0.01	0.59	<0.01	<0.01
	Anthracene	120127	µg l-1	N	21		3.6	0.52	<0.01	<0.01	<0.01	<0.01
	Fluoranthene	206440	µg l-1	N	31		6.5	1.7	2	0.93	<0.01	0.89
	Pyrene	129000	µg l-1	N	24		6.6	3.3	2.7	2.1	1.7	1.1
	Benzo[a]anthracene	56553	µg l-1	N	3.1		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Chrysene	218019	µg l-1	N	0.96		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[b]fluoranthene	205992	µg l-1	N	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[k]fluoranthene	207089	µg l-1	N	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[a]pyrene	50328	µg l-1	N	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Dibenzo[a,h]anthracene	53703	µg l-1	N	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l-1	N	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[g,h,i]perylene	191242	µg l-1	N	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Total (of 16) PAHs		µg l-1	N	236.6		79.06	16.22	10.2	7.37	3.37	3.6
1750	Fuel Type (waters)			n/a	w/diesel&PAH	w/diesel&PAH	w/diesel&PAH	w/diesel&PAH	n/a	n/a	n/a	n/a
1760	Benzene	71432	µg l-1	U	3.2	150	< 1	< 1	< 1	< 1	< 1	< 1
	Toluene	108883	µg l-1	U	4	2.6	< 1	< 1	< 1	< 1	< 1	< 1
	Ethyl benzene	100414	µg l-1	U	5.2	< 1	< 1	< 1	< 1	< 1	< 1	< 1
	m- & p-Xylene	1330207	µg l-1	U	12	< 1	< 1	< 1	< 1	< 1	< 1	< 1
	o-Xylene	95476	µg l-1	U	12	< 1	< 1	< 1	< 1	< 1	< 1	< 1
	Methyl tert-butyl ether	1634044	µg l-1	N	5.4	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1800	Naphthalene	91203	µg l-1	N		22						
	Acenaphthylene	208968	µg l-1	N		0.1						
	Acenaphthene	83329	µg l-1	N		200						
	Fluorene	86737	µg l-1	N		140						
	Phenanthrene	85018	µg l-1	N		460						
	Anthracene	120127	µg l-1	N		88						

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Report Date
03 April 2009

FAO R McKellar

I.W.H.C. - CL1294

					94194
					AD92358
					Downstream
					WATER
1675	Total Petroleum Hydrocarbons		µg l-¹	N	18
1700	Naphthalene	91203	µg l-¹	N	3.4
	Acenaphthylene	208968	µg l-¹	N	<0.01
	Acenaphthene	83329	µg l-¹	N	<0.01
	Fluorene	86737	µg l-¹	N	<0.01
	Phenanthrene	85018	µg l-¹	N	<0.01
	Anthracene	120127	µg l-¹	N	<0.01
	Fluoranthene	206440	µg l-¹	N	<0.01
	Pyrene	129000	µg l-¹	N	2.5
	Benzo[a]anthracene	56553	µg l-¹	N	<0.01
	Chrysene	218019	µg l-¹	N	<0.01
	Benzo[b]fluoranthene	205992	µg l-¹	N	<0.01
	Benzo[k]fluoranthene	207089	µg l-¹	N	<0.01
	Benzo[a]pyrene	50328	µg l-¹	N	<0.01
	Dibenzo[a,h]anthracene	53703	µg l-¹	N	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l-¹	N	<0.01
	Benzo[g,h,i]perylene	191242	µg l-¹	N	<0.01
	Total (of 16) PAHs		µg l-¹	N	5.9
1750	Fuel Type (waters)			n/a	n/a
1760	Benzene	71432	µg l-¹	U	< 1
	Toluene	108883	µg l-¹	U	< 1
	Ethyl benzene	100414	µg l-¹	U	< 1
	m- & p-Xylene	1330207	µg l-¹	U	< 1
	o-Xylene	95476	µg l-¹	U	< 1
	Methyl tert-butyl ether	1634044	µg l-¹	N	< 1
1800	Naphthalene	91203	µg l-¹	N	
	Acenaphthylene	208968	µg l-¹	N	
	Acenaphthene	83329	µg l-¹	N	
	Fluorene	86737	µg l-¹	N	
	Phenanthrene	85018	µg l-¹	N	
	Anthracene	120127	µg l-¹	N	

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					94194							
					AD92350	AD92351	AD92352	AD92353	AD92354	AD92355	AD92356	AD92357
					WS203	WS205	CP1	CP2	CP4	CP6	Upstream	Midstream
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1800	Fluoranthene	206440	µg l-1	N		260						
	Pyrene	129000	µg l-1	N		240						
	Benzo[a]anthracene	56553	µg l-1	N		52						
	Chrysene	218019	µg l-1	N		40						
	Benzo[b]fluoranthene	205992	µg l-1	N		31						
	Benzo[k]fluoranthene	207089	µg l-1	N		10						
	Benzo[a]pyrene	50328	µg l-1	N		28						
	Dibenzo[a,h]anthracene	53703	µg l-1	N		0.5						
	Indeno[1,2,3-cd]pyrene	193395	µg l-1	N		5.9						
	Benzo[g,h,i]perylene	191242	µg l-1	N		7.5						
	Total (of 16) PAHs		µg l-1	N		1600						
1920	Phenols (total)		mg l-1	N	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

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Report Date
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FAO R McKellar

I.W.H.C. - CL1294

					94194
					AD92358
					Downstream
					WATER
1800	Fluoranthene	206440	µg l-¹	N	
	Pyrene	129000	µg l-¹	N	
	Benzo[a]anthracene	56553	µg l-¹	N	
	Chrysene	218019	µg l-¹	N	
	Benzo[b]fluoranthene	205992	µg l-¹	N	
	Benzo[k]fluoranthene	207089	µg l-¹	N	
	Benzo[a]pyrene	50328	µg l-¹	N	
	Dibenzo[a,h]anthracene	53703	µg l-¹	N	
	Indeno[1,2,3-cd]pyrene	193395	µg l-¹	N	
	Benzo[g,h,i]perylene	191242	µg l-¹	N	
	Total (of 16) PAHs		µg l-¹	N	
1920	Phenols (total)		mg l-¹	N	< 0.03

All tests undertaken between 26-Mar-2009 and 3-Apr-2009

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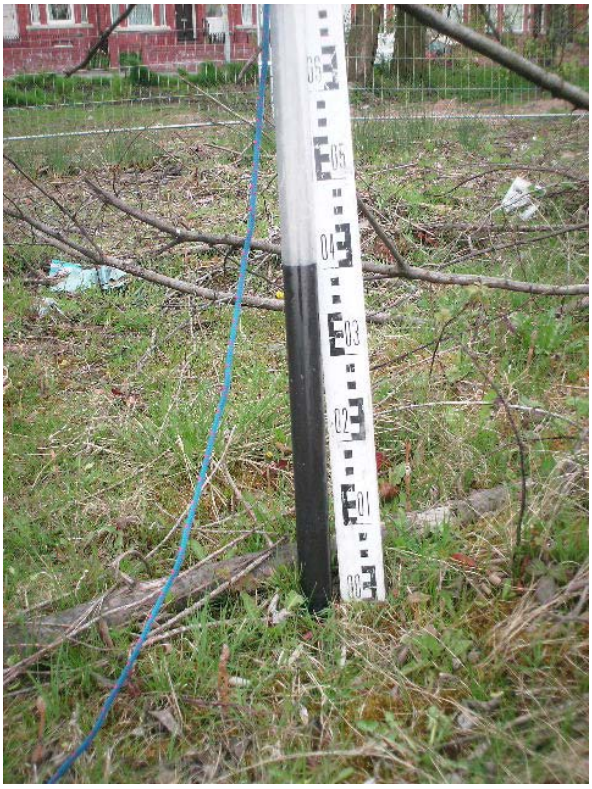
APPENDIX D

PHOTOGRAPHIC EVIDENCE OF WATER COLUMN IN BAILER



Photograph 1A. Showing water column of groundwater taken from WS201.

Showing no evidence of free product.
Much suspended solids -
Slight hydrocarbon odour noted.



Photograph 1B. Close-up of top of water column within WS201



Photograph 2A. Showing water column of groundwater taken from WS203.

Showing no evidence of free product. Some suspended solids present. Slight hydrocarbon odour noted.



Photograph 2B. Close-up of top of water column within WS203.



Photograph 3A.Showing water column of groundwater taken from WS205.

Showing slight film on top of water column. Much suspended solids - Hydrocarbon odour noted.



Photograph 3B. Close-up of top of water column within WS205. Showing slight hydrocarbon film

APPENDIX E

SUMMARY OF SSVs

Author Atkins
Revision 0
Date 26/03/2009

Title **SSVs derived using CLEA v1.04 for 6% SOM, Commercial land use**

PLEASE NOTE
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Compound	SSV mg/kg	Notes
Arsenic	3.32E+02	
Cadmium	2.94E+02	
Chromium	3.30E+02	
Nickel	1.34E+03	
Lead	5.37E+03	Lead has been modelled as a threshold substance. Should background exposure not be taken into account, the SSV would be 6830 mg/kg if free product is not observed.
Mercury	5.30E+02	
Beryllium	1.01E+03	
Selenium	8.32E+03	
Vanadium	7.53E+03	
Copper	1.09E+05	
Zinc	9.17E+05	
Antimony	4.83E+03	
Acenaphthene	9.37E+02	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 106000 mg/kg if free product is not observed.
Anthracene	2.09E+01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 545000 mg/kg if free product is not observed.
Benzo(a)anthracene	1.03E+01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 218 mg/kg if free product is not observed.
Benzo(a)pyrene	5.46E+00	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 22.3 mg/kg if free product is not observed.
Benzo(b)fluoranthene	7.29E+00	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 223 mg/kg if free product is not observed.
Benzo(g,h,i)perylene	1.12E-01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 2250 mg/kg if free product is not observed.
Benzo(k)fluoranthene	4.12E+00	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 2240 mg/kg if free product is not observed.
Chrysene	2.64E+00	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 22000 mg/kg if free product is not observed.
Dibenzo(ah)anthracene	2.36E-02	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 22.4 mg/kg if free product is not observed.
Fluoranthene	1.13E+02	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 72700 mg/kg if free product is not observed.
Fluorene	7.46E+02	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 72100 mg/kg if free product is not observed.
Indeno(1,2,3-cd)pyrene	3.68E-01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 222 mg/kg if free product is not observed.
Pyrene	1.32E+01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 54500 mg/kg if free product is not observed.
Phenol	1.74E+05	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathways contribute less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of >1 kg/kg if free product is not observed.
2,3,7,8-tetrachlorodibenzo-p-dioxin	1.79E-03	
Naphthalene	4.32E+02	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 22700 mg/kg if free product is not observed.
Benzene	7.37E+00	
Toluene	1.78E+03	

Author Atkins
Revision 0
Date 26/03/2009

Title **SSVs derived using CLEA v1.04 for 6% SOM, Commercial land use**

PLEASE NOTE
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Compound	SSV mg/kg	Notes
Ethylbenzene	2.84E+03	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of122000 mg/kg if free product is not observed.
o-xylene	2.62E+03	Users must consider total exposure from all xylene isomers and not consider them in isolation. The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 131000 mg/kg if free product is not observed.
m-xylene	3.46E+03	Users must consider total exposure from all xylene isomers and not consider them in isolation. The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 46000 mg/kg if free product is not observed.
p-xylene	3.17E+03	Users must consider total exposure from all xylene isomers and not consider them in isolation. The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 56200 mg/kg if free product is not observed.
Trichloroethene	5.50E+01	
Vinyl chloride	1.24E-01	
1,1,1,2-tetrachloroethane	5.91E+02	
1,1,2,2-tetrachloroethane	1.19E+03	
Tetrachloroethene	8.23E+02	
1,1,1-trichloroethane	3.13E+03	
1,2-dichloroethane	1.75E+00	
Carbon tetrachloride	1.50E+01	
Chlorobenzene (mono)	2.48E+03	
Carbon disulphide	1.00E+02	
TPH Aromatic C5-C7 (benzene)	7.37E+00	Benzene is the only constituent of this fraction (TPHCWG 1997).
TPH Aromatic C7-C8 (toluene)	1.78E+03	Toluene is the only constituent of this fraction (TPHCWG 1997).
TPH Aromatic C8-C10	2.70E+03	
TPH Aromatic C10-C12	2.19E+03	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 36800 mg/kg if free product is not observed.
TPH Aromatic C12-C16	9.25E+02	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 38000 mg/kg if free product is not observed.
TPH Aliphatic C5-C6	1.10E+03	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of >1 kg/kg .
TPH Aliphatic C6-C8	7.69E+02	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of > 1kg/kg .
TPH Aliphatic C8-C10	4.76E+02	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 86700 mg/kg if free product is not observed.
TPH Aliphatic C10-C12	2.97E+02	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 94600 mg/kg if free product is not observed.
TPH Aliphatic C12-C16	1.26E+02	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the saturation limit. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 95300 mg/kg if free product is not observed.
TPH Aromatic C16-C21	2.84E+04	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
TPH Aromatic C21-C35	2.84E+04	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
TPH Aliphatic C16-C35	> 1 kg/kg	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
Cyanide	34	Based on acute exposure for a 0-6 year old child, using 5th percentile bodyweight from CLR10. Information is not available in SR3 and supporting documents regarding the 5th percentile bodyweight of SR3 bodyweight data. It is not considered likely that new data would significantly affect the SSV.

APPENDIX F

HAZARD INDEX WORKSHEETS

$$HI = \sum_{Fi=1}^{16} HQ\ Fi = \frac{\text{Measured concentration Fi (mg/kg)}}{\text{SGV/GAC Fi (mg/kg)}}$$

where: HI = Hazard Index
HQ = Hazard Quotient
Fi = Fraction I
SGV/GAC = Soil Guideline Value or Generic Assessment Criteria

Commercial/Industrial Land Use

Job	IWHC-Petrol Station
Job No.	CL1294
SOM	6.0%
Comment	based upon highest value (WS203) as a conservative measure.

Commercial/Industrial

	1% SGV/SSV	2.50% SGV/SSV	6% SGV/SSV	Max Soil Concn.	**HQ (6% SOM)**
Aliphatic					
EC5-EC6			1.00E+06	0.1	1.00E-07
EC6-EC8			1.00E+06	0.1	1.00E-07
EC8-EC10			8.67E+04	140	1.61E-03
EC10-EC12			9.46E+04	1300	1.37E-02
EC12-EC16			9.53E+04	6400	6.72E-02
EC16-EC21			1.00E+06	6800	6.80E-03
EC21-EC35			1.00E+06	2900	2.90E-03
EC35-EC44			1.00E+06	0	
Aromatic					
EC5-EC7 (benzene)			9.50E+01	0.1	1.05E-03
EC7-EC8 (tolulene)			4.40E+03	0.1	2.27E-05
EC8-EC10			2.70E+03	110	4.07E-02
EC10-EC12			3.68E+04	680	1.85E-02
EC12-EC16			3.80E+04	1600	4.21E-02
EC16-EC21			2.84E+04	2000	7.04E-02
EC21-EC35			2.84E+04	1000	3.52E-02
EC35-EC44			2.84E+04	0	

HI	0.30

$$HI = \sum_{Fi=1}^{16} HQ\ Fi = \frac{\text{Measured concentration Fi (mg/kg)}}{\text{SGV/GAC Fi (mg/kg)}}$$

where: HI = Hazard Index
HQ = Hazard Quotient
Fi = Fraction I
SGV/GAC = Soil Guideline Value or Generic Assessment Criteria

Commercial/Industrial Land Use

Job	IWHC-Petrol Station
Job No.	CL1294
SOM	6.0%
Comment	based upon highest value (WS203) as a conservative measure.

Commercial/Industrial

	1% SGV/SSV	2.50% SGV/SSV	6% SGV/SSV	Max Soil Concn.	Max Water Concn.	**HQ (6% SOM)**
Aliphatic						
EC5-EC6			1.00E+06	0.1	0.1	2.00E-07
EC6-EC8			1.00E+06	0.1	0.1	2.00E-07
EC8-EC10			8.67E+04	140	2.8	1.65E-03
EC10-EC12			9.46E+04	1300	49	1.43E-02
EC12-EC16			9.53E+04	6400	180	6.90E-02
EC16-EC21			1.00E+06	6800	230	7.03E-03
EC21-EC35			1.00E+06	2900	22	2.92E-03
EC35-EC44			1.00E+06	0		
Aromatic						
EC5-EC7 (benzene)			9.50E+01	0.1	0.64	7.79E-03
EC7-EC8 (tolulene)			4.40E+03	0.1	0.1	2.50E-02
EC8-EC10			2.70E+03	110	3.6	2.53E-01
EC10-EC12			3.68E+04	680	29	4.43E-02
EC12-EC16			3.80E+04	1600	23	5.32E-02
EC16-EC21			2.84E+04	2000	23	3.60E-02
EC21-EC35			2.84E+04	1000	6.6	2.32E-04
EC35-EC44			2.84E+04	0		

HI	0.51

APPENDIX G

PARAMETERS FOR REMEDIAL TARGETS WORKSHEETS

***Area A (River Irk Receptor)* - Assumed Perched Waters in Made Ground Overlying Till**			
Equations Used to Generate Remedial Targets[1]			Ogata Banks
			Dispersion: simulate vertical dispersion in 1 direction (EA default)
			Degradation: Apply to pollutants in all phases
Parameter	**Value**	**Unit**	**Reference**
Width of Plume in Aquifer at Source	100	m	Assumed to be width of site in the north
Plume Thickness at Source	2.4	m	CP1 highest water level to bottom of made ground (6.9mbgl)
Saturated Aquifer Thickness	15	m	CP1 site made ground and Till thickness
Bulk Density of Aquifer Material	1.2	g/cm^3	Typical clay sandy loam from CLEA v1.04[2] (unconsolidated material)
Effective Porosity of Aquifer	0.25	dim	Typical Sand and Gravel as conservative value[3]
Hydraulic Gradient	1E-01	dim	Site info from shallow, perched groundwater (range 0.09-0.13)
Hydraulic Conductivity of Aquifer	1	m/d	Worst case typical unconsolidated deposits (range 10^{-3} to 10^{-1})[3]
Distance to Compliance Point	480	m	Distance to the River Irk from highest concentrations found in Area A and calculated groundwater flow direction
Ammonium (Physical-Chemical Parameters)			
Target Concentration	0.5	mg/l	UKDWS
Initial Contaminant Concentration	6.7	mg/l	Highest concentration from WS203
Degradation Half Life	1280	days	Literature search by EA[4] Value chosen from studies in Permo-Triassic sandstone overlain by a landfill. Approximate 40 studies ranged 13-2190 days
Soil Partition Coefficient (Kd)	0.12	l/kg	Literature search by EA[4] Value chosen from Coal Measure sandy clay (lowest value assumed from studies)
Naphthalene (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	SWAD
Initial Contaminant Concentration	2.9	mg/l	Highest concentration from WS203
Degradation Half Life	30	days	Typical degradation rates in aerobic waters identified from EA[5] studies and Canadian studies[6]
Organic Carbon-Water Partition Coefficient (Koc)	645	cm^3/g	UK guidance for naphthalene[7]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Benzene (Physical-Chemical Parameters)			
Target Concentration	0.03	mg/l	EQS
Initial Contaminant Concentration	0.64	mg/l	Highest concentration from WS203
Degradation Half Life	730	days	Typical degradation rates in groundwater on the Canadian studies[6] are highly variable (10 days to 2 years). Worst case assumed.
Organic Carbon-Water Partition Coefficient (Koc)	79.4	cm^3/g	UK guidance for benzene[7]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Xylene (Physical-Chemical Parameters)			
Target Concentration	0.03	mg/l	EQS
Initial Contaminant Concentration	0.169	mg/l	Highest concentration from WS205
Degradation Half Life	32	days	Typical degradation rates in groundwater on the Canadian studies[6] indicated 11 to 32 days. Worst case assumed.
Organic Carbon-Water Partition Coefficient (Koc)	489	cm^3/g	UK guidance for xylene[7]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)

[1] EA (2006). "Remedial Targets Methodology: Hydrological Risk Assessment for Land Contamination."
[2] EA (2008). "CLEA Software (Version 1.03 beta) Handbook." Science Report – SC050021/SR4.
[3] Brasington, R (1993). "Field Hydrology." Second Edition. John Wiley and Sons (ISBN 0-471-97347-5.
[4] EA (2003). "Review of Ammonium Attenuation in Soil and Groundwater." NGWCLC report NC/02/49
[5] EA (2002). "Polycyclic Aromatic Hydrocarbons (PAH): Priorities for Environmental Quality Standard Development." R&D Technical Report P45.
[6] CCME (2008). "Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale Supporting Technical Document." PN 1399
[7] EA (2008). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science Report SC050021/SR7.

Continued

***Area A (River Irk Receptor)* - Assumed Perched Waters in Made Ground Overlying Till**			
Aliphatic >EC8-EC10 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	2.8	mg/l	Highest concentration from WS205
Degradation Half Life	712	days	Literature search Canadian studies[8] for this fraction (Table K1 & C4)
Organic Carbon-Water Partition Coefficient (Koc)	3.16E+04	cm^3/g	TPHCWG report for this fraction[9]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Aliphatic >EC10-EC12 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	49	mg/l	Highest concentration from WS205
Degradation Half Life	1750	days	Literature search Canadian studies[8] for this fraction (Table K1 & C4)
Organic Carbon-Water Partition Coefficient (Koc)	2.51E+05	cm^3/g	TPHCWG report for this fraction[9]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Aliphatic >EC12-EC16 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	180	mg/l	Highest concentration from WS205
Degradation Half Life	1750	days	Literature search Canadian studies[8] for this fraction (Table K1 & C4)
Organic Carbon-Water Partition Coefficient (Koc)	5.01E+06	cm^3/g	TPHCWG report for this fraction[9]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Aliphatic >EC16-EC21 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	230	mg/l	Highest concentration from WS205
Degradation Half Life	4500	days	Literature search UK study on PAHs[10]. Assumed worst case aromatic B(a)P for this aliphatic fraction due to limited biodegradation in the environment
Organic Carbon-Water Partition Coefficient (Koc)	6.31E+08	cm^3/g	TPHCWG report for this fraction[9]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Aliphatic >EC21-EC35 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	22	mg/l	Highest concentration from WS205
Degradation Half Life	4500	days	Literature search UK study on PAHs[10]. Assumed worst case aromatic B(a)P for this aliphatic fraction due to limited biodegradation in the environment
Organic Carbon-Water Partition Coefficient (Koc)	6.31E+08	cm^3/g	TPHCWG report for this fraction[9], assumed same as Aliphatic >EC16-EC21
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)

[8] CCME (2008). "Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale Supporting Technical Document." PN 1399
[9] TPHCWG (1999). "Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach: Volume 5."
[10] EA (2002). "Polycyclic Aromatic Hydrocarbons (PAH): Priorities for Environmental Quality Standard Development." R&D Technical Report P45.

Continued

***Area A (River Irk Receptor)* - Assumed Perched Waters in Made Ground Overlying Till**			
Aromatic >EC8-EC10 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	3.6	mg/l	Highest concentration from WS205
Degradation Half Life	712	days	Literature search Canadian studies[11] for this fraction (Table K1 & C4)
Organic Carbon-Water Partition Coefficient (Koc)	1.59E+03	cm^3/g	TPHCWG report for this fraction[12]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Aromatic >EC10-EC12 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	29	mg/l	Highest concentration from WS205
Degradation Half Life	1750	days	Literature search Canadian studies[11] for this fraction (Table K1 & C4)
Organic Carbon-Water Partition Coefficient (Koc)	2.51E+03	cm^3/g	TPHCWG report for this fraction[12]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Aromatic >EC12-EC16 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	23	mg/l	Highest concentration from WS205
Degradation Half Life	1750	days	Literature search Canadian studies[11] for this fraction (Table K1 & C4)
Organic Carbon-Water Partition Coefficient (Koc)	5.01E+03	cm^3/g	TPHCWG report for this fraction[12]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Aromatic >EC16-EC21 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	23	mg/l	Highest concentration from WS205
Degradation Half Life	4500	days	Literature search UK study on PAHs[13]. Assumed worst case aromatic B(a)P for this fraction due to limited biodegradation in the environment
Organic Carbon-Water Partition Coefficient (Koc)	1.58E+04	cm^3/g	TPHCWG report for this fraction[12]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)
Aromatic >EC21-EC35 (Physical-Chemical Parameters)			
Target Concentration	0.01	mg/l	UKDWS as precaution for individual fractions
Initial Contaminant Concentration	6.6	mg/l	Highest concentration from WS205
Degradation Half Life	4500	days	Literature search UK study on PAHs[13]. Assumed worst case aromatic B(a)P for this fraction due to limited biodegradation in the environment
Organic Carbon-Water Partition Coefficient (Koc)	1.26E+05	cm^3/g	TPHCWG report for this fraction[12]
Fraction of Organic Carbon (foc)	3.8E-02	dim	Site data based on the lowest soil organic matter of 6.4% (foc = SOM/167)

[11] CCME (2008). "Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale Supporting Technical Document." PN 1399
[12] TPHCWG (1999). "Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach: Volume 5."
[13] EA (2002). "Polycyclic Aromatic Hydrocarbons (PAH): Priorities for Environmental Quality Standard Development." R&D Technical Report P45.

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	23rd April 2009		Version:	1
Contaminant	Ammonium			
Target Concentration (C_T)	0.5	mg/l	Origin of C_T:	UKDWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Ammonium		from Level 1
Target Concentration	C_T	5.00E-01	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	6.70E+00	mg/l	*Highest concentration Area A*
Half life for degradation of contaminant in water	$t_{1/2}$	8.05E+02	days	*Literature v alue*
Calculated decay rate	λ	8.61E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.20E-01	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	1.58E+00	fraction
Decay rate used	λ	8.61E-04	d^{-1}
Rate of contaminant flow due to retardation	u	2.54E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	7.72E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**8.67E+01**	

Remedial Targets

Remedial Target	**4.34E+01**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**480**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**7.72E-02**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	1.20E-01	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.20E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

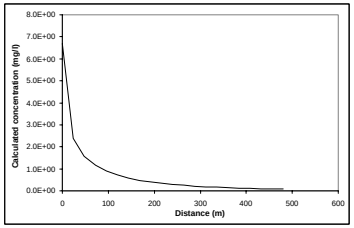
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	23rd April 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	6.7E+00
24.0	2.39E+00
48.0	1.57E+00
72.0	1.16E+00
96.0	8.96E-01
120.0	7.13E-01
144.0	5.80E-01
168.0	4.80E-01
192.0	4.02E-01
216.0	3.40E-01
240.0	2.90E-01
264.0	2.49E-01
288.0	2.15E-01
312.0	1.87E-01
336.0	1.63E-01
360.0	1.43E-01
384.0	1.26E-01
408.0	1.11E-01
432.0	9.80E-02
456.0	8.69E-02
480.0	7.72E-02

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Benzene			
Target Concentration (C_T)	0.03	mg/l	Origin of C_T:	EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Benzene		from Level 1
Target Concentration	C_T	3.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	6.40E-01	mg/l	*Highest concentration WS203*
Half life for degradation of contaminant in water	$t_{1/2}$	7.30E+02	days	*conserv. Literature v alues*
Calculated decay rate	λ	9.50E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.04E+00	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	1.56E+01	fraction
Decay rate used	λ	9.50E-04	d^{-1}
Rate of contaminant flow due to retardation	u	2.56E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	2.98E-06	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**2.14E+05**	

Remedial Targets

Remedial Target		**6.43E+03**	**mg/l**
Ogata Banks			
Distance to compliance point		**480**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**2.98E-06**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	7.94E+01	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{OC,n}$		l/kg
Sorption coefficient for ionised species	$K_{OC,I}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.04E+00	l/kg

Define dispersivity (click brown cell and use pull down list)

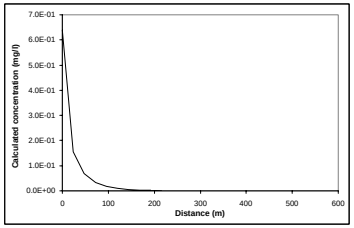
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	6.4E-01
24.0	1.54E-01
48.0	6.88E-02
72.0	3.43E-02
96.0	1.79E-02
120.0	9.66E-03
144.0	5.32E-03
168.0	2.98E-03
192.0	1.69E-03
216.0	9.65E-04
240.0	5.57E-04
264.0	3.24E-04
288.0	1.89E-04
312.0	1.11E-04
336.0	6.57E-05
360.0	3.90E-05
384.0	2.32E-05
408.0	1.38E-05
432.0	8.27E-06
456.0	4.96E-06
480.0	2.98E-06

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	23rd April 2009		Version:	1
Contaminant	Naphthalene			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	SWAD

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Naphthalene		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.90E+00	mg/l	*Highest concentration Area A*
Half life for degradation of contaminant in water	$t_{1/2}$	3.00E+01	days	*Literature value*
Calculated decay rate	λ	2.31E-02	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.47E+01	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	1.20E+02	fraction
Decay rate used	λ	2.31E-02	d^{-1}
Rate of contaminant flow due to retardation	u	3.35E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.61E-78	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.80E+78**	

Remedial Targets

Remedial Target		**1.80E+76**	**mg/l**
Ogata Banks			
Distance to compliance point		**480**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**1.61E-78**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	6.45E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	2.47E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

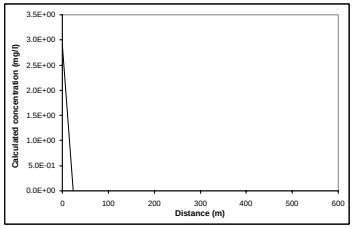
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	23rd April 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.9E+00
24.0	1.58E-04
48.0	1.59E-08
72.0	1.79E-12
96.0	2.11E-16
120.0	2.57E-20
144.0	3.20E-24
168.0	4.04E-28
192.0	5.17E-32
216.0	6.68E-36
240.0	8.70E-40
264.0	1.14E-43
288.0	1.51E-47
312.0	2.00E-51
336.0	2.67E-55
360.0	3.57E-59
384.0	4.80E-63
408.0	6.47E-67
432.0	8.74E-71
456.0	1.18E-74
480.0	1.61E-78

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Xylene			
Target Concentration (C_T)	0.03	mg/l	Origin of C_T:	EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
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Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Xylene		from Level 1
Target Concentration	C_T	3.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.69E-01	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	3.20E+01	days	*conserv. Literature v alues*
Calculated decay rate	λ	2.17E-02	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E+00	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E-01	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.87E+01	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	9.09E+01	fraction
Decay rate used	λ	2.17E-02	d^{-1}
Rate of contaminant flow due to retardation	u	4.40E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.94E-67	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**8.71E+65**	

Remedial Targets

Remedial Target		**2.61E+64**	**mg/l**
Ogata Banks			
Distance to compliance point		**480**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**1.94E-67**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient — Kd — l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer — foc — 3.83E-02 — fraction

Organic carbon partition coefficient — Koc — 4.89E+02 — l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species — $K_{OC,n}$ — l/kg

Sorption coefficient for ionised species — $K_{OC,I}$ — l/kg

pH value — pH

acid dissociation constant — pKa

Fraction of organic carbon in aquifer — foc — fraction

Soil water partition coefficient — Kd — 1.87E+01 — l/kg

Define dispersivity (click brown cell and use pull down list)

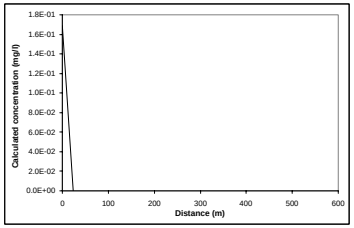
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-01	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	1.7E-01
24.0	3.80E-05
48.0	1.58E-08
72.0	7.34E-12
96.0	3.58E-15
120.0	1.80E-18
144.0	9.22E-22
168.0	4.81E-25
192.0	2.54E-28
216.0	1.36E-31
240.0	7.30E-35
264.0	3.95E-38
288.0	2.16E-41
312.0	1.18E-44
336.0	6.50E-48
360.0	3.59E-51
384.0	1.99E-54
408.0	1.11E-57
432.0	6.19E-61
456.0	3.46E-64
480.0	1.94E-67

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Alipahtic EC8-EC10			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Alipahtic EC8-EC10		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.80E+00	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	7.12E+02	days	*conserv. Literature v alues*
Calculated decay rate	λ	9.74E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.21E+03	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	5.81E+03	fraction
Decay rate used	λ	9.74E-04	d^{-1}
Rate of contaminant flow due to retardation	u	6.88E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.23E-112	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**2.28E+112**	

Remedial Targets

Remedial Target	**2.28E+110**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**480**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**1.23E-112**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	3.16E+04	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.21E+03	l/kg

Define dispersivity (click brown cell and use pull down list)

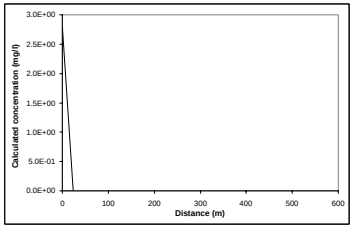
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-01	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.8E+00
24.0	3.01E-06
48.0	5.97E-12
72.0	1.32E-17
96.0	3.08E-23
120.0	7.40E-29
144.0	1.81E-34
168.0	4.52E-40
192.0	1.14E-45
216.0	2.91E-51
240.0	7.47E-57
264.0	1.93E-62
288.0	5.03E-68
312.0	1.32E-73
336.0	3.46E-79
360.0	9.14E-85
384.0	2.42E-90
408.0	6.43E-96
432.0	1.71E-101
456.0	4.58E-107
480.0	1.23E-112

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Alipahtic EC10-EC12			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Alipahtic EC10-EC12		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	4.90E+01	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	1.75E+03	days	*conserv. Literature v alues*
Calculated decay rate	λ	3.96E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	9.62E+03	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	4.62E+04	fraction
Decay rate used	λ	3.96E-04	d^{-1}
Rate of contaminant flow due to retardation	u	8.66E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.15E-201	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**4.26E+202**	

Remedial Targets

Remedial Target		**4.26E+200**	**mg/l**
Ogata Banks			
Distance to compliance point		**480**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**1.15E-201**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	2.51E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{OC,n}$		l/kg
Sorption coefficient for ionised species	$K_{OC,I}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	9.62E+03	l/kg

Define dispersivity (click brown cell and use pull down list)

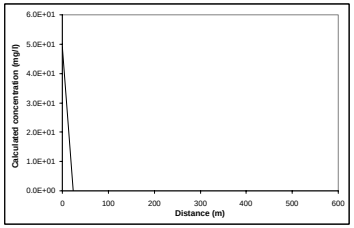
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	4.9E+01
24.0	1.61E-09
48.0	9.81E-20
72.0	6.67E-30
96.0	4.76E-40
120.0	3.50E-50
144.0	2.63E-60
168.0	2.01E-70
192.0	1.55E-80
216.0	1.21E-90
240.0	9.56E-101
264.0	7.59E-111
288.0	6.06E-121
312.0	4.86E-131
336.0	3.92E-141
360.0	3.17E-151
384.0	2.57E-161
408.0	2.09E-171
432.0	1.71E-181
456.0	1.40E-191
480.0	1.15E-201

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Alipahtic EC12-EC16			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Alipahtic EC12-EC16		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.80E+02	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	1.75E+03	days	*conserv. Literature v alues*
Calculated decay rate	λ	3.96E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.92E+05	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	9.21E+05	fraction
Decay rate used	λ	3.96E-04	d^{-1}
Rate of contaminant flow due to retardation	u	4.34E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance poin**	

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	5.01E+06	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{OC,n}$		l/kg
Sorption coefficient for ionised species	$K_{OC,I}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.92E+05	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

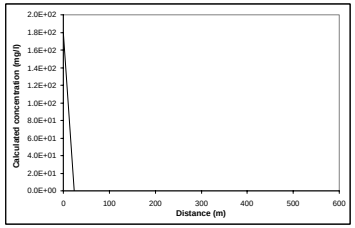
For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Remedial Targets

Remedial Target	No impact	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**480**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	1.8E+02
24.0	3.25E-44
48.0	1.09E-89
72.0	4.05E-135
96.0	1.59E-180
120.0	6.41E-226
144.0	2.64E-271
168.0	0.00E+00
192.0	0.00E+00
216.0	0.00E+00
240.0	0.00E+00
264.0	0.00E+00
288.0	0.00E+00
312.0	0.00E+00
336.0	0.00E+00
360.0	0.00E+00
384.0	0.00E+00
408.0	0.00E+00
432.0	0.00E+00
456.0	0.00E+00
480.0	0.00E+00

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Alipahtic EC16-EC21			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Alipahtic EC16-EC21		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.30E+02	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	4.50E+03	days	*conserv. Literature v alues*
Calculated decay rate	λ	1.54E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.42E+07	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	1.16E+08	fraction
Decay rate used	λ	1.54E-04	d^{-1}
Rate of contaminant flow due to retardation	u	3.45E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance poin**	

Remedial Targets

Remedial Target	No impact	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**480**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{OC,n}$		l/kg
Sorption coefficient for ionised species	$K_{OC,I}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	2.42E+07	l/kg

Define dispersivity (click brown cell and use pull down list)

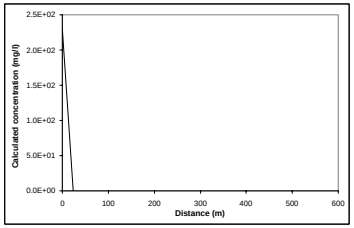
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.3E+02
24.0	0.00E+00
48.0	0.00E+00
72.0	0.00E+00
96.0	0.00E+00
120.0	0.00E+00
144.0	0.00E+00
168.0	0.00E+00
192.0	0.00E+00
216.0	0.00E+00
240.0	0.00E+00
264.0	0.00E+00
288.0	0.00E+00
312.0	0.00E+00
336.0	0.00E+00
360.0	0.00E+00
384.0	0.00E+00
408.0	0.00E+00
432.0	0.00E+00
456.0	0.00E+00
480.0	0.00E+00

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Alipahtic EC21-EC35			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Alipahtic EC21-EC35		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.20E+01	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	4.50E+03	days	*conserv. Literature v alues*
Calculated decay rate	λ	1.54E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.42E+07	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	1.16E+08	fraction
Decay rate used	λ	1.54E-04	d^{-1}
Rate of contaminant flow due to retardation	u	3.45E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance poin**	

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**480**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{OC,n}$		l/kg
Sorption coefficient for ionised species	$K_{OC,I}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	2.42E+07	l/kg

Define dispersivity (click brown cell and use pull down list)

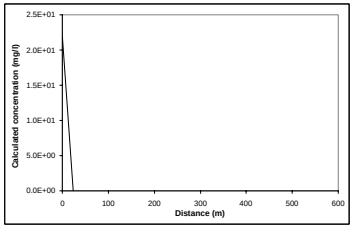
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	**2.2E+01**
24.0	**0.00E+00**
48.0	**0.00E+00**
72.0	**0.00E+00**
96.0	**0.00E+00**
120.0	**0.00E+00**
144.0	**0.00E+00**
168.0	**0.00E+00**
192.0	**0.00E+00**
216.0	**0.00E+00**
240.0	**0.00E+00**
264.0	**0.00E+00**
288.0	**0.00E+00**
312.0	**0.00E+00**
336.0	**0.00E+00**
360.0	**0.00E+00**
384.0	**0.00E+00**
408.0	**0.00E+00**
432.0	**0.00E+00**
456.0	**0.00E+00**
480.0	**0.00E+00**

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Aromatic EC8-EC10			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
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Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Aromatic EC8-EC10		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	3.60E+00	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	7.12E+02	days	*conserv. Literature v alues*
Calculated decay rate	λ	9.74E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	6.07E+01	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	2.92E+02	fraction
Decay rate used	λ	9.74E-04	d^{-1}
Rate of contaminant flow due to retardation	u	1.37E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	8.74E-25	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**4.12E+24**	

Remedial Targets

Remedial Target		**4.12E+22**	**mg/l**
Ogata Banks			
Distance to compliance point		**480**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**8.74E-25**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient — Kd — l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer — foc — 3.83E-02 — fraction

Organic carbon partition coefficient — Koc — 1.58E+03 — l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species — $K_{oc,n}$ — l/kg

Sorption coefficient for ionised species — $K_{oc,i}$ — l/kg

pH value — pH

acid dissociation constant — pKa

Fraction of organic carbon in aquifer — foc — fraction

Soil water partition coefficient — Kd — 6.07E+01 — l/kg

Define dispersivity (click brown cell and use pull down list)

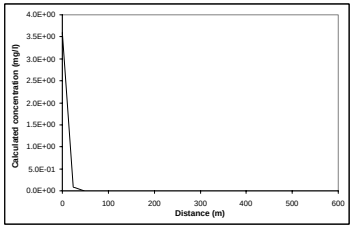
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	3.6E+00
24.0	9.42E-02
48.0	4.56E-03
72.0	2.47E-04
96.0	1.40E-05
120.0	8.21E-07
144.0	4.91E-08
168.0	2.98E-09
192.0	1.83E-10
216.0	1.14E-11
240.0	7.15E-13
264.0	4.51E-14
288.0	2.86E-15
312.0	1.83E-16
336.0	1.17E-17
360.0	7.55E-19
384.0	4.88E-20
408.0	3.16E-21
432.0	2.05E-22
456.0	1.34E-23
480.0	8.74E-25

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Aromatic EC10-EC12			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
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The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Aromatic EC10-EC12		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.90E+01	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	1.75E+03	days	*conserv. Literature v alues*
Calculated decay rate	λ	3.96E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	9.62E+01	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	4.63E+02	fraction
Decay rate used	λ	3.96E-04	d^{-1}
Rate of contaminant flow due to retardation	u	8.65E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	6.82E-19	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**4.25E+19**	

Remedial Targets

Remedial Target		**4.25E+17**	**mg/l**
Ogata Banks			
Distance to compliance point		**480**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**6.82E-19**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	2.51E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	9.62E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

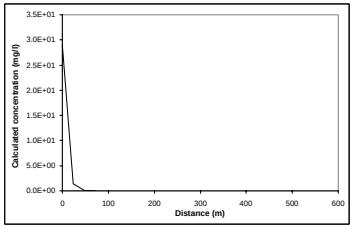
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.9E+01
24.0	1.35E+00
48.0	1.16E-01
72.0	1.11E-02
96.0	1.12E-03
120.0	1.17E-04
144.0	1.24E-05
168.0	1.34E-06
192.0	1.46E-07
216.0	1.61E-08
240.0	1.79E-09
264.0	2.01E-10
288.0	2.27E-11
312.0	2.57E-12
336.0	2.92E-13
360.0	3.34E-14
384.0	3.83E-15
408.0	4.41E-16
432.0	5.09E-17
456.0	5.88E-18
480.0	6.82E-19

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Aromatic EC12-EC16			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
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R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Aromatic EC12-EC16		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.30E+01	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	1.75E+03	days	*conserv. Literature v alues*
Calculated decay rate	λ	3.96E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.92E+02	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	9.22E+02	fraction
Decay rate used	λ	3.96E-04	d^{-1}
Rate of contaminant flow due to retardation	u	4.34E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	2.41E-27	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**9.56E+27**	

Remedial Targets

Remedial Target	**9.56E+25**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**480**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**2.41E-27**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	5.01E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{OC,n}$		l/kg
Sorption coefficient for ionised species	$K_{OC,I}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.92E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

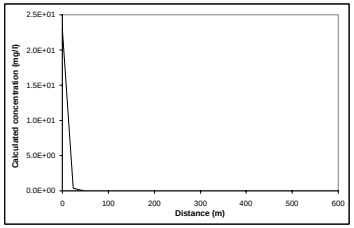
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.3E+01
24.0	4.09E-01
48.0	1.34E-02
72.0	4.94E-04
96.0	1.90E-05
120.0	7.56E-07
144.0	3.07E-08
168.0	1.26E-09
192.0	5.28E-11
216.0	2.23E-12
240.0	9.48E-14
264.0	4.06E-15
288.0	1.75E-16
312.0	7.59E-18
336.0	3.30E-19
360.0	1.44E-20
384.0	6.33E-22
408.0	2.78E-23
432.0	1.23E-24
456.0	5.43E-26
480.0	2.41E-27

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Aromatic EC16-EC21			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Aromatic EC16-EC21		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.30E+01	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	4.50E+03	days	*conserv. Literature v alues*
Calculated decay rate	λ	1.54E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	6.05E+02	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	2.91E+03	fraction
Decay rate used	λ	1.54E-04	d^{-1}
Rate of contaminant flow due to retardation	u	1.38E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	2.05E-30	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.12E+31**	

Remedial Targets

Remedial Target	**1.12E+29**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**480**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**2.05E-30**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	1.58E+04	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	6.05E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

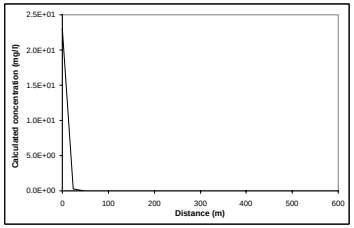
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-02	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.3E+01
24.0	2.87E-01
48.0	6.63E-03
72.0	1.71E-04
96.0	4.63E-06
120.0	1.29E-07
144.0	3.68E-09
168.0	1.07E-10
192.0	3.13E-12
216.0	9.26E-14
240.0	2.77E-15
264.0	8.33E-17
288.0	2.52E-18
312.0	7.67E-20
336.0	2.34E-21
360.0	7.19E-23
384.0	2.22E-24
408.0	6.84E-26
432.0	2.12E-27
456.0	6.59E-29
480.0	2.05E-30

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Area A - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	7th May 2009		Version:	1
Contaminant	Aromatic EC21-EC35			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS (conservative screen for individual fractions)

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Aromatic EC21-EC35		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	6.60E+00	mg/l	*Highest concentration WS205*
Half life for degradation of contaminant in water	$t_{1/2}$	4.50E+03	days	*conserv. Literature v alues*
Calculated decay rate	λ	1.54E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	*widest point Area A*
Plume thickness at source	Sy	2.40E+00	m	*CP1 site groundwater levels to base*
Saturated aquifer thickness	da	1.50E+01	m	*CP1 site made ground and Till*
Bulk density of aquifer materials	ρ	1.20E+00	g/cm^3	*CLEA v1.04 for sandy clay l oam*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G as precaution*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical unconsolodated deposits*
Distance to compliance point	x	4.80E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	4.83E+03	l/kg	*see options*
Longitudinal dispersivity	ax	4.80E+01	m	*see options*
Transverse dispersivity	az	4.80E+00	m	*see options*
Vertical dispersivity	ay	4.80E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E-01	m/d
Retardation factor	Rf	2.32E+04	fraction
Decay rate used	λ	1.54E-04	d^{-1}
Rate of contaminant flow due to retardation	u	1.73E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	5.99E-89	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.10E+89**	

Remedial Targets

Remedial Target		**1.10E+87**	**mg/l**
Ogata Banks			
Distance to compliance point		**480**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**5.99E-89**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.83E-02	fraction
Organic carbon partition coefficient	Koc	1.26E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	4.83E+03	l/kg

Define dispersivity (click brown cell and use pull down list)

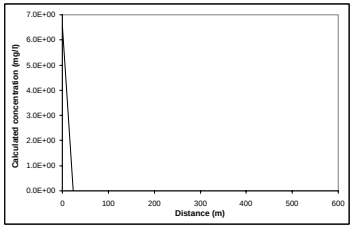
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.80E+01	8.98E-01	m
Transverse dispersivity	**az**	0.00E+00	4.80E+00	8.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.80E-01	8.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Area A - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	7th May 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	6.6E+00
24.0	1.04E-04
48.0	3.02E-09
72.0	9.82E-14
96.0	3.35E-18
120.0	1.18E-22
144.0	4.23E-27
168.0	1.54E-31
192.0	5.70E-36
216.0	2.13E-40
240.0	8.02E-45
264.0	3.04E-49
288.0	1.16E-53
312.0	4.45E-58
336.0	1.71E-62
360.0	6.62E-67
384.0	2.57E-71
408.0	1.00E-75
432.0	3.90E-80
456.0	1.53E-84
480.0	5.99E-89

Landfill (River Irk Receptor) - Assumed Perched Waters in Sand & Gravel Overlying Major Aquifer			
Equations Used to Generate Remedial Targets[14]			Ogata Banks
			Dispersion: simulate vertical dispersion in 1 direction (EA default)
			Degradation: Apply to pollutants in all phases
Parameter	**Value**	**Unit**	**Reference**
Width of Plume in Aquifer at Source	150	m	Assumed to be width of site in the south
Plume Thickness at Source	3.3	m	Max groundwater levels to base of borehole in landfill (CP4).
Saturated Aquifer Thickness	10	m	Aquifer thickness assumed to be the Sand and Gravel in CP6 (not bottomed so doubled)
Bulk Density of Aquifer Material	2.02	g/cm^3	Typical Sand and Gravel[15]
Effective Porosity of Aquifer	0.25	dim	Typical medium gravel[15]
Hydraulic Gradient	1E-01	dim	Site info from shallow, perched groundwater (range 0.09-0.13)
Hydraulic Conductivity of Aquifer	10	m/d	Ranges in Sand and Gravel[15] between 10 and 100. Lower assumed since Sands & Gravel likely to be replaced by Till in the landfill towards the River Irk.
Distance to Compliance Point	320	m	Distance to the River Irk from highest concentrations found in the landfill and calculated groundwater flow direction
Ammonium (Physical-Chemical Parameters)			
Target Concentration	0.5	mg/l	UKDWS
Initial Contaminant Concentration	20	mg/l	Highest concentration from CP6
Degradation Half Life	805	days	Literature search by EA[16] Value chosen from studies in Permo-Triassic sandstone overlain by a landfill. Approximate 40 studies ranged 13-2190 days.
Soil Partition Coefficient (Kd)	0.12	l/kg	Literature search by EA[16] Value chosen from studies in Permo-Triassic sandstone (lowest value assumed from studies)
Sulphate (Physical-Chemical Parameters)			
Target Concentration	250	mg/l	UKDWS
Initial Contaminant Concentration	2100	mg/l	Highest concentration from CP6
Degradation Half Life	912	days	Literature value based on landfill case study at Villa Farm, Hooton[17]
Soil Partition Coefficient (Kd)	0.16	l/kg	Literature value based on dimethyl sulphate[18] for aerobic environment (limited information for other compounds)

[14] EA (2006). "Remedial Targets Methodology: Hydrological Risk Assessment for Land Contamination."
[15] Brasington, R (1993). "Field Hydrology." Second Edition. John Wiley and Sons (ISBN 0-471-97347-5.
[16] EA (2003). "Review of Ammonium Attenuation in Soil and Groundwater." NGWCLC report NC/02/49
[17] Williams, GM (1985). "Assessing Groundwater Pollution from Landfill Sites: Results of Case Studies." Hydrogeology in the Service of Man, Memoirs of the 18th congress of the international Association of hydrologists, Cambridge 1985.
[18] RIVM (1999). " Dimethyl Sulphate: Risk Assessment."

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Landfill Area - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	23rd April 2009		Version:	1
Contaminant	Ammonium			
Target Concentration (C_T)	0.5	mg/l	Origin of C_T:	UKDWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Ammonium		from Level 1
Target Concentration	C_T	5.00E-01	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.00E+01	mg/l	*Highest conc.north CP6*
Half life for degradation of contaminant in water	$t_{1/2}$	8.05E+02	days	*Literature v alue*
Calculated decay rate	λ	8.61E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.50E+02	m	*widest point (major Aquifer)*
Plume thickness at source	Sy	3.30E+00	m	*Max groundwater level (CP4)*
Saturated aquifer thickness	da	1.00E+01	m	*double measured S&G thick (CP6)*
Bulk density of aquifer materials	ρ	2.02E+00	g/cm^3	*Typical S&G*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+01	m/d	*Typical S&G*
Distance to compliance point	x	3.20E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.20E-01	l/kg	*see options*
Longitudinal dispersivity	ax	3.20E+01	m	*see options*
Transverse dispersivity	az	3.20E+00	m	*see options*
Vertical dispersivity	ay	3.20E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E+00	m/d
Retardation factor	Rf	1.97E+00	fraction
Decay rate used	λ	8.61E-04	d^{-1}
Rate of contaminant flow due to retardation	u	2.03E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	2.88E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**6.95E+00**	

Remedial Targets

Remedial Target		**3.47E+00**	**mg/l**
Ogata Banks			
Distance to compliance point		**320**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**2.88E+00**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient — Kd — 1.20E-01 — l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer — foc — fraction

Organic carbon partition coefficient — Koc — l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species — $K_{OC,n}$ — l/kg

Sorption coefficient for ionised species — $K_{OC,I}$ — l/kg

pH value — pH

acid dissociation constant — pKa

Fraction of organic carbon in aquifer — foc — fraction

Soil water partition coefficient	Kd	1.20E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

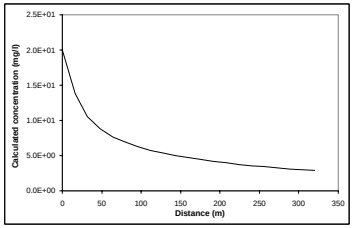
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	0.00E+00	3.20E+01	7.62E-02	m
Transverse dispersivity	**az**	0.00E+00	3.20E+00	7.62E-01	m
Vertical dispersivity	**ay**	0.00E+00	3.20E-01	7.62E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Landfill Area - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	23rd April 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.0E+01
16.0	1.39E+01
32.0	1.05E+01
48.0	8.79E+00
64.0	7.67E+00
80.0	6.87E+00
96.0	6.25E+00
112.0	5.76E+00
128.0	5.35E+00
144.0	5.00E+00
160.0	4.69E+00
176.0	4.42E+00
192.0	4.18E+00
208.0	3.96E+00
224.0	3.77E+00
240.0	3.59E+00
256.0	3.42E+00
272.0	3.27E+00
288.0	3.13E+00
304.0	3.00E+00
320.0	2.88E+00

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Landfill Area - Receptor is River Irk)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	23rd April 2009		Version:	1
Contaminant	sulphate			
Target Concentration (C_T)	400	mg/l	Origin of C_T:	EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		sulphate		from Level 1
Target Concentration	C_T	4.00E+02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.10E+03	mg/l	*Highest concentration onsite(CP6)*
Half life for degradation of contaminant in water	$t_{1/2}$	9.12E+02	days	*Literature v alues*
Calculated decay rate	λ	7.60E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.50E+02	m	*widest point (major Aquifer)*
Plume thickness at source	Sy	3.30E+00	m	*Max groundwater level (CP4)*
Saturated aquifer thickness	da	1.00E+01	m	*double measured S&G thick.CP6)*
Bulk density of aquifer materials	ρ	2.02E+00	g/cm^3	*Typical S&G*
Effective porosity of aquifer	n	2.50E-01	fraction	*Typical S&G*
Hydraulic gradient	i	1.00E-01	fraction	*site info from shallow groundwater*
Hydraulic conductivity of aquifer	K	1.00E+01	m/d	*Typical S&G*
Distance to compliance point	x	3.20E+02	m	*distance to river from highest conc.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.60E-01	l/kg	*see options*
Longitudinal dispersivity	ax	3.20E+01	m	*see options*
Transverse dispersivity	az	3.20E+00	m	*see options*
Vertical dispersivity	ay	3.20E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	4.00E+00	m/d
Retardation factor	Rf	2.29E+00	fraction
Decay rate used	λ	7.60E-04	d^{-1}
Rate of contaminant flow due to retardation	u	1.74E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	3.01E+02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**6.97E+00**	

Remedial Targets

Remedial Target	**2.79E+03**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**320**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**3.01E+02**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	1.60E-01	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{OC,n}$		l/kg
Sorption coefficient for ionised species	$K_{OC,I}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.60E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

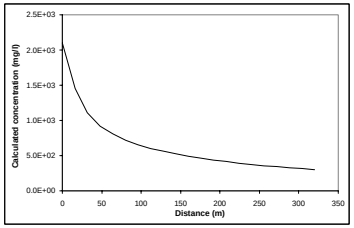
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	3.20E+01	7.62E-02	m
Transverse dispersivity	**az**	0.00E+00	3.20E+00	7.62E-01	m
Vertical dispersivity	**ay**	0.00E+00	3.20E-01	7.62E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Landfill Area - Receptor is River Irk)
Completed by:	Paul Quimby
Date:	23rd April 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.1E+03
16.0	1.45E+03
32.0	1.11E+03
48.0	9.22E+02
64.0	8.05E+02
80.0	7.20E+02
96.0	6.56E+02
112.0	6.04E+02
128.0	5.61E+02
144.0	5.24E+02
160.0	4.92E+02
176.0	4.63E+02
192.0	4.38E+02
208.0	4.15E+02
224.0	3.94E+02
240.0	3.76E+02
256.0	3.58E+02
272.0	3.42E+02
288.0	3.28E+02
304.0	3.14E+02
320.0	3.01E+02

Landfill (Major Aquifer to Potable Water Supply Receptor) - Assumed Sandstone Major Aquifer			
Equations Used to Generate Remedial Targets[19]			Ogata Banks
			Dispersion: simulate vertical dispersion in 1 direction (EA default)
			Degradation: Apply to pollutants in all phases
Parameter	**Value**	**Unit**	**Reference**
Width of Plume in Aquifer at Source	150	m	Assumed to be width of site in the south
Plume Thickness at Source	3.3	m	Max groundwater levels to base of borehole in landfill (CP4).
Saturated Aquifer Thickness	150	m	The Collyhurst Sandstone ranges between 0-300m in Greater Manchester[20] (mid-range assumed), due to no nearby historical boreholes
Bulk Density of Aquifer Material	2.3	g/cm^3	Typical sandstone[21]
Effective Porosity of Aquifer	0.15	dim	Typical sandstone[21]
Hydraulic Gradient	3E-02	dim	Assumed, since not allowed to drill into the aquifer (based on LKA experience)
Hydraulic Conductivity of Aquifer	1	m/d	Ranges in sandstone[21] between 10^{-4} and 10^{-1} (worst case assumed)
Distance to Compliance Point	450	m	Half distance to the potable water supply 900m west of the site
Ammonium (Physical-Chemical Parameters)			
Target Concentration	0.5	mg/l	UKDWS
Initial Contaminant Concentration	20	mg/l	Highest concentration from CP6
Degradation Half Life	805	days	Literature search by EA[22] Value chosen from studies in Permo-Triassic sandstone overlain by a landfill. Approximate 40 studies ranged 13-2190 days.
Soil Partition Coefficient (Kd)	0.12	l/kg	Literature search by EA[22] Value chosen from studies in Permo-Triassic sandstone (lowest value assumed)
Sulphate (Physical-Chemical Parameters)			
Target Concentration	250	mg/l	UKDWS
Initial Contaminant Concentration	2100	mg/l	Highest concentration from CP6
Degradation Half Life	912	days	Literature value based on landfill case study and Villa Farm, Hooton[23]
Soil Partition Coefficient (Kd)	0.16	l/kg	Literature value based on dimethyl sulphate[24] for aerobic environment (limited information for other compounds)
Arsenic (Physical-Chemical Parameters)			
Target Concentration	10	µg/l	UKDWS
Initial Contaminant Concentration	33	µg/l	Highest concentration from CP6
Degradation Half Life	1E+99	days	Assumed no degradation.
Soil Partition Coefficient (Kd)	0.5	l/kg	Literature value based on Thorne PRISM report for sand[25]

[19] EA (2006). "Remedial Targets Methodology: Hydrological Risk Assessment for Land Contamination."
[20] EA (2003). " The Permo-Triassic Sandstones of Manchester and East Cheshire." Baseline Report Series 8.
[21] Brasington, R (1993). "Field Hydrology." Second Edition. John Wiley and Sons (ISBN 0-471-97347-5.
[22] EA (2003). "Review of Ammonium Attenuation in Soil and Groundwater." NGWCLC report NC/02/49
[23] Williams, GM (1985). "Assessing Groundwater Pollution from Landfill Sites: Results of Case Studies." Hydrogeology in the Service of Man, Memoirs of the 18th congress of the international Association of hydrologists, Cambridge 1985.
[24] RIVM (1999). " Dimethyl Sulphate: Risk Assessment."
[25] Thorne, M; Maul, P; Robinson, P (2005). "The PRISM Foodchain Modelling Software: Parameter Values for the Soil/Plant Model." QRS-1198A-3, version 1.1. London:FSA.

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Landfill Area - Major Aquifer to Potable Water Supply Receptor)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	23rd April 2009		Version:	1
Contaminant	Ammonium			
Target Concentration (C_T)	0.5	mg/l	Origin of C_T:	UKDWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Ammonium		from Level 1
Target Concentration	C_T	5.00E-01	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.00E+01	mg/l	*Highest conc. In landfill (CP6)*
Half life for degradation of contaminant in water	$t_{1/2}$	8.05E+02	days	*Literature v alue*
Calculated decay rate	λ	8.61E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.50E+02	m	*widest point (major Aquifer)*
Plume thickness at source	Sy	3.30E+00	m	*Max groundwater level (CP4)*
Saturated aquifer thickness	da	1.50E+02	m	*Typical Collyhurst Sandstone in Area*
Bulk density of aquifer materials	ρ	2.30E+00	g/cm^3	*Typical Sandstone*
Effective porosity of aquifer	n	1.50E-01	fraction	*Typical Sandstone*
Hydraulic gradient	i	3.00E-02	fraction	*Assumed (not allowed to drill in Aquifer*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical Sandstone*
Distance to compliance point	x	4.50E+02	m	*Half distance to potable supply*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.20E-01	l/kg	*see options*
Longitudinal dispersivity	ax	4.50E+01	m	*see options*
Transverse dispersivity	az	4.50E+00	m	*see options*
Vertical dispersivity	ay	4.50E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	2.00E-01	m/d
Retardation factor	Rf	2.84E+00	fraction
Decay rate used	λ	8.61E-04	d^{-1}
Rate of contaminant flow due to retardation	u	7.04E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	3.84E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**5.21E+02**	

Remedial Targets

Remedial Target		**2.61E+02**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**450**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**3.84E-02**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	1.20E-01	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.20E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

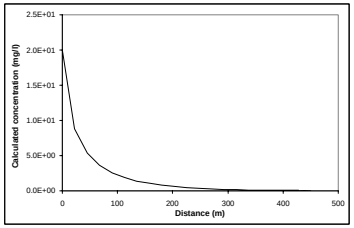
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.50E+01	8.75E-02	m
Transverse dispersivity	**az**	0.00E+00	4.50E+00	8.75E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.50E-01	8.75E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Landfill Area - Major Aquifer to Potable Water Supply Receptor)
Completed by:	Paul Quimby
Date:	23rd April 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.0E+01
22.5	8.81E+00
45.0	5.34E+00
67.5	3.62E+00
90.0	2.58E+00
112.5	1.88E+00
135.0	1.40E+00
157.5	1.05E+00
180.0	7.92E-01
202.5	6.03E-01
225.0	4.61E-01
247.5	3.55E-01
270.0	2.74E-01
292.5	2.12E-01
315.0	1.65E-01
337.5	1.29E-01
360.0	1.01E-01
382.5	7.88E-02
405.0	6.19E-02
427.5	4.87E-02
450.0	3.84E-02

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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Liability: The Environment Agency does not promise that the worksheet will provide any particular facilities or functions. You must ensure that the worksheet meets your needs and you remain solely responsible for the competent use of the worksheet. You are entirely responsible for the consequences of any use of the worksheet and the Agency provides no warranty about the fitness for purpose or performance of any part of the worksheet. We do not promise that the media will always be free from defects, computer viruses, software locks or other similar code or that the operation of the worksheet will be uninterrupted or error free. You should carry out all necessary virus checks prior to installing on your computing system.

IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Landfill Area - Major Aquifer to Potable Water Supply Receptor)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	23rd April 2009		Version:	1
Contaminant	sulphate			
Target Concentration (C_T)	250	mg/l	Origin of C_T:	UKDWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		sulphate		from Level 1
Target Concentration	C_T	2.50E+02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.10E+03	mg/l	*Highest conc. In landfill (CP6)*
Half life for degradation of contaminant in water	$t_{1/2}$	9.12E+02	days	*Literature v alue*
Calculated decay rate	λ	7.60E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.50E+02	m	*widest point (major Aquifer)*
Plume thickness at source	Sy	3.30E+00	m	*Max groundwater level (CP4)*
Saturated aquifer thickness	da	1.50E+02	m	*Typical Collyhurst Sandstone in Area*
Bulk density of aquifer materials	ρ	2.30E+00	g/cm^3	*Typical Sandstone*
Effective porosity of aquifer	n	1.50E-01	fraction	*Typical Sandstone*
Hydraulic gradient	i	3.00E-02	fraction	*Assumed (not allowed to drill in Aquifer*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical Sandstone*
Distance to compliance point	x	4.50E+02	m	*Half distance to potable supply*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.60E-01	l/kg	*see options*
Longitudinal dispersivity	ax	4.50E+01	m	*see options*
Transverse dispersivity	az	4.50E+00	m	*see options*
Vertical dispersivity	ay	4.50E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	2.00E-01	m/d
Retardation factor	Rf	3.45E+00	fraction
Decay rate used	λ	7.60E-04	d^{-1}
Rate of contaminant flow due to retardation	u	5.79E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	3.22E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**6.51E+02**	

Remedial Targets

Remedial Target		**1.63E+05**	**mg/l**
Ogata Banks			
Distance to compliance point		**450**	**m**
Concentration of contaminant at compliance point	C_{ED}/C_0	**3.22E+00**	**mg/l**
after		**1.0E+100**	**days**

For comparison with measured groundwater concentration.

Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	1.60E-01	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{OC,n}$		l/kg
Sorption coefficient for ionised species	$K_{OC,I}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.60E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

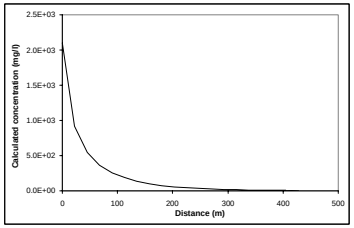
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.50E+01	8.75E-01	m
Transverse dispersivity	**az**	0.00E+00	4.50E+00	8.75E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.50E-01	8.75E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Landfill Area - Major Aquifer to Potable Water Supply Receptor)
Completed by:	Paul Quimby
Date:	23rd April 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.1E+03
22.5	9.15E+02
45.0	5.48E+02
67.5	3.68E+02
90.0	2.59E+02
112.5	1.87E+02
135.0	1.37E+02
157.5	1.02E+02
180.0	7.60E+01
202.5	5.72E+01
225.0	4.33E+01
247.5	3.30E+01
270.0	2.52E+01
292.5	1.93E+01
315.0	1.48E+01
337.5	1.14E+01
360.0	8.84E+00
382.5	6.85E+00
405.0	5.32E+00
427.5	4.14E+00
450.0	3.22E+00

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: October 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment				
Site Name:	IWHC (Landfill Area - Major Aquifer to Potable Water Supply Receptor)			
Site Address:	Manchester			
Completed by:	Paul Quimby			
Date:	23rd April 2009		Version:	1
Contaminant	Arsenic			
Target Concentration (C_T)	0.01	mg/l	Origin of C_T:	UKDWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Arsenic		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in HRA publication

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	3.30E-02	mg/l	*Highest conc. In landfill (CP6)*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+99	days	*No degredation*
Calculated decay rate	λ	6.93E-100	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.50E+02	m	*widest point (major Aquifer)*
Plume thickness at source	Sy	3.30E+00	m	*Max groundwater level (CP4)*
Saturated aquifer thickness	da	1.50E+02	m	*Typical Collyhurst Sandstone in Area*
Bulk density of aquifer materials	ρ	2.30E+00	g/cm^3	*Typical Sandstone*
Effective porosity of aquifer	n	1.50E-01	fraction	*Typical Sandstone*
Hydraulic gradient	i	3.00E-02	fraction	*Assumed (not allowed to drill in Aquifer*
Hydraulic conductivity of aquifer	K	1.00E+00	m/d	*Typical Sandstone*
Distance to compliance point	x	4.50E+02	m	*Half distance to potable supply*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*default*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*default*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	5.00E-01	l/kg	*see options*
Longitudinal dispersivity	ax	4.50E+01	m	*see options*
Transverse dispersivity	az	4.50E+00	m	*see options*
Vertical dispersivity	ay	4.50E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	2.00E-01	m/d
Retardation factor	Rf	8.67E+00	fraction
Decay rate used	λ	6.93E-100	d^{-1}
Rate of contaminant flow due to retardation	u	2.31E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	3.27E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.01E+01**	

Remedial Targets

Remedial Target	**1.01E-01**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**450**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**3.27E-03**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	5.00E-01	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	5.00E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

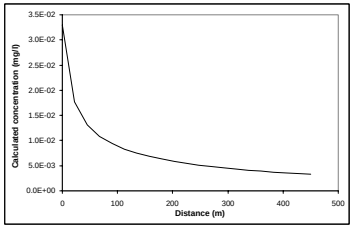
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value Xu & Eckstein		
Longitudinal dispersivity	**ax**	0.00E+00	4.50E+01	8.75E-02	m
Transverse dispersivity	**az**	0.00E+00	4.50E+00	8.75E-01	m
Vertical dispersivity	**ay**	0.00E+00	4.50E-01	8.75E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

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Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	IWHC (Landfill Area - Major Aquifer to Potable Water Supply Receptor)
Completed by:	Paul Quimby
Date:	23rd April 2009
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	3.3E-02
22.5	1.77E-02
45.0	1.31E-02
67.5	1.08E-02
90.0	9.36E-03
112.5	8.33E-03
135.0	7.52E-03
157.5	6.87E-03
180.0	6.33E-03
202.5	5.87E-03
225.0	5.47E-03
247.5	5.13E-03
270.0	4.82E-03
292.5	4.55E-03
315.0	4.31E-03
337.5	4.10E-03
360.0	3.90E-03
382.5	3.72E-03
405.0	3.56E-03
427.5	3.41E-03
450.0	3.27E-03

APPENDIX E – GAS AND VAPOUR MEMBRANE VERIFICATION PRO FORMA

VISUAL INSPECTION OF GAS PROTECTION MEASURES

VISIT: 1 of 4

Site name:	[Keywords]	Gas characteristic situation:	[Category]
Job number:	[Company]	Type of development and building:	[Company Address]
Date:		Building description:	[Manager]
Visit by:		Foundation type:	[Status]
Weather:		Gas protection type:	[Subject]

No.	Item	Comments
1	*Gas membrane*	
1.1	Condition of sub-grade and/or underside of gas membrane	
1.2	Gas membrane type	
1.3	Gas membrane condition	
1.4	Joining tape product	
1.5	Lapping design	
1.6	Laps, welds and joint seals	
1.7	Service entries seals	
2	*Passive venting*	
2.1	Sub-floor void	
2.2	External wall airbricks	
2.3	Internal sleeper walls	
2.4	External vent trenches/ducts	
3	*Active venting*	
3.1	System details	
Additional notes:		

Photographs

No.	Description

The gas protection measures inspected are:	

Name: **Signature:** **Date:**

VISUAL INSPECTION OF GAS PROTECTION MEASURES

VISIT: 2 of 4

Site name:	[Keywords]	Gas characteristic situation:	[Category]
Job number:	[Company]	Type of development and building:	[Company Address]
Date:		Building description:	[Manager]
Visit by:		Foundation type:	[Status]
Weather:		Gas protection type:	[Subject]

No.	Item	Comments
1	*Gas membrane*	
1.1	Condition of sub-grade and/or underside of gas membrane	
1.2	Gas membrane type	
1.3	Gas membrane condition	
1.4	Joining tape product	
1.5	Lapping design	
1.6	Laps, welds and joint seals	
1.7	Service entries seals	
2	*Passive venting*	
2.1	Sub-floor void	
2.2	External wall airbricks	
2.3	Internal sleeper walls	
2.4	External vent trenches/ducts	
3	*Active venting*	
3.1	System details	
Additional notes:		

Photographs

No.	Description

The gas protection measures inspected are:	

Name: **Signature:** **Date:**

VISUAL INSPECTION OF GAS PROTECTION MEASURES

VISIT: 3 of 4

Site name:	[Keywords]	Gas characteristic situation:	[Category]
Job number:	[Company]	Type of development and building:	[Company Address]
Date:		Building description:	[Manager]
Visit by:		Foundation type:	[Status]
Weather:		Gas protection type:	[Subject]

No.	Item	Comments
1	*Gas membrane*	
1.1	Condition of sub-grade and/or underside of gas membrane	
1.2	Gas membrane type	
1.3	Gas membrane condition	
1.4	Joining tape product	
1.5	Lapping design	
1.6	Laps, welds and joint seals	
1.7	Service entries seals	
2	*Passive venting*	
2.1	Sub-floor void	
2.2	External wall airbricks	
2.3	Internal sleeper walls	
2.4	External vent trenches/ducts	
3	*Active venting*	
3.1	System details	
Additional notes:		

Photographs

No.	Description

The gas protection measures inspected are:	

Name: **Signature:** **Date:**

VISUAL INSPECTION OF GAS PROTECTION MEASURES

VISIT: 4 of 4

Site name:	[Keywords]	Gas characteristic situation:	[Category]
Job number:	[Company]	Type of development and building:	[Company Address]
Date:		Building description:	[Manager]
Visit by:		Foundation type:	[Status]
Weather:		Gas protection type:	[Subject]

No.	Item	Comments
1	*Gas membrane*	
1.1	Condition of sub-grade and/or underside of gas membrane	
1.2	Gas membrane type	
1.3	Gas membrane condition	
1.4	Joining tape product	
1.5	Lapping design	
1.6	Laps, welds and joint seals	
1.7	Service entries seals	
2	*Passive venting*	
2.1	Sub-floor void	
2.2	External wall airbricks	
2.3	Internal sleeper walls	
2.4	External vent trenches/ducts	
3	*Active venting*	
3.1	System details	
Additional notes:		

Photographs

No.	Description

The gas protection measures inspected are:	

Name: **Signature:** **Date:**