Additional Ground Investigation for Land at Bankside, Banbury

Final Report

Prepared by

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for

Bovis Homes, Barratt Homes and Taylor Wimpey Homes

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1	January 2012	Original issue.
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CONTENTS

APPENDICES

EXECUTIVE SUMMARY AND CONCEPTUAL SITE MODEL

SITE INFORMATION & SETTING	**Purpose of this report**	To review previous works at the site, add new data and identify any geo-environmental or geotechnical constraints associated with the site.
	Client	Bovis Homes, Barratt Homes and Taylor Wimpey Homes.
	Site	Land at Bankside, Banbury.
	Site Location	Land north east of Oxford Road, west of the Oxford Canal and east of Bankside in Banbury. Nearest postcode: OX15 4AD). Approximate National Grid Reference of centroid is 446470E 238326N.
	Current Land Use & Description	The site covers approximately 75ha and is currently agricultural land with a fenced off area of over grown open ground predominantly used by dog walkers at the north end of the site.
	Development	Residential development in the south and north of the site with public open space on the central east part of the site.
PHASE 1 (DESK STUDY)	**Site History**	The area of land at the northern end of the site is known to formerly have been used as a tip. The remainder of the site is undeveloped farm land.
	Geology	The southern end of the site is underlain by a thin layer of the Whitby Mudstone Formation and the Marlstone Rock Bed. The central part of the site is underlain by the Dyrham Formation. The north and eastern part of the site is underlain by the Charmouth Mudstone Formation. There is Made Ground associated with the former tip in the northern end of the site.
	Hydrogeology	The Made Ground is considered to be low or low to moderate permeability because of high clay content. The Whitby Mudstone Formation is classified as Unproductive Strata. The Marlstone Rock Formation is classified as a Secondary A Aquifer. The Dyrham Formation is classified as a Undifferentiated Secondary Aquifer. The Charmouth Mudstone Formation is classified as Unproductive Strata. The site is not in a source protection zone. Springs issue from of the Marlstone Rock Bed / Dyrham Formation junction with the Charmouth Mudstone.
	Hydrology	The nearest watercourse is the Oxford Canal located adjacent to the north eastern boundary of the site.
	Environmental Sensitivity	The Oxford Canal and the land beyond the Oxford Canal are registered as an Environmentally Sensitive Area.
PHASE 2 – GROUND INVESTIGATION	**Historical Site Works**	Historical assessments of the site have been undertaken by Wardell Armstrong LLP and Corsair since 2005. The data from theses assessments are used alongside Hydrock data in this report.
	Hydrock Site Works	The Hydrock Ground investigation comprised 41 trial pits, with geo-environmental chemical testing, excavated to a maximum depth of 3.5m bgl.
	Findings of the Ground Investigation	In the Tip Area Made Ground was encountered over the Charmouth Mudstone Formation. In general, the Made Ground consisted of variable content comprising gravelly clay with cobbles and boulders, gravel and cobbles and boulders of brick, white polystyrene, plastic sheeting, concrete, concrete fragments, plastic and a boulder-sized section of brick walling. Elevated concentrations of metals and PAHs were recorded within the Made Ground materials. The elevated metals are considered to the attributed to the natural background levels in the local area. The Charmouth Mudstone Formation comprised variable conditions including low to high strength, orange brown, brown and grey, silty, residual clay and sand with high groundwater seepage. The Dyrham Formation comprised very low to low strength, orange brown and grey, silty, residual, wet clay. The Whitby Mudstone Formation comprised medium to high strength, firm to stiff, brown and yellow brown mottled, gravelly, sandy, silty, residual clay overlaying the Marlstone Rock Bed. The Marlstone Rock Bed comprised medium to high strength, red brown and brown, sandy, gravelly clay and moderately strong, blue grey and red brown banded, shelly, weathered limestone. Elevated concentrations of vanadium and arsenic were recorded within the natural soils however these were found not to be bioaccessible and are attributed to the natural background levels of the site.

ASSESSMENT & CONSIDERATIONS		
	Site Preparation, Earthworks & Landscaping	Where the proposed development is in close proximity to existing live services, they must be located and a way leave clearly marked prior to undertaking ground works in the vicinity. Temporary slope stability works may be required in any deep excavations in the north of the site. Obstructions may be present in the Made Ground . Significant excavation into the Marlstone Rock Bed may require the use of pneumatic breakers or rock rippers and there will be a reduction in progress where their use is necessary. Topsoil and unsuitable Made Ground should be removed from beneath all building and hard standing areas. Spoil resulting from excavations within the Made Ground may be suitable for reuse as fill to raise site levels elsewhere within the tip area, subject to its suitability with respect to appropriate geotechnical and geo-environmental specifications. Contaminated material should not be re-used on any part of the site currently uncontaminated. Well-pumping may be required for dewatering as sump pumping will increase the instability of unsupported ground in these conditions. It is recommended that no site personnel enter any trenches unless there is adequate support and this has been assessed by a competent person. The earthworks will need to be undertaken under a Materials Management Plan to ensure the appropriate management and reuse of the existing soils. Where the earthworks perform a structural role, a suitable specification will be required.
	Foundations	**Tip area** - it is anticipated that trench fill spread foundations should be appropriate for the proposed row of plots along the western boundary of the tip area, to be founded in the underlying natural soils with the remainder of the tip area requiring deeper pile foundations to penetrate through the Made Ground and the unstable ground conditions in the eastern end of the tip area into the stiff clay of the Charmouth Mudstone. **Northern area outside of the tip** - competent founding strata ranges from 0.2 to 3m bgl with no obvious pattern. As a result of the variable ground conditions a combination of spread foundations and piled foundations would be appropriate in this area. This would need to be assessed by a plot by plot basis. **Southern area** - the underlying Marlstone Rock Bed should be adequate to support the proposed development using spread foundations.
	Floor Slabs	In the north part of the site as Made Ground is greater than 600mm thick in the tip area and clay soils of moderate to high volume change potential are present, it is recommended that suspended floor slabs should be adopted, in accordance with NHBC Standards. Ground bearing slabs may be used in the south of the site if, the foundation depth (such as due to the influence of trees) is less than 1.5m, any fill is suitable, well-compacted granular material and less than 600mm thick and it is demonstrated that desiccation is not present and soils are at their equilibrium moisture content.
	Roads	In the north part of the site where the CBR was found to be less than 2.5%, the sub-grade may be unsuitable for both the trafficking of site plant and as support for a permanent foundation, without improvement works being undertaken. Improvement works should be carried out. It is considered likely a CBR of 5% will be achievable over the south of the site of the site and can be used for preliminary design, subject to in situ testing during construction. Proof rolling of the formation level will be required and any loose or soft spots to be removed and replaced with an engineered fill, in accordance with a suitable specification.
	Soakaways & Drainage	The 2012 Wardell Armstrong highlights that limited soakaway testing was undertaken at the site but details are not available and it is possible that further soakaway testing may be required at the site.
	Buried Concrete	The materials at the site would be classified as Design Sulfate Class DS-1 and Aggressive Chemical Environment for Concrete (ACEC) Class AC-1d.
	Results of Generic Risk Assessment Requiring Consideration	**Human Health -** PAHs and potential asbestos containing materials in the Made Ground associated with the tip area in the north of the site. Elevated naturally occurring vanadium in the areas underlain by the Marlstone Rock Bed and Whitby Mudstone Formation are not considered to represent a risk to human health, but this has yet to be confirmed by the Local Authority. **Controlled Waters -** None. **Plant Life -** None. **Human health / property from ground gases -** Full radon protective measures are indicated by the current guidance.
	Outline Contamination Remediation	A cut and fill remedial strategy for the tip area will have to be developed in consultation with the design team and the regulatory authorities. The material removed, if geotechnical suitable could be used to raise levels under roads and hard

Strategy	standing or with proposed public open space as long as a suitable cover or contaminant pathway breakage is in place to prevent direct contact with the Made Ground by end users of the site. Through an appropriate Materials Management Plan and on-site processing of materials the development will keep as much of the Made Ground material on site as possible, thus minimising vehicle movements and landfilling. The 'fine' fraction, containing the soil, will require sampling (e.g. one sample per 500m^3) to aid in the assessment of its suitability for reuse on the site as either clean cover or, if the material is contaminated, as fill material to raise the site levels, where required and be covered by an appropriate clean cover. Areas of Made Ground under gardens and public open space will require a clean cover of a minimum of 600mm thickness. The extent and thickness will need to be estimated from knowledge of the existing and final ground levels. Foundations will have to be taken down to natural ground and consideration given to protection of water supply pipes and other utilities. Full radon protection measures will be required and these should be capable of preventing ingress of naphthalene vapours in the tip area. The methodology for the remediation should be detailed in a Remediation Method Statement which will need to be submitted to the NHBC and the regulatory authorities for approval. Following completion of the above works verification reports, undertaken by a suitably qualified independent engineer will be required.
Construction Materials & Water Supply Pipework	It is envisaged that standard pipework will be suitable for the majority of the site, but barrier pipe will be required within the Made Ground. However, due to conflicting guidance, confirmation should be sought from the water supply company at the earliest opportunity.
Uncertainties	Risks to human health from naturally occurring vanadium is not considered significant, but at the time of writing this has yet to be confirmed with the Local Authority. Asbestos-containing materials may be present in the Made Ground. Risks to the surface water environment are not considered significant , but this will have to be agreed with the Environment Agency. A piling risk assessment is likely to be required in the tip area to demonstrate the lack of establishing any new contaminant pathway. There is the potential for running sand conditions to develop in excavations close to the canal where silty or sandy soils are combined with a high water table. In these conditions it may be necessary to employ well-point dewatering before stable excavations can be formed. The practical cut-off between trenchfill and piled foundations is normally taken to be a founding depth of 2-2.5 mbgl. It has been shown that potential foundation depths exceed this threshold in the northern part of the site. The areas where piling is likely to be required have been highlighted, but this is a provisional finding and more detailed assessment will be needed on a ploy by plot basis. Existing CBR testing is sufficient for preliminary design, but confirmatory testing will be required in actual road foundation locations. The 2012 Wardell Armstrong highlights that limited soakaway testing was undertaken at the site but details are not available and it is possible that further soakaway testing may be required at the site.
Further Work	The following further works will be required with regard to the tip area in the north part of the site: • Liaison with the NHBC, Contaminated Land Officer and Environment Agency concerning the findings of this report in respect of contamination. • Confirmation with the water company with respect to water supply pipe materials. • Provision of a piling contamination risk assessment. • Provision of a Geotechnical Design Report including design and possible further geotechnical investigation for (a) spread footings (including suitability of plots, safe bearing pressure and mitigation of the effects of trees and shrubs); and (b) piled foundations (including specialist sub-contractor design and design of a piling mat for tracked plant). • Soakaway testing in areas where these may be feasible, ie granular soils without high water table. • Provision of a Materials Management Plan for re-use of site arisings. • Provision of a Remedial Method Statement for the cover over the tip area and agreement with the regulatory authorities; and • Verification of the remedial works on completion.

This Executive Summary forms part of Hydrock Consultants Limited report number R/12702/001 (Issue 2) and should not be used as a separate document.

1.0 INTRODUCTION

1.1 Terms of Reference

In November 2012, Hydrock Consultants Limited (Hydrock) was commissioned by Bovis Homes, Barratt Homes and Taylor Wimpey Homes (E7556/002) to undertake additional ground investigation at Land at Bankside, Banbury. The site is located on land north east of Oxford Road, west of the Oxford Canal and east of Bankside in Banbury (nearest postcode : OX15 4AD).

The site covers approximately 75ha and is currently predominantly agricultural land with a fenced off area of overgrown open ground predominantly used by dog walkers at the north end of the site.

The proposed development is to comprise combined residential and commercial development with public open space.

A site location plan (Drawing C12702-G001), is presented in Appendix A.

1.2 Objectives

The objectives of this investigation are to review previous works at the site and to identify any geo-environmental or geotechnical constraints associated with the site.

1.3 Scope

The scope of work for this commission comprises:

- a review of historical works and a site walk over reconnaissance;
- a review of previous investigations carried out at the site;
- a supplementary ground investigation including trial pitting and chemical testing to provide confirmation of the findings of the historical investigations and provide additional information to support any remedial proposals; and
- reporting on findings of the review, ground investigation, geo-environmental assessment of the site conditions.

See Appendix D for detailed reporting methodology.

1.4 Information Sources Provided by the Client

A number of phases of site investigations have been undertaken at the site. In preparing this report Hydrock has consulted the following documentation:

- October 2005 site investigation by Corsair Consultants focused on the former tip area within the north of the site (reviewed as part of the WA 2010 Report);
- 2006 site investigation by Corsair Consultants was designed to provide a broader assessment of the ground conditions across the site (reviewed as part of the WA 2010 Report);

- 2007 site investigation and testing by Wardell Armstrong LLP, Further investigation works were then undertaken to establish the bio-accessibility of the arsenic present within the site (reviewed as part of the WA 2010 Report);
- August 2010, Wardell Armstrong LLP, *Report on Ground Conditions*, Bankside, Banbury;
- 3 February 2012, Wardell Armstrong Letter Report, *Assessment of Area Adjacent to Fuel Station* – Bankside, Banbury;
- 26 March 2012, Wardell Armstrong Letter Report, *Site at Bankside, Banbury – Results of Ground Gas Monitoring*;
- 17th May 2012, GEG Geo Environmental Group, *Intrusive Assessment of Canal Base*, Oxford Canal, Banbury, Oxfordshire; and
- August 2012, Wardell Armstrong LLP, *Remediation, Ground Investigation Report*, Bankside, Banbury;
- 13-09-2012, Focus, Drawing; SK01 - Development Proposals Parcel E -A1L;
- 22-10-2012, Focus, Drawing; SK02 - Development Proposals-A0L;
- 20-10-2012, Focus, Drawing; SK03 - Development Proposals-A0L;
- 23-10-2012, Focus, Drawing; SK04 - Development Proposals Parcel F-A0L;
- 23-10-2012, Focus, Drawing; SK05 - Development Proposals Parcel D;
- 31-10-2012, M-EC, Drawing; 20488_00_001 - Engineering Viability Plan Sheet 1 Of 2;
- 31-10-2012, M-EC, Drawing; 20488_00_002 - Engineering Viability Plan Sheet 2 Of 2;
- July 2004, Gallagher Estates, Drawing; Bodicote, Banbury, Oxfordshire - Constraints Plan;
- 29-06-2010, Paul Drew Design, Drawing; 005 – College Fields, Bankside Banbury, Master Plan; and
- 25-09-2012, SAVILLS, Drawing; Longford Park, Banbury Extract.

This report covers all previous investigations at the site which are summarised in Section 2.8.

2.0 BACKGROUND

The available information from previous reports has been reviewed and is presented in this section, augmented by additional information from Hydrock's resources (Sections 2.1 to 2.5).

2.1 Site Referencing

The site is referenced in Table 2.1.

Table 2.1: Site Referencing Information

Item	Brief Description
Site name	Land at Bankside, Banbury.
Site location and Grid reference	The site is located 2km to the south of Banbury town centre to the west of the Oxford Canal. The site occupies an area of approximately 75 ha and is shown on Drawing C12702-G001. Nearest postcode is OX15 4AD. Approximate National Grid Reference of centroid is 446470E 238326N.

A site location plan is provided in Appendix A (Drawing C12702-G001).

2.2 Site Description and Walk-Over Survey

The basic description of the current site conditions is summarised in Table 2.2.

Table 2.2: Site Description

Item	Brief Description
Site access	Either via Canal Lane at the centre of the site or off of the road Bankside which follows the north western boundary of the site.
Land area	Approximately 75 ha.
Elevation, topography etc.	The elevation of the site ranges from approximately 123.5m AOD in the west of the site to 89.7m AOD in the north east of the site. The southern half of the site is predominately flat. The north half of the site slopes downhill to the Oxford Canal which is adjacent to the north eastern boundary of the site. Springs were located in east of the site which were noted to run down the sides of the hedgerows towards the Oxford Canal.
Site boundaries	Site boundaries consist of the Oxford Canal on the north eastern boundary of the site with the remainder consisting of hedge boundaries either to roads (west of the site) or more agricultural fields to the south east of the site.
Present land use	The site is currently open fields used primarily for agriculture.
Surrounding land	To the west and south of the site is residential development, to the east of the site are agricultural fields and to the north east of the site is the Oxford Canal beyond which are more agricultural fields and the River Cherwell which lies approximately 230m beyond the canal.

A walk-over reconnaissance survey was undertaken to confirm the findings of the information review and assess visually any potential hazards and receptors that may not have been picked up in the previous work. Photographs are presented in Appendix B.

2.3 Geology

The general geology of the site area is shown on the 1:50,000 geological map of Chipping Norton (Sheet 218) and is summarised in Table 2.3.

No superficial geology is indicated at the site and Drawing C12702-G004 (sourced from the previous site investigation of the site) illustrates the conjectured geological setting at the site.

Table 2.3: Geology

Location	Age	Stratigraphic Name	Description
On site	Jurassic	Whitby Mudstone Formation - Mudstone.	The geological records indicate a small outlier of the Whitby Mudstone Formation in the south eastern part of the site.
	Jurassic	Marlstone Rock Formation Ferruginous Limestone And Ironstone	The Marlstone Rock Bed is shown to crop out in the southern half of the site. The Marlstone Rock Bed contains ironstone deposits. Weathered ironstone deposits are known to be associated with elevated levels of metals/metalloids, especially arsenic and vanadium in soils. Generally, areas which are rich in ironstone have naturally elevated levels of arsenic and vanadium in soils.
	Jurassic	Dyrham Formation- Siltstone And Mudstone, Interbedded.	There is an outcrop of the Dyrham Formation recorded as clays and silts, in the central portion of the site.
	Jurassic	Charmouth Mudstone Formation Mudstone.	There is an outcrop of the Charmouth Mudstone Formation in the northern portion of the site. It is reported that the junction between the Charmouth Mudstone Formation and the Dyrham Formation is marked by a change in slope and water seepages which are in places pronounced by a spring line. The geological map notes two springs (however, up to four springs are noted on some of the historic plans) within the site area near this junction.

Due to the historic tipping in at the north end of the site, deep Made Ground is anticipated in this area. The depth of Made Ground is considered be up to 4m deep. Available information indicates that tipped materials included brick, concrete, timber, ironstone, tarmac, tile, asbestos, flint, ash, coal, slate and metal in a gravelly, sandy, clayey, matrix in this area.

2.4 BR 211 Guidance on Radon

Reference to the Annex A maps in BR 211 (Scivyer 2007), based on the Indicative Atlas of Radon in England and Wales (Miles *et a*l 2007) indicates that full radon protection is required for new dwellings at this location in line with current guidance.

The documentation indicates that between 10% and 30% of houses record radon levels above the action level of 200 bq/m^3, therefore full radon protective measures would be required within the construction of residential dwellings at the Bankside site.

2.5 Hydrogeology

The strata beneath the site are classified by the Environment Agency as a Secondary Aquifer and /or Unproductive Strata, depending on the underlying geology. The aquifer designations given in Table 2.4 are based on the Environment Agency interactive aquifer designation map.

Table 2.4: Hydraulic Characteristics of Strata

Stratum	Aquifer Designation	Hydraulic Characteristics
Made Ground (north end of the site)	N/A	Moderate to high porosity because of unconsolidated nature, but permeability likely to be constrained to low or low to moderate because of poor sorting and high clay content.
Whitby Mudstone Formation - Mudstone.	Unproductive Strata	The Whitby Mudstone Formation encountered in the area is mainly clay drift deposits with low permeability that has negligible significance for water supply or river base flow.
Marlstone Rock Formation - Ferruginous Limestone And Ironstone	Secondary A Aquifer	The Marlstone Rock Bed is the likely source of the springs noted in the eastern end of the site which is the likely change in the geology to the Dyrham Formation and the Charmouth Mudstone Formation.
Dyrham Formation - Siltstone And Mudstone, Interbedded.	Undifferentiated Secondary Aquifer	Secondary Undifferentiated has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. The groundwater springs may be issuing at the boundary between the Marlstone Rock Formation and the Dyrham Formation or the Charmouth Mudstone Formation because of the variable nature of these strata.
Charmouth Mudstone Formation - Mudstone.	Unproductive Strata	The Charmouth Mudstone Formation consists sedimentary bedrock deposited as mud, silt, sand and gravel rock layers with low permeability that have negligible significance for water supply or river base flow.

According to the Environment Agency web site, there are no recorded source protection zones within the site area.

Natural springs were noted in the eastern end of the site about halfway up the slope of the hill. It is likely that these springs issue from where the boundary of the Marlstone Rock Formation meets with either the Dyrham Formation of the Charmouth Mudstone Formation. It is therefore considered that groundwater within these Secondary Aquifers issue from the springs in the area.

Reference to the Environment Agency web site shows the following Groundwater Body beneath the site and the current chemical status.

Table 2.5: Groundwater Body

Category	Label / Status
Waterbody ID	GB40602G600200
Waterbody name	Banbury Jurassic
River basin district	Thames
Current quantitative status	Good
Current chemical status	Good
Upward chemical trend	No
2015 predicted qualitative status	Good
2015 predicted chemical status	Good

Category	Label / Status
Overall risk	Probably Not At Risk
Protected area	Yes

The site is not within a Source Protection Zone (SPZ).

It is indicated that there are no licensed groundwater abstractions within 1 km of the site.

2.6 Hydrology & Flooding

The nearest watercourse shown on current plans is the Oxford Canal which forms the eastern boundary of the site. The River Cherwell lies approximately 230m beyond the Oxford Canal to the east of the site and is classified as Grade B by the Environment Agency. A number of springs (up to four) are identified to issue within the site. Additionally, anecdotal evidence from Cherwell District Council, reported in the Environmental Statement submitted with the Planning Application, suggests that minor ephemeral shallow ponds form from time to time in two stretches along the Oxford Canal.

Reference to the Environment Agency web site shows the following River Basin Management Plans – Rivers Current Ecological Quality information for the Oxford Canal adjacent to the east boundary of the site and the current chemical status (Table 2.6).

Table 2.6: Surface Water Body

Category	Label / Status
Water Body Name	Oxford Canal, summit to Aynho
Waterbody Name	GB70610197
Management Catchment	Oxford Canal, summit to Aynho
River Basin District	N_A
Typology Description	Thames
Hydromorphological Status	Canal
Current Ecological Quality	Artificial
Current Chemical Quality	Good Potential
2015 Predicted Ecological Quality	Does Not Require Assessment
2015 Predicted Chemical Quality	Good Potential
Overall Risk	Does Not Require Assessment
Number of Measures Listed (waterbody level only)	-

A significant (Category 2) pollution incident to Controlled Waters occurred approximately 188m to the east of the site boundary. The incident is not detailed fully within the report but described as involving ‘chemicals’. The incident date is not supplied, however it is unlikely that this incident would affect the site. Further incidents have been recorded further from the site. It is unlikely that any of these occurrences would adversely affect the site.

A number of discharge consents are recorded within the area of the site with the closest being approximately 158m from the boundary of the site. The majority of these consents are to water courses principally being the Oxford Canal and the River Cherwell. It is considered unlikely that these discharges would affect the site.

Several abstraction licences are in place within the area surrounding the site, the most significant of these is a potable water supply extracted from groundwater located approximately 1km from the site boundary. A further abstraction approximately 342m from the site is for the washing of vegetables.

The site is in Flood Zone 1, with low probability of flooding, however the site is located adjacent to both a Flood Zone 2, with medium/moderate probability of flooding and a Flood Zone 3, with high/significant probability of flooding located beyond the Oxford Canal to adjacent to the eastern site boundary.

No further consideration of flood risk is undertaken in this report. Specialist flood risk advice should be sought with regards to drainage and flooding.

2.7 Site History

The previous assessment of the site identified the area of land at the northern end of the site is known to formerly have been used as a tip. Available information indicates that tipped materials included brick, concrete, timber, ironstone, tarmac, tile, asbestos, flint, ash, coal, slate and metal in a gravelly, sandy, clayey matrix in this area. It is thought that the materials were tipped on to the natural surface and may be up to 4m thick in places. However, there is no official record of the materials that have been infilled in this area, nor is the site known to be a registered landfill site.

2.8 Waste Management and Hazardous Substances

A landfill is recorded approximately 400m to the north of the site boundary. The waste type is described to be domestic and inert materials and liquid sludge. It is not recorded when the landfill site was in operation nor whether the site has closed. It is considered unlikely that this landfill site would affect the Bankside site.

An existing petrol station is noted within the Envirocheck Report in the Wardell Armstrong 2010 report as being situated adjacent to the south western boundary of the site on the Oxford Road.

The land beyond the Oxford Canal is part of an Environmentally Sensitive Area Agreement and is a registered Environmentally Sensitive Area.

2.9 Previous Site Investigations or Other Reports

As outlined in Section 1.4 there has been significant previous ground investigation and assessment undertaken at the site. This is summarised below.

2.9.1 October 2005 Site Investigation by Corsair Consultants

In October 2005, Corsair Consultants focussed on the former tip area within the north of the Bankside site. These works comprised the excavation of 18 trial pits using a JCB 3CX excavator. The trial pits encountered generally Made Ground materials which comprised gravelly and cobbly, sandy clay materials with varying proportions of broken brick, concrete and other construction debris. Geochemical testing of materials recovered from the investigation locations was undertaken to provide information on the contaminative nature of the materials.

In addition to the geochemical testing a spiker bar gas survey was undertaken at the location of each trial pit to a depth of 1m.

The trial pits identify multifarious anthropogenic materials in the tip area of the site up to 4m in thickness including brick, concrete, timber, ironstone, tarmac, tile, asbestos, flint, ash, coal, slate and metal in a gravelly sandy clayey matrix. The spiker bar gas survey revealed only low concentrations (up to 1.7%) of carbon dioxide and no methane. A total of fourteen trial pits encountered tipped materials across an area of approximately 3.3ha.

Decaying vegetation was found at the base of the tipped materials in a number of locations implying that the materials were deposited on the natural surface of the site, thus raising levels in this area of the site.

Geochemical testing results revealed elevated levels of arsenic, lead, PAH and TPH in selected samples compared to conservative screening values (i.e. SGV/GAC derived for residential with plant uptake standard land uses). Elevated levels of arsenic were detected in both Made Ground and natural soils at the site. Five samples were also analysed for asbestos fibres where asbestos containing material was suspected. Of the five samples tested, four returned positive results for asbestos fibres within cement bound materials.

In addition, ten soil samples were subjected to leachate testing for a range of inorganic and organic determinands. While organic analysis is normally not considered appropriate due to the processes involved in producing the leachate, as analysis had been undertake, results were included for initial assessment purposes. The leachate testing results were compared with water quality guideline values. None of the leachate results were above the relevant guidelines indicating that the soils in the tip area are not a significant risk to controlled waters.

2.9.2 2006 Site Investigation by Corsair Consultants

In April 2006 further site investigation designed to provide a broader assessment of the ground conditions across the site was undertaken by Corsair Consultants. The investigation involved the drilling of four cable percussion boreholes, excavation of forty two trial pits, undertaking five California Bearing Ratio (CBR) tests and four soakaway tests. The investigation works are reviewed in greater detail within the Wardell Armstrong 2010 ‘Report on Ground Conditions’ with the testing results and logs included within that report.

The exploratory holes in this phase of investigation record varying geologic conditions across the site area broadly consistent with the published geology. All locations record natural material below the top soil across the site area investigated.

Soil, leachate, groundwater and gas samples were collected during the site investigation works for geochemical and geotechnical (soil only) analysis. A similar suite of chemical analysis was used as in the October 2005 investigation on selected samples.

Arsenic was generally found to be elevated in natural materials across the site, with elevated nickel in one sample. The recorded concentrations of arsenic (and nickel) increase in the southern site area; and are highest in soils above Marlstone Rock Bed. The arsenic (and nickel) was considered to be naturally occurring and to be associated with the weathering of the Marlstone Rock Bed (e.g. ironstone deposits) known to contain elevated concentrations of these substances.

The leachate testing results from this phase of investigation was compared to the water quality guidelines for screening purposes. As with the northern site area, all leachate samples record concentrations of all determinands were below the relevant water quality guidance.

Geotechnical testing on selected samples included natural moisture content, Atterberg limits, particle size distribution, particle density, dry density/moisture content relationship and oedometer consolidation testing.

2.9.3 2007 Site Investigation and Testing by Wardell Armstrong LLP

Further investigation works were undertaken to establish the bio-accessibility of the arsenic present within the site (reviewed as part of the WA 2010 Report).

In order to assess the potential significance of elevated arsenic recorded at the site further sampling was undertaken in the southern site area. Soil samples were collected from areas of the site where arsenic was known to be elevated. The soil samples were subject to geochemical analysis for total and PBET for arsenic.

The results enabled the generic assessment criteria to be modified to produce a Site Specific Assessment Criteria (SSAC). Through the development of Site Specific Assessment Criteria (SSAC) which took into account the PBET results it was demonstrated that the elevated concentrations of arsenic were within the SSAC.

This work demonstrated that the naturally occurring arsenic levels encountered at the site do not pose an unacceptable risk to human health.

2.9.4 August 2010, Wardell Armstrong LLP, Report on Ground Conditions, Bankside, Banbury

This report presents relevant background information regarding the geo-environmental setting of the site in the form of desk study researches and a review of published environmental information including hydrology, hydrogeology, radon, geology along with a site history and the findings from all the previous site investigations.

The findings from all the previous site investigation data at the site are used along with the understanding of the site and its environs from the desk study work to develop a Conceptual Site Model (CSM) and to design a remediation strategy with respect to the proposals for redevelopment.

The results of the risk assessments and revised understanding of the conceptual site model indicate that the levels of contaminants recorded in the former tip area Made Ground materials are considered unsuitable for the residential development proposed for that area of the site without mitigation.

The risk assessment also demonstrated that elevated arsenic, considered to be naturally occurring, in the southern site area does not represent a significant risk to human health at the site and therefore no mitigation is required.

The report also recommends that it is necessary to provide full radon protection measures at the site in accordance with guidance from the BRE and highlights the potential risk from the fuel station adjacent to the western site boundary along with the potential for gas generation from the former tip in the northern part of the site.

An outline remediation strategy has been presented to mitigate the potential contamination issues in the north part of the site. The proposed remediation strategy includes:

- screening of material to remove deleterious materials from the soils, which would then be removed from site, if necessary;
- concrete and brick recovered from the screening process to be crushed and reused within the development of the site; and
- the ‘fine’ fraction, containing the soil, would require sampling (e.g. one sample per $500m^3$) to aid in the assessment of its suitability for re-use on the site.

The report concludes that depending on the results of the testing, it is likely that the majority of the soils generated from the screening process would be suitable for reuse in either residential, commercial or public open space areas of the site, either at depth or in the near surface, allowing the majority of materials to be retained in a sustainable approach.

Finally the report concludes that where necessary, depending on the extent of the excavations and subsequent processing of materials in the northern site area, a clean cover pathway break may be required to separate end users (this area of the site is proposed for residential development) from the underlying materials, if tipped materials are left in place. The extent of areas requiring clean cover (if any) would need to be developed following delineation of this area along with assessment of current and proposed finished ground levels in the development.

2.9.5 3 February 2012, Wardell Armstrong Letter Report, Assessment of Area Adjacent to Fuel Station – Bankside, Banbury

Additional site investigation works were undertaken by Wardell Armstrong within the vicinity of the fuel filling station and the car dealership located adjacent to the western boundary of the Bankside site.

The investigative works were aimed at determining whether this area of the site might have been affected by possible leaking petroleum hydrocarbons.

The site investigation works comprised the excavation of seven machine excavated trial pits to a maximum depth of 2.8m below ground level along the line of the boundary between the site and the filling station.

The trial pit excavations encountered natural soil and rock materials comprising red brown, sandy gravel and cobbles of sandstone and limestone in a clay matrix underlain by weathered rock recovered as gravel and cobbles of limestone and sandstone. No visual or olfactory evidence of hydrocarbons were noted within any of the trial pits at the time of the site investigation.

A total of twelve samples of soils from the seven trial pit excavations were scheduled for a suite of laboratory geochemical testing. The results indicate that none of the determinands were found above the laboratory limit of detection. This confirms that petroleum hydrocarbon compounds are not present at detectable levels within the soils adjacent to the boundary of the site with the filling station.

The report concluded that the results of the investigations provide sufficient evidence that the site is not being significantly impacted by fuel and or fuel derived compounds emanating from the filling station.

2.9.6 26 March 2012, Wardell Armstrong Letter Report, Site at Bankside, Banbury – *Results of Ground Gas Monitoring*

This ground gas monitoring letter report presents the results of the ground investigation to assess ground gas generation associated with the tip area in the northern part of the site.

The purpose of the report was the assessment of the current near-surface soil gas regime in the tip area with respect to the proposed future residential development.

The site investigation included the installation of 20 boreholes on a 50m grid across the former tip area of the site to depths ranging between 3 and 4m bgl. All of the boreholes were installed with gas monitoring standpipes.

Six rounds of gas monitoring visits were undertaken between 13 December 2011 and 2 March 2012 under varying weather conditions including falling atmospheric pressure.

The gas monitoring included the monitoring of carbon dioxide, methane and oxygen measured in each borehole along with flow rate, atmospheric pressure and water level.

The maximum concentration of methane recorded was 0.2% (LP1) and the maximum concentration of carbon dioxide recorded was 5.4% (LP8), with a maximum borehole flow rate recorded at 1.1 litres/hour (LP7, LP13 and LP14).

Through the development of a GSV in accordance with CIRIA 665 the sites highest methane concentration and the highest gas flow rate gave a GSV for methane of 0.0022. The same exercise for carbon dioxide gave a GSV of 0.0594.

Although the maximum recorded concentration of carbon dioxide marginally exceeds the TMC between “Green” and “Amber 1”, it was noted that this was on one occasion only on six visits with twenty monitoring points and as the maximum flow rates recorded were typically about 1 l/hr it was concluded that a “Green” classification should be applicable to the northern part of the site and no gas protection would be required in new build in respect of methane or carbon dioxide in near surface soils.

The letter report did highlight that the site levels and soil conditions could be subject to change depending on the material movement and final levels of the proposed development.

2.9.7 17th May 2012, GEG Geo Environmental Group, Intrusive Assessment of Canal Base, Oxford Canal, Banbury, Oxfordshire

Geo Environmental Group (GEG) was commissioned to undertake an intrusive investigation of the canal base at a single location on the Oxford Canal in order to provide relevant information with respect to the proposed drilling of a 300mm drain directly beneath the canal.

The purpose of this report was to determine:

- the natural ground conditions likely to exist beneath the canal; and
- the thickness of ‘puddle clay’ sealing the base of the canal.

The site investigation comprised the drilling of one window sample borehole to a depth of 6.00m at the side of the canal, and the percussive hand drilling of one borehole utilising a 38mm sampler tube in the base of the canal.

The ground conditions encountered in the window sample borehole next to the canal (BH1) included a layer of re-worked topsoil which comprised red brown, slightly clayey to clayey topsoil with occasional charcoal fragments to 1.20m bgl over alluvium to the base of the borehole (6.00m).

The alluvium consisted of a layer of soft to firm, red brown, slightly friable clay (1.00m thick) overlying loose light red brown, very clayey, fine to medium sand (0.40m thick) which overlaid loose, light red, gravelly, fine to medium sand (sub-angular gravel becoming rare with depth) to the base of the borehole. SPT N-values recorded within the alluvium range from 8 at 3m bgl 14 at 6m bgl.

The Charmouth Mudstone strata were not encountered in this investigation.

During the drilling of the borehole, groundwater was encountered initially in the stratum at 2.20m (wet ground) which became very wet from 3.70m. On completion of the borehole, the groundwater was dipped at a depth 1.80m bgl.

2.9.8 August 2012, Wardell Armstrong LLP, Remediation Ground Investigation Report, Bankside, Banbury

This report was prepared to provide an assessment of the ground conditions which exist across the Bankside site and to identify potential geotechnical constraints to the proposed residential development. The works were aimed at determining the geotechnical characteristics of the ground conditions for the outline recommendation of foundation zoning areas across the site.

The investigation works comprised the excavation of 64 trial pits and the drilling of 29 light percussion probe holes and 7 cable percussion boreholes with 10 CBR tests. The investigation works were undertaken across the whole of the site area focussing particularly on the areas of the proposed residential development within the north east and south of the site. Investigation was undertaken on an approximate 70m grid across the development areas with an approximate 200m grid across the areas of public open space.

Standpipes were installed within three of the light percussion probe holes and within two of the cable percussion boreholes to monitor groundwater levels within the shallow soils.

Relatively shallow groundwater levels were encountered and recorded in the vicinity of three springs at the site (near LPs 107, 108 and 109). Development in these areas may, therefore, require some groundwater control measures to keep excavations dry and precautions to maintain stability. In the historic site investigations groundwater was encountered within three of the cable percussion boreholes, five of the trial pit excavations and 11 of the light percussion probe holes across the site area. As a generality the groundwater was encountered in four main zones as follows.

- Groundwater was encountered within the south west of the site adjacent to Oxford Road where the investigation positions (LP123, LP125, TP162 and BH105) penetrated the Marlstone Rock Bed strata into the Dyrham Formation. The water was noted to be a slight seepage at approximately 2.0m depth with a greater flow noted at a depth of approximately 5.0m below ground level.
- Groundwater was noted within the west of the site within the field adjacent to Canal Lane within investigation positions LP115 and LP116 as damp soils materials at approximately 1.5m depth below ground level. This is conjectured to be within the Whitby Mudstone Formation and was noted to be directly above the weathered sandstone materials.
- Investigations were undertaken within the vicinity of three springs recorded on the historical mapping of the site. LP107, LP108 and LP109 all recorded groundwater seepages at depths of between 1.03m and 2.0m depth below ground level. This corresponds with the conjectured spring locations.
- Groundwater was also noted within the north east of the site close to the Oxford Canal. Two light percussion probe holes, two cable percussion boreholes and four trial pits within this area record ingress of groundwater during the undertaking of the investigation. It is conjectured that the groundwater levels encountered within these positions represents the water table within this area. The groundwater was encountered at depths of between 0.9m and 2.9m within these materials although it is considered that the groundwater encountered within TP107 at 0.9m depth may represent a perched water level within sand lenses present within the clay materials. It is therefore considered that the water table within this area of the site is approximately 1.5m to 2.5m depth below the surface level.

Selected samples of soils from the trial pits and cable percussion boreholes were analysed to determine their geotechnical characteristics.

The laboratory testing comprised the following:

- 37 samples for natural moisture content;
- 25 samples for plastic limit and liquid limits;
- 34 samples for particle size distribution;

- 20 samples for pH and sulfate content; and
- 4 samples for compaction with a 4.5kg rammer.

No undisturbed samples of material were retrieved as part of the site investigation due to the nature of the ground conditions at the site. It was, therefore, not possible to undertake compressibility or shear strength testing on undisturbed samples of materials.

The average moisture content within the cohesive materials was found to be 24% with the average moisture content within the granular materials of 23%.

The modified plasticity index results range from 11% to 49% and were split into the following groups pertaining to the underlying geology at the site:

- Charmouth Mudstone Formation, moderate to high volume change potential;
- Marlstone Rock Bed, low volume change potential; and
- Whitby Mudstone Formation, medium volume change potential.

Similarly the particle size distribution results were split into the following groups pertaining to the underlying geology at the site.

- The Charmouth Mudstone Formation is silty and sandy clay materials with some gravelly clay materials. The fines content ranges from 39% to 96% although the majority comprise over 51% fines.
- Only one sample of material from the Dyrham Formation was tested, with a fines content of 35% and is described as gravelly, sandy clay.
- The Marlstone Rock Bed is clayey, sandy gravel and cobbles to very gravelly clay. The analysis records the gravel and cobble content between 20% and 84% although the majority, are greater than 30%.
- The Whitby Mudstone Formation is dominated by clay and silt which is likely to be present as a thin band above the Marlstone Rock Bed in the area.

Four samples were used to determine the dry density / moisture content relationship. Two were from the proposed development area within the north east of the site and two from the south west of the site. The results indicate that the materials are generally wet of the optimum moisture content (OMC) and the maximum dry densities vary between 1.63Mg/m^3 and 1.90Mg/m^3 with OMC between 14% and 21%.

The CBR results indicate that whilst the shallow ground within the south of the site recorded CBR values of between3% to 12%, the shallow ground conditions close to the Oxford Canal indicated softer materials with CBR values ranging from 0.9% to 1.6%.

It was highlighted that detailed pavement design should take account of these results and appropriate measures be taken in the construction of the roads.

The geotechnical assessment was undertaken based on the information from both the 2012 site investigation works and the previous investigation phases. The assessment identified three generalised foundation zones.

These three areas comprise:

- Zone A (the area of residential development in the northern part of the site with in the former tip area) – variable foundation solutions including possible vibro-stone or piled foundations within the clay and sand-based Made Ground materials. Foundation loads would either need to be transferred to the underlying stiff clay materials or the bearing properties of the Made Ground materials improved;
- Zone B (the area of residential development in the northern part of the site that is outside the tip area) – shallow strip foundations within the firm to stiff, grey clay materials at depths of approximately 1.0m depth below ground level. An allowance should be made for possible localised soft materials where soft materials may require removal and replacement with more competent materials or concrete / trench fill; and
- Zone C (the area of residential development in the south part of the site) – shallow strip foundations may be constructed within the stiff clay materials or within the weathered sandstone at shallow depths across this section of the site. An allowance should be made for treatment of localised soft spots if encountered. Investigation undertaken within this zone has also indicated localised soft materials to a depth of 2.7m bgl therefore foundations loads would need to be transferred to the underlying stiff clay materials.

2.10 Suitability of Previous Data

2.10.1 Geotechnical Test Data

The geotechnical testing undertaken at the site is reasonably extensive and considered suitable. However, additional trial pitting will be needed to confirm the findings for design purposes. The information will be incorporated into the assessment of the site undertaken within this report and will enable an appropriate zoning of foundation solutions.

2.10.2 Chemical Test Data (Soil)

The chemical testing undertaken at the site is limited in its spatial distribution and selection of determinands. The chemical test data are, however, useful and will be incorporated into the data set used in the assessment of the site undertaken within this report.

2.10.3 Chemical Test Data (Water)

Only limited groundwater/surface water has been encountered and sampled at the site to date. The testing of water and leachate samples from the site undertaken to date does not indicate a significant potential for contamination.

2.10.4 Ground Gas Data

There are substantial amounts of ground gas data available for the north part of the site which is in accordance with current guidelines (CIRIA 665). Hydrock considers the data to be suitable for the purposes of this report.

3.0 ADDITIONAL GROUND INVESTIGATION

3.1 Investigation Rationale

The ground investigation rationale was to confirm the findings of previous work and fill in gaps of the existing ground investigation information at the site as summarised in Table 3.1.

Table 3.1: Investigation Rationale

Exploratory Holes	Purpose
Tip Area in the north of the site	
HTP 01-06	To investigate the depth and physical and chemical composition with a view to the foundations requirements and to provide further samples for chemical testing.
Remainder of site	
HTP 11-46	To assess shallow ground conditions with a view to the foundation requirements and to provide further samples for chemical testing.

3.2 Site Works

The position of site investigation locations (surveyed using GPS) are shown on the Ground Investigation Plan (Drawing C12702-G002) in Appendix C.

The site works undertaken for this investigation are summarised in Table 3.2. The logs are presented in Appendix C.

Table 3.2: Summary of Site Works

Activity	Method	No.	Max. Depth (m)
Trial pits	Machine (JCB 3X)	46	3.5

3.3 Geo-Environmental Testing

3.3.1 Sampling Strategy and Protocols

The locations of the investigatory holes were located to provide a reasonable spread of information on the site ground conditions and to fill in the gaps in the coverage of the previous site investigation information. No specific sampling statistics or grid were utilised in this instance.

Samples were taken stored and transported in general accordance with BS 10175:2011.

3.3.2 Laboratory Analyses

The findings of the former site investigation and risk assessment have been used to scope the analyses of chemicals of potential concern as follows.

The following were performed on samples of **soil or other solids**:

- 25 Hydrock default suite of determinands for solids comprising: As, B (water soluble), Be, Cd, Cr (III), Cr(VI), Cu, Hg (inorganic), Ni, Pb, Se, V, Zn, cyanide (free), pH, asbestos screen, speciated polycyclic aromatic hydrocarbons (PAH, by GC-MS), total phenols and fraction of organic carbon; and

- 4 Hydrock default waters suite of determinands, following leaching to BS12457-2, comprising: Ag, Al, As, B, Ba, Cd, Co, Cr (III), Cr(VI), Cu, Fe, Hg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Zn, V, cyanide (total), phenols (total), ammonium, bromate, chloride, fluoride, nitrate, nitrite, sulfate, PAH (speciated), pH, EC and hardness.

The chemical test results are provided in Appendix E.

4.0 GROUND INVESTIGATION DATA

4.1 Physical Ground Conditions

The ground conditions encountered during the current works are in general accordance with the expectations from the previous investigation works at the site.

In 2012 Hydrock were not given permission to access a paddock and large field at the southern end of the site and as a result the proposed trial pits in this area had to be abandoned. These are HTP30, HTP31, HTP34, HTP36 and HTP37 which accounts for their absence from this report.

In 2013, when access was permitted Hydrock progressed a total of six trial pits within this area, these are labelled HTP41 to HTP46.

Details are provided in the logs in Appendix C and the individual strata are described in the sections below. The geology of the site is shown on the Geo-environmental Zonation Plan (Drawing C12702-G003) in Appendix A.

4.1.1 Topsoil

Topsoil was encountered across the site. It is a sandy, silty, gravelly clay or gravel in the southern area underlain by the Whitby Mudstone Formation and Marlstone Rock Bed, and a sandy, silty, gravelly clay in the central and eastern areas underlain by the Dyrham and Charmouth Mudstone Formations. The tip in the north has a partial covering of brown, clayey, sandy topsoil.

4.1.2 Made Ground

Made Ground was only encountered in the tip area in the north part of the site, at depths ranging from the ground surface to 1.6m bgl.

In general, the Made Ground is of variable content comprising gravelly clay with cobbles and boulders, gravel and cobbles and boulders of brick, white polystyrene, plastic sheeting, concrete, concrete fragments, plastic. A boulder-sized section brick walling was encountered.

4.1.3 Charmouth Mudstone Formation

The Charmouth Mudstone Formation was encountered in the northern half of the site including underlying the Made Ground, at depths ranging from 0.2 to 1.6m bgl. The Charmouth Mudstone Formation consisted of low to high strength, orange brown, brown and grey, silty residual clay and moderately packed, light orange brown, residual, fine sand and with depth firm dark brown, mottled, orange brown and grey, residual, clay with frequent fine to medium extremely weak lithorelicts (encountered from 1.7 to 2.2m bgl).

At the lower end of the slope in the northern part of the site the Charmouth Mudstone encountered in HTP04 and HTP06, adjacent to the Oxford Canal, was unstable, moderately packed, brown and orange brown, fine sand and moderately packed, red brown, clayey, gravelly, fine sand with groundwater seepage (encountered between 0.9 and 1.8m bgl).

4.1.4 Dyrham Formation

The Dyrham Formation was encountered in HTP12 in the centre of the site and consisted of very low to low strength, orange brown and grey, silty, residual, wet clay to a depth of 2.8m bgl where the trial pit was terminated because of collapse.

4.1.5 Marlstone Rock Bed

The Marlstone Rock Bed was encountered in the southern half of the site. This generally consisted of medium to high strength, red brown and brown, sandy, gravelly, residual clay over moderately strong, blue grey and red brown banded, shelly, partially weathered limestone.

4.1.6 Whitby Mudstone Formation

The Whitby Mudstone Formation was encountered in the southern end of the site and consisted of a layer of medium to high strength, firm to stiff, brown and yellow brown mottled, gravelly, sandy, silty residual clay which was underlain by weathered limestone of the Marlstone Rock Bed.

4.2 Geo-Environmental Results

Soil Chemistry

The chemical test results are given in Appendix E.

Concentrations of metals and organic compounds (PAHs) were detected above the laboratory detection limit in all soil samples.

As indicated in previous investigations, notable concentrations of arsenic were recorded across the site and notable concentrations of organic contaminants encountered in the northern part of the site associated with the Made Ground. Vanadium was also detected in significant concentrations, although this was not tested for by previous investigators.

It is apparent from the arsenic and vanadium distribution that there are two distinct geochemical provinces related to the underlying geology: the area underlain by the Marlstone Rock Bed and Whitby Mudstone Formation having higher concentrations than the area underlain by the Dyrham and Charmouth Mudstone Formations.

Asbestos

The presence of asbestos was not detected during laboratory analysis on the soil samples. However, due to the uncontrolled nature of the tip the presence of asbestos cannot be discounted.

Leachate Chemistry

Eluate (leachate) testing was undertaken to assess the risk to controlled waters from soil contaminants in line with good practice defined in ISO 15175:2004.

The test results are given in Appendix E.

There is no particular spatial distribution of chemicals of potential concern that requires explanation.

5.0 GENERIC QUANTITATIVE RISK ASSESSMENTS

5.1 Conceptual Site Model

The additional site investigation has not produced any significant changes to the conceptual site model which is summarised as follows.

The site has not been previously developed and has a history of agricultural use. However, it is known that the northern site area has previously been used as a tip. Therefore the site can be split between the tip area and the wider site area.

For the wider site area, testing of samples of natural materials from the site indicates that there are two geochemical provinces: the Marlstone Rock Bed and Whitby Mudstone Formation having higher metal concentrations than the Dyrham and Charmouth Mudstone Formations.

The tip area has been shown to include various types of Made Ground. From the investigation and testing these materials have been found to contain elevated contaminants recorded in various locations throughout the tip.

Only limited groundwater/surface water has been encountered and sampled at the site to date. The south end of the site which overlays the Marlstone Rock Bed is a Secondary A Aquifer and springs are observed at the eastern end of the site which are likely to expel where the Marlstone Rock Bed changes to the either the Dyrham Formation or the Charmouth Mudstone Formation.

The tip area is not underlain by the Secondary A Aquifer and is considered unproductive strata.

The Oxford Canal forms the north eastern site boundary and the River Cherwell is located approximately 230m further to the north.

The plausible contamination linkages are:

- risks to the health of end users of the site from substances in the natural soils and Made Ground;
- risks to plant life from metals in the natural soil and Made Ground; and
- pollution of the surface water environment by runoff of contaminants in the Made Ground.

These linkages are assessed in the following sections.

Generic risk assessment is a two stage process. Firstly, the measured contaminant concentrations are compared to the relevant GACs. This is the Risk Estimation stage. Where there is a suitable dataset, this is done after carrying out statistical analysis to determine the upper confidence limit on the true mean. Otherwise, maximum or specific data points are compared directly.

The second stage, Risk Evaluation, comprises an authoritative review of the findings with other pertinent information, in cases where the GACs are exceeded, in order to consider if exceedance may be acceptable in the particular circumstances.

5.2 Human Health and Plant Life

This is a Tier 2 assessment using soil screening values and involves generic human health risk assessment for the CLEA **residential with plant uptake** land use scenario.

The soil chemical analysis results from this ground investigation and historical ground investigation information have been screened against guideline soil concentrations to provide an assessment of potential risks associated with contamination at the site. Justification for the criteria adopted for this risk assessment is given in Appendix D.

It has been assumed in this report that the exposure conditions are within the generic conditions used to derive Soil Guideline Values (SGVs). Where no SGVs are published, or where the published values require modification, a number of Generic Assessment Criteria (GAC) have been developed for certain chemicals of potential concern. These GAC have been developed using largely generic assumptions about the characteristics and behaviour of sources, pathways and receptors, i.e. similar to those used by the Environment Agency in the derivation of SGVs.

It should be noted that the term “further assessment required” is used to denote soil concentrations that are equal to, or exceed, a GAC. This does not automatically mean that the soil is “contaminated”.

5.2.1 Risk Estimation (Including Statistical Testing)

The ‘averaging areas’ used in this report are based on the conceptual model and the proposed development and are summarised as:

1. the former tip area in the north part of the site which is proposed for residential development; and

2. the wider site area underlain by natural ground of the Marlstone Rock Bed and Whitby Mudstone Formation.

Initial Data Review

The data set for each chemical determinand has been assessed for the presence of potential outliers (based on the conceptual model) and to determine if the data are normally or non-normally distributed, in line with the methods described in Appendix D.

No outliers have been removed.

Statistical Testing

Suitable data sets are available for statistical analysis of the determinands tested.

Using the methodology detailed in Appendix D and in line with the guidance provided by the CIEH (May 2008) the 95th upper confidence level on the true mean (US_{95}) has been calculated from the sample data.

Data have been assessed using the one-sample t-test (for data which can be treated as normally distributed or that do not deviate significantly from normal) or the one-sided Chebychev Theorem (for significantly non-normally distributed data).

Appendix E contains the detailed results of the statistical assessment for each chemical of potential concern, together with summary sheets for human health and plant life. The results are summarised below.

Human Health & Plant Life

With regards to human health, based on a US_{95} exceedance of the GAC, the pervasive chemicals of potential concern which require further assessment and/or remediation are summarised in Table 5.1 and Table 5.2 below.

Table 5.1: Pervasive Chemicals of Potential Concern for Which Further Assessment is Required (Human Health)

Chemical of Potential Concern	Generic Criterion (mg/kg)	Basis for Generic Criterion	No. Samples	Min. (mg/kg)	Max. (mg/kg)	No. Samples Exceeding Generic Criterion	US_{95} (mg/kg)
Tip Area							
Arsenic	32	SGV report + CLEA 1.06	28	12	150	19	80
Vanadium	74	LQM/CIEH + CLEA 1.06	7	0.5	230	4	230
Benz(a)anthracene	4.7	LQM/CIEH + CLEA 1.06	19	0.031	36	4	16
Benzo(a)pyrene	0.94	LQM/CIEH + CLEA 1.06	19	0.017	56	9	20
Benzo(b)fluoranthene	6.5	LQM/CIEH + CLEA 1.06	19	0.047	40	4	16.2
Chrysene	8	LQM/CIEH + CLEA 1.06	19	0.027	40	4	18
Dibenz(a,h)anthracene	0.86	LQM/CIEH + CLEA 1.06	19	0.01	4.5	4	1.8
Indeno(1,2,3,cd) pyrene	3.9	LQM/CIEH + CLEA 1.06	19	0.01	43	4	15
Naphthalene	3.7	LQM/CIEH + CLEA 1.06	19	0.01	42	3	14
Wider Site Area Underlain by Marlstone Rock Bed and Whitby Mudstone Formation							
Arsenic	32	SGV report + CLEA 1.06	40	17	230	37	111
Vanadium	74	LQM/CIEH + CLEA 1.06	16	100	740	16	550

Table 5.2: Pervasive Chemicals of Potential Concern for Which Further Assessment is Required (Plant Life)

Chemical of Potential Concern	Generic Criterion (mg/kg)	Basis for Generic Criterion	No. Samples	Min. (mg/kg)	Max. (mg/kg)	No. Samples Exceeding Generic Criterion	US_{95} (mg/kg)
Wider Site Area Underlain by Marlstone Rock Bed and Whitby Mudstone Formation							
Nickel	75	BS3882 2007	40	29	210	31	127
Zinc	300	BS3882 2007	23	74	970	5	394

5.2.2 Risk Estimation (Without Statistical Testing)

In this section the results are discussed for determinands for which the data set does not allow application of statistical analysis by virtue of low sample numbers. This applies to the wider site area underlain by natural ground of the Dyrham and Charmouth Mudstone Formations.

Reference to the summary sheets in Appendix E shows that there are no exccedances of the GACs for human health or plant life.

5.2.3 Risk Evaluation – Human Health

Tip Area – Made Ground

The metals in the Made Ground are likely to have been derived from soils in the region because the tipped material appears to be construction waste incorporating a significant proportion of soil. The comments made below concerning natural soils elsewhere apply. However the risk driver is seen to be the PAHs in the Made Ground. As an example, benzo(a)pyrene is present at a concentration of 60 times the GAC and consequently the soils in this area are considered unsuitable for use as near surface soils in residential developed areas of the site and mitigation measures will be required.

Wider Site Area Underlain by Marlstone Rock Bed and Whitby Mudstone Formation

Chemical testing has indicated elevated concentrations of arsenic and vanadium above the GACs. DEFRA (2005) has made it clear that exceedance of a GAC does not necessarily meet the legal test of contaminated land, i.e. exceedance of a GAC does not necessarily equate to unacceptable risk. Consequently, the GACs must be considered as screening values only and the exceedances have been further assessed below.

Arsenic

Chemical testing has indicated pervasive concentrations of arsenic ranging from 17 to 230mg/kg with a US_{95} percentile of 111 mg/kg within the natural soil.

There is also a naturally high background level of arsenic in the area, which ranges from 30 to 820mg/kg and, as with vanadium, this is not considered a significant risk.

In addition the six PBET test results at the site means it is possible to assess the percentage of arsenic that is bioaccessible and integrate this information into the CLEA model to derive a Site Specific Assessment Criteria (SSAC) for this area of the site.

Using the highest percentage of arsenic bioaccessibility encountered in the areas underlain by the Marlstone Rock Bed formation a worst case of 5.9% bioaccessibility has been used.

The CLEA model has therefore been used to produce SSAC. All other parameters were set to default values in the CLEA v1.06 model, run for residential with plant uptake, which generated an SSAC of 136 mg/kg. This is greater than the US_{95} which indicates no significant risk.

It is concluded that no further assessment or mitigation with regard to arsenic is required. This has been confirmed by Mr S Gregory, Environmental Protection Officer at Cherwell DC (email to Hydrock dated 28 February 2013).

Vanadium

The GAC for vanadium (74mg/kg) is exceeded in the area of the site underlain by the Marlstone Rock Bed and Whitby Mudstone Formation, with the US_{95} being 550mg/kg.

These strata are known to have naturally high levels of vanadium, which in this area range between 122mg/kg and 626mg/kg according to the *Advanced Geochemical Atlas of England and Wales* (Rawlins *et al* 2012) which states that elevated concentrations in the UK occur mainly over Jurassic strata especially between Banbury and Melton Mobray (spatially associated with the ironstones).

According to Breward (2007) the vanadium may be a resistate element, one whose host minerals are highly resistant to both chemical and physical weathering and hence have a very long residence time in soils and sediments. However, there is a strong correlation between iron and vanadium concentration and Breward attributes this, at least in part, to *in situ* sorption and concentration by sedimentary iron oxides during their formation. It is possible that an Fe(III) vanadate complex replacement mineral related to the strengite-scorodite group is formed. The arsenic and other trace elements in the soil are similarly attributed to co-precipitation enhancement during mineral formation.

Comparing the sediment and the stream water vanadium contents, Breward concludes that because of the stability of the iron oxides, the environmental mobility and bioaccessibility of the vanadium (and arsenic) is extremely low.

Whichever of these mechanisms is the actual one operating, this means that the vanadium is tightly bound in the mineral crystal lattice and has survived as such for millions of years. These strata are of Toarcian age, which spans the time between 183.0 and 175.6 million years ago.

The GAC report (Nathanail *et al* 2009) states that naturally occurring vanadium in soils is generally relatively insoluble V(III), but can be present in the more soluble V(V) form. The bulk of and released vanadium is retained in the soil, associated with the organic matter because humic acids convert the more mobile meta-vanadate anions into the immobile vanadyl cations resulting in local accumulation. There may be some mobility under oxidising, unsaturated conditions, but the vanadium is immobile under reducing, saturated conditions.

Consequently, this exceedance is not likely to constitute a significant risk to human health, in line with the current Contaminated Land Statutory Guidance, which accepts that there may be natural background levels of substances as a result of geology.

Further consideration of the likely risks can be undertaken by way of a sensitivity analysis of the CLEA 1.06 derived GAC. The GAC is an initial screening value and not a remediation standard and as such is very conservative. It is designed to protect against all forms of vanadium, most particularly the most common commercial form, vanadium pentoxide, which is a strong oxidising agent and has many important industrial uses.

The GAC report (Nathanail *et al* 2009) states that vanadium occurs in six oxidation states and has a complex chemistry, forming more compounds than any element except carbon. The toxicologically most significant ones are V_2O_5, $NaVO_3$, Na_3VO_4, $VOSO_4$ and NH_4VO_3. The toxicity increases with the oxidation state (Expert Group on Vitamins and Minerals 2003) and the toxic effects are mostly the result of inhalation, with very few reported cases relating to ingestion. In fact, vanadium is used in dietary supplements as $VOSO_4$ and $NaVO_3$ up to 0.025mg/day, although there is no evidence to support any useful effect. According to the Oak Ridge National Laboratory (Opresko 1991) V(V) is five times as toxic as V(III).

The Health Criterion Values (HCV) used in the CLEA model are designed to protect against the simple, and much more toxic, vanadium compounds. The complex vanadium-iron minerals of the soils beneath the site will display significantly reduced toxicity.

There is no information available, however, that can be used to redefine the HCV with respect to these minerals and so the default values are retained in this exercise.

An important parameter in the derivation of the GAC is the soil-water partition coefficient (Kd). This dictates how much of the vanadium stays in the soil and how much can go into solution, thereby making it mobile and capable of entering the vascular system in the body. The range of values reported in the GAC report, Section 7.7.3, is 12.6-1000 l/kg. One of the studies cited was by the USEPA (2005) which reported a range of 3.2-316, with a mean of 50.1 l/kg. The lowest value was adopted in the derivation of the GAC as the default because of this high range the authors wished to be as conservative as possible.

There is insufficient data available to derive a site-specific Kd value, so a range of values has been tried in the sensitivity analysis.

The highest solubility in water was adopted by the GAC authors (Section 7.7.2 of the report) as a conservative value. However, sensitivity analysis has shown the GAC to be insensitive to solubility in this instance and the default value has been retained.

As mentioned by Breward above, the bioaccessibility is much lower than the 100% assumed as a default in the CLEA model. This is mentioned by a number of sources, including Oak Ridge National Laboratory which reports 0.5-2% for ingestion and 20-25% for inhalation. The maximum values have been adopted in this exercise.

Accordingly, the CLEA model has been run setting the oral and inhalation relative bioavailabilities to 0.02 and 0.25, respectively and varying the Kd. In order to use the Kd in the model, the soil to plant concentration factors are changed from the default numerical values in the GAC report to those calculated internally by the CLEA model. This has been verified by running the model with all the vanadium defaults and only changing these factors, and there is no change to the residential GAC.

The results of the sensitivity analysis for Kd are as follows:

Kd (l/kg)	**Residential SSAC (mg/kg) (Two significant figures)**
12.6 (default)	120
45	380
48	410
50	420
60	490
69	550
70	560
100	730

It can be seen that for the SSAC to be the same as the US_{95}, the Kd need be only 69 l/kg and this is well within the range of literature values of 12.6-1000 l/kg and is close to the mean value quoted by the USEPA.

Given the published comments concerning the stability of the iron-vanadium minerals, it is entirely feasible that the Kd will be 69 l/kg or greater.

Furthermore, the US_{95} of 550mg/kg is based on the use of the non-parametric statistical test (Chebychev Theorem) as a conservative measure. The visual assessment of the normality of the data set distribution is included in Appendix E as a Q-q plot and histogram. Although the data are non-normal, the degree of non-normality is not great and it is highly likely that the parametric statistic (t-test) could cope (Barnes *et al* 2010). A check using the Shipiro-Wilk test for normality shows the data set to be just outside the definition of normally distributed because the W statistic is 0.813, a only little below the W-critical value of 8.887.

In which case, the US_{95} would be 405mg/kg and the required Kd would be 48 l/kg, less than the USEPA (2005) mean value.

Given that such a large swathe of the country is underlain by sediments of this nature, there will be a great number of developments where no mitigation measures have been incorporated. Indeed, it is believed that the current site use includes the commercial production of vegetables. Hydrock is not aware of any evidence to suggest that existing residents are being affected by the presence of naturally occurring vanadium.

It is concluded that the presence of naturally-occurring vanadium is not a significant risk to human health.

This assessment has been presented to Cherwell DC for consideration, but no reply has been received at the time of writing.

5.2.4 Risk Evaluation – Plant Life

Plant Life

With regards to plant life the testing and statistical assessment to date indicates apparently pervasive nickel and zinc with US_{95} of 127mg/kg and 394mg/kg versus GAC of 75mg/kg and 300mg/kg, respectively. With reference to *Advanced Geochemical Atlas of England and Wales* (Rawlins *et al* 2012), high zinc and nickel are expected within the Marlstone Rock Bed.

Whilst detriment to plant life is hard to quantify as many of the GACs are based on agricultural crop yields rather than serious harm of death of a species. The exceedance for zinc is slight and that for nickel is not large. Given that the vegetation on site did not show any signs of physical distress and the land is currently use for farming, Hydrock does not believe any additional consideration is required with regards to risks to plant life.

5.3 Pollution of Controlled Waters

5.3.1 Risk Estimation

The risks to groundwater and surface water have been assessed according to the remedial targets methodology (RTM) prescribed by the Environment Agency (2006) as described in Appendix D. Pollutant inputs from contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC) (WFD) and its daughter Directives, and as such are regulated under the Agency's 'limit' pollution objective.

Acceptable water quality targets (WQT) are defined for protection of human health (based on drinking water standards (DWS)) and for protection of aquatic ecosystems (environmental quality standards (EQS)). For the purposes of this report, the site data are compared with the various targets as set out according to the Hydrock scenario(s) in Table 5.2 (see Appendix D for details), on the basis of the following:

- the tip area in the north of the site is underlain by the Charmouth Mudstone Formation which is classified as unproductive strata and the Oxford Canal is adjacent to the east of the tip area, therefore there is a low risk of leachate entering the Oxford Canal through surface water runoff or leachate migration; and
- the southern part of the site underlain by the Marlstone Rock Bed and Whitby Mudstone Formation is underlain by a Secondary A Aquifer and therefore there is a low risk of leachate entering the aquifer and migrating to the Oxford Canal to the east of the site.

Table 5.2: Summary of Water Quality Risk Assessment Protocol

Hydrock Scenario	Water Body Receptors	Secondary Receptors	Example Contaminant linkages	RTM Level and Data Used	Water Quality Targets
Tip area					
F	Surface water.	Aquatic ecosystem.	Contaminants from site leach or seep into surface water which may be an aquatic ecosystem.	RTM Level 1 - Soil leachate.	EQS (inland)
Wider Site Area					
B	Groundwater. Surface water.	Aquatic ecosystem.	Contaminants from site leach or seep into groundwater body and this feeds surface water by base flow. The surface water may be an aquatic ecosystem.	RTM Level 1 - Soil leachate.	EQS (inland)

Notes:
Some EQS are water hardness dependent. This is measured either in the receiving water or in groundwater (if it is part of the pathway), or is estimated from national maps.
Inland waters EQS applicable to freshwater, other waters EQS applicable to marine or transitional waters.
Where both DWS and EQS are applicable, it is assumed that the EQS is for inland waters.
This table and the results of the assessment are considered as a first screening for potential risks of pollution of Controlled Waters. More specific requirements may be stipulated by the Environment Agency.

The results of the remedial targets methodology assessment are presented in Appendix E and are summarised in Table 5.3.

It should be noted that in some instances the reporting limit (or detection limit) quoted by the laboratory may be greater than the water quality target that it is being assessed against. As the current exercise is an initial screening assessment, further assessment of these elements has not been undertaken if all the results for all samples are below the detection limit but above the water quality target. However, in other cases, even though the detection limit is greater than the water quality target, some sample results do exceed the target and assessment is viable. See Appendix D for comment on detection limits.

Table 5.3: Chemicals of Potential Concern for Which Further Assessment is Required (Controlled Waters)

Chemical of Potential Concern	Water Quality Target (ug/l)	Basis for Water Quality Target	No. Samples	Min. (ug/l)	Max. (ug/l)	No. Samples Exceeding Target
Tip Area						
Cu (dissolved)	6	Inland Water EQS	2	1	6.3	1
Benzo(a)pyrene	0.05	Inland Water EQS	2	6.7	8.9	2
PAH sum of benzo(b)fluoranthene benzo(k)fluoranthene	0.03	Inland Water EQS	2	0.02	1.21	2
Fluoranthene	0.1	Inland Water EQS	2	0.01	0.6	1
Naphthalene	2.4	Inland Water EQS	2	2.6	3.3	2
Wider Site Area						
Fe (dissolved)	1000	Inland Water EQS	20	1	1200	1
Zn (total)	8	Inland Water EQS	21	1	27	4
Benzo(a)pyrene	0.05	Inland Water EQS	12	0.02	7.1	2

Chemical of Potential Concern	Water Quality Target (ug/l)	Basis for Water Quality Target	No. Samples	Min. (ug/l)	Max. (ug/l)	No. Samples Exceeding Target
Tip Area						
Fluoranthene	0.1	Inland Water EQS	12	0.01	1	1
Cr(iii)(diss)	417	Inland Water EQS	15	1	8	2
Note: the 95%ile value is compared with the water quality target and a June 2007 Site Investigation of the Spring and Surface Water demonstrated no exceedances of the Inland Water EQS. * The Water Supply Regulations 1989 and the Private Water Supply Regulations 1991 both contained a prescribed concentration of 10 µg/l for "dissolved or emulsified hydrocarbons (after extraction with petroleum ether); mineral oils". This was removed when these Regulations were updated in 2000 (consolidated 2007) and 2009, respectively. However 10 µg/l is used in this report as an initial screening assessment as it is frequently the preferred approach of the Environment Agency.						

5.3.2 Risk Evaluation

Tip Area – Made Ground

The data indicate that the EQS are exceeded for copper and various PAH species.

The surface gradient is to the eastwards to the Oxford Canal but no groundwater was encountered within the Made Ground with the exception of a slight seepage of perched water in HTP3.

In general, it can be concluded that the Made Ground within the tip area is contaminated with leachable copper and PAHs. However it is that unlikely that contaminants are significantly mobile due to the high clay content of the Made Ground and underlying solid geology and any lateral movement away from the Made Ground would degrade due to natural attenuation of the of the leachate. In addition the proposed development will add hard standing and soil cover that will further limit the potential for the infiltration of water into the Made Ground and further minimise the potential migration of contaminants within the Made Ground.

Whilst there are elevated concentrations of Chemicals of Potential Concern, based on the investigation works undertaken to date and subject to agreement with the Environment Agency, Hydrock does not believe the site poses a significant risk to Controlled Water for the following reasons:

- the high clay content of the Made Ground and underlying Charmouth Mudstone Formation forms an aquiclude to prevent migration of leachate vertically and laterally to the Oxford Canal, which is not at risk;
- the shallow waters at, and in the vicinity of, the site are not abstracted for human consumption;
- whilst the ecosystem in the Oxford Canal to the east of the tip area is a potential receptor, the reduction of concentrations due to leachate attenuation will reduce the risks as the distance from the Made Ground increases. In addition the Wardell Armstrong 2007 site investigation tested a sample of water associated with the canal and no exceedances of the GAC were noted; and
- subject to a piling risk assessment showing no additional pathways to the Oxford Canal, no changes to the groundwater regime are expected to occur during development.

Wider Site Area – Natural Ground

The data indicate that the EQS are exceeded for metals (chromium (III), iron and zinc) and PAH species (benzo(a)pyrene and fluoranthene) leachate within the natural ground.

The general groundwater gradient is to the east and follows the surface contours. The groundwater in Marlstone Rock Bed provides base flow to the springs in the east of the site. A limited suite of metals were determined in the 2007 investigation at the site, in two spring water samples. The current (2013) EQS for copper was exceeded in one of these samples.

There is no obvious source of PAHs in the natural soil and the most likely explanation is fall-out from atmospheric pollution.

Whilst there are elevated concentrations of Chemicals of Potential Concern, based on the investigation works undertaken to date and subject to agreement with the Environment Agency, Hydrock does not believe the site poses a significant risk to Controlled Water for the following reasons:

- the elevated metals are likely attributed to the underlying geology of the Marlstone Rock Bed and are typical of the wider area; and
- the PAHs are likely to be derived from atmospheric pollution and not a source of PAHs within the soil.

5.3.3 Radon

Reference to the Annex A maps in BR 211 (Scivyer 2007), based on the Indicative Atlas of Radon in England and Wales (Miles *et a*l 2007) indicates that **full** radon protection is required for new dwellings at this location in line with current guidance.

5.4 Summary of Findings of the Generic Risk Assessments

Particular areas of the site which are of potential concern are indicated on the Geo-environmental Zonation Plan (Drawing C12702-G003) in Appendix A.

Table 5.4: Summary of Unacceptable Contaminant linkages

Receptor Group	Unacceptable Pervasive Pollution Source
Human Health	PAHs and potential asbestos containing materials in the Made Ground associated with the tip area in the north of the site. Elevated naturally occurring vanadium in the areas underlain by the Marlstone Rock Bed and Whitby Mudstone Formation are not considered to represent a risk to human health, but this has yet to be confirmed by the Local Authority.
Human health / property (from ground gases)	Full radon protection is required for new dwellings at this location in line with current guidance.
Controlled Waters	None
Plant Life	None

6.0 GEO-ENVIRONMENTAL CONCLUSIONS AND RECOMMENDATIONS

6.1 Human Health

Approximately 3.3ha of the northern site area is known to have been used to deposit Made Ground where trial pits have recorded up to 4m of builders' waste in a gravelly, sandy, clayey matrix.

The risk assessment undertaken in Section 5.2 indicates that the Made Ground constitutes an unacceptable risk from PAHs. Asbestos containing materials were encountered in a previous investigation. This area will require remediation / mitigation prior to redevelopment for residential end use.

Proposed mitigation options include:

- removal of Made Ground, and / or
- installation of a clean cover over remaining areas of Made Ground.

One on the contaminants of concern is naphthalene, which is semi-volatile and smells of moth balls. It is not possible to say if a cover on its own would severe the indoor vapour pathway and numerical modelling is notoriously uncertain. Even if there are no adverse health effects, there may be residual nuisance odours. For these reasons the addition of a vapour membrane in buildings is recommended. However, since full radon protection measures are also required, it will be possible to design the radon barrier to also prevent the ingress of naphthalene vapours.

Outline mitigation measures are discussed in Section 6.6.

6.2 Controlled Waters

The Level 1 risk assessment undertaken in Section 5.3 indicates that whilst there are elevated concentrations of Chemicals of Potential Concern Hydrock does not believe the site poses a significant risk to Controlled Waters. Consultation with regulators is recommended to confirm this.

6.3 Construction Materials

6.3.1 Water Pipelines

The current guidance on selection of materials for water supply pipes to be laid in contaminated land is contained in UKWIR Report 10/WM/03/02 (re-issued 2010) which sets out in Table 3.1 of that document threshold values for a selection of organic contaminants that may have a detrimental effect on pipes and fittings. However, the document is for guidance and is not mandatory and has not been adopted universally by all water suppliers.

In addition, various consultative technical bodies have expressed concern on the nature of the document and the methodologies proposed, which would result in significant cost and time implications for all site assessments. It is Hydrock's opinion that the guidance is not appropriate and it has not been followed as part of this report.

However, the findings of this investigation have been compared to the threshold values in UKWIR Table 3.1 as far as is practicable to give an indication of the possible restrictions to the use of plastic water pipes.

The majority of the site is greenfield and the investigation and assessment has indicated elevated concentrations of naturally occurring arsenic, vanadium associate with the underlying Marlstone Rock Bed. It is envisaged that standard pipework will be suitable for the site. However, this investigation was not designed specifically for water pipe runs and because of conflicting and ambiguous guidance, confirmation should be sought from the water supply company at the earliest opportunity.

The tip area in the north is brownfield and organic contamination (including benzo(a)pyrene) has been identified in exceedance of the threshold values and Hydrock believes barrier pipe is required where water supply pipes are to be place within this material. However, confirmation should be sought from the water supply company at the earliest opportunity.

6.4 Precautions Against Ground Gases

6.4.1 Radon

Current advice based on the BR 211 Report states that full radon protection is required for new dwellings across the entire site.

6.4.2 Landfill Gases

For the tip area in the north, all six of the required monitoring visits have been completed in previous investigations. The ground gas readings and gas regime conceptual model are considered to be sufficiently rigorous to provide an assessment of the ground gas regime and the scope of protection measures in accordance with CIRIA Report C665 (Wilson *et al* (2007).

For Situation B the Made Ground associated with the tip area in the northern part of the site, may be classified as “Green” and no protection would be required in new build in respect of methane or carbon dioxide in near surface soils.

6.5 Waste Management

Any material excavated on site may be classified as waste and it is the responsibility of the holder of a material to form their own view on whether or not it is waste. This includes determining when waste that has been treated in some way can cease to be classed as waste for a particular purpose.

One of the ways this can be achieved is set out in the Development Industry Code of Practice (CoP) (CL:AIRE, March 2011). This builds on the Environment Agency guidance document *Definition of waste: developing greenfield and brownfield sites* (2006).

The handling, re-use or disposal of waste is regulated by the Environment Agency. The Agency will take into account the use of the CoP in deciding whether to regulate materials as waste. If materials are dealt with in accordance with the CoP, the Agency considers that those materials are unlikely to be waste at the point when they are to be used for the purpose of land development. This may be because the materials were never discarded in the first place, or because they have been submitted to a recovery operation and have been completely recovered so that they have ceased to be waste.

Further details of the CoP and the classification of waste are presented in Appendix D.

6.6 Outline Remedial Strategy

A cut and fill remedial strategy for the site will have to be developed in consultation with the design team and the regulatory authorities. Liaison should be continued during implementation and subsequent verification. The following approach is suggested for the area of Made Ground associated with the tip in the northern part of the site.

It is understood that the proposed development ground levels are to be raised over the majority of in this area to facilitate development, but there may also be some removal of materials in parts.

The material removed, if geotechnical suitable could be used to raise levels under roads and hard standing, or under proposed public open space, as long as a suitable cover or contaminant pathway breakage is in place to prevent direct contact with the Made Ground by end users of the site.

Through an appropriate Materials Management Plan (e.g. reuse of Made Ground on site with appropriate capping system) and on site processing of materials (e.g. separation of inert materials) the development will keep as much of the Made Ground material on site as possible, thus minimising vehicle movements and landfilling.

The ‘fine’ fraction, containing the soil, will require sampling (e.g. one sample per 500m^3) to aid in the assessment of its suitability for re-use on the site. Depending on the results of the testing, the soils generated from the screening process will either be reused on site as either clean cover or, if the material is contaminated, as fill material to raise the site levels, where required and be covered by an appropriate clean cover.

Areas of Made Ground under gardens and public open space will require a clean cover of a minimum of 600mm thickness (designed in accordance with BRE guidance (Hollingworth 2004)). The extent and total thickness will need to be estimated from knowledge of the existing and final ground levels.

Foundations will have to be taken down to natural ground and consideration given to protection of water supply pipes and other utilities.

Full radon protection measures will be required and these should be capable of preventing ingress of naphthalene vapours in the tip area.

The methodology for the remediation should be detailed in a Remediation Method Statement which will need to be submitted to the NHBC and the regulatory authorities for approval.

Following completion of the above works verification reports, undertaken by a suitably qualified independent engineer will be required.

7.0 GEOTECHNICAL INTERPRETATION AND RECOMMENDATIONS

7.1 Geotechnical Categorization of the Proposed Development

Eurocode 7, Section 2 advocates the use of geotechnical categorization of the proposed structures to establish the design requirements. For the purposes of this investigation, the proposed structures have been classed as Geotechnical Category 1.

7.2 Geotechnical Aspects of the Development

Geotechnical aspects of the site are discussed in the following sections. Specific areas of potential concern are associated with the appropriate foundations and earthworks associated with the proposed development.

7.3 Site Preparation, Earthworks, Groundworks and Landscaping

A rising sewer main and water main cross the eastern edge of the site from north to south. During the site investigation, works were undertaken in an attempt to locate the rising main. A manhole on the north eastern boundary of the site was dewatered for inspection and though the sewer pipe was not seen, the base of the manhole was approximately 7.5 m bgl, indicating the significant depth of the rising main and thus explaining the lack of success in locating the rising main through hand digging south of this point.

Where the proposed development is in close proximity to existing live services, they must be located and a wayleave clearly marked prior to undertaking ground works in the vicinity. Excavation in close proximity to live services will need to ensure that the excavation walls are stable or appropriately battered to a safe angle.

Temporary slope stability works may be required in any deep excavations.

Whilst no buried obstructions were encountered in the wider site area, an obstruction consisting of a large boulder-sized section of brick wall was encountered within the Made Ground in the tip area. Obstructions like this may affect piling and it is recommended that an allowance be made for removal or breaking up of obstructions.

Following the removal of obstructions, excavations of shallow soils should be feasible for conventional plant and equipment.

Significant excavation into the Marlstone Rock Bed may require the use of pneumatic breakers or rock rippers and there will be a reduction in progress where their use is necessary.

Topsoil and unsuitable Made Ground should be removed from beneath all building and hard standing areas.

Spoil resulting from excavations within the Made Ground may be suitable for reuse as fill to raise site levels elsewhere within the tip area, subject to its suitability with respect to appropriate geotechnical and geo-environmental specifications. Contaminated material should not be re-used on any part of the site currently uncontaminated.

Excavations undertaken during site works in the eastern edge of the site encountered unstable conditions in the sand and given the loose nature of the shallow material associated with the Charmouth Mudstone Formation and the high water table in this area, all excavations in the eastern end of the site should be supported and groundwater control may also be needed. Well-pumping may be required for dewatering as sump pumping will increase the instability of unsupported ground in these conditions.

It is recommended that no site personnel enter any trenches unless there is adequate support and this has been assessed by a competent person.

Groundwater seepages were encountered in the trial pits at shallow depths elsewhere on the site. In places where the sides are stable, groundwater seepage during excavation can be dealt with by sump pumping.

Groundwater levels may vary from those at the time of the investigation, for example in response to seasonal fluctuations.

The proposed development aims to generally raise levels and where material needs to be removed for either geotechnical or geo-environmental reasons (such as installation of a suitable capping layer or the excavation of foundations trenches) it is considered that the reuse of existing soils as part of redevelopment proposals will be necessary. The earthworks will need to be undertaken under a Materials Management Plan to ensure the appropriate management and reuse of the existing soils. Where the earthworks perform a structural role, a suitable specification will be required.

7.4 Foundations

The recommendations in this report follow NHBC Standards Chapter 4.2 (2011).

The preliminary foundation designs in this section are based on the parameters given by the 2012 Wardell Armstrong Report in Section 2.9.8. Selection of geotechnical design parameters should be undertaken in conjunction with the design process and discussed in a separate Geotechnical Design Report. For the consideration of foundations the site has been split into three separate areas as a result of the different ground conditions encountered. These areas are as follows and are highlighted on the Foundation Zonation Plan (Drawing C12702-G004) in Appendix A.

- Tip Area – at the northern end of the site underlain by Made Ground of varying thickness over the Charmouth Mudstone Formation;
- The Northern Area Outside of the Tip Area - in the northern part of the site, south of the tip area, underlain by the Charmouth Mudstone Formation; and
- The Southern Area of the site - underlain by the Whitby Mudstone Formation and the Marlstone Rock Bed.

7.4.1 Development Foundations for the Tip Area

The proposed finished levels in this area are generally to rise.

It is estimated that the combined existing Made Ground and proposed land-raise fill along the western edge of the site ranges from 0.5m in the north western corner to 2.8m in the south western corner. As a result, it is anticipated that trench fill spread foundations should be appropriate for the proposed row of plots along the western boundary of the tip area, to found in the underlying natural soils. This is shown on the Foundation Zonation Plan (Drawing C12702-G004), but will require confirmation by way of a plot-by-plot foundation assessment. The Wardell Armstrong Report outlined that the clays in the Charmouth Mudstone Formation are subject to moderate to high volume change potential, which should be taken into account in the separate Geotechnical Design Report.

The depth of foundations should be designed and the formations inspected by a geotechnical engineer. Any sub-formation materials deemed as unsuitable such as soft or loose zones should be excavated and replaced with well compacted suitable granular fill or lean mix concrete.

Foundation excavations should be protected from water and inclement weather including frost and any water should be removed by pumping from a sump in the base of the excavation.

Foundations which span founding materials of different stiffness should have mesh reinforcement placed top and bottom of the foundation.

The estimated thickness of existing Made Ground and land-raise fill across the remainder of the tip area is approximately 4.3m in the centre (at TP7), falling to 2.5m on the eastern edge of the tip (at HTP06). In addition, there are unstable natural ground conditions along the eastern edge of the tip area at the bottom of the slope next to the Oxford Canal (caused by water seepage promoting running sand conditions). At this stage, piled foundations are recommended in these areas, as highlighted on the Foundation Zonation Plan (Drawing C12702-G004).

The piles should be designed to penetrate into the stiff clay of the Charmouth Mudstone, gaining support from shaft adhesion and end bearing in the Charmouth Mudstone. Negative skin friction should be allowed for in the Made Ground and land-raise fill.

Bored or continuous flight auger cast *in situ* concrete piles or driven preformed concrete piles are considered suitable for the ground conditions at the site. Care should be taken with cast *in situ* piles where collapse of the pile shaft or running sand conditions could lead to ‘necking’ of the pile. A specialist piling contractor should be consulted for selection of appropriate piling method. An assessment should be made if driven piles are considered, as these may be subject to excessive noise or vibration which may be unacceptable to neighbouring properties.

Piles should be installed through the Made Ground and the sand deposits into the Charmouth Mudstone to estimated depths of between 5 and 10 m, but the final design will depend on detailed assessment by the piling contractor.

A working platform will be required to be designed and constructed prior to arrival on site of tracked piling plant. This should be designed and installed in accordance with BR470 (BRE 2004) based on data on the piling plant in accordance with an FPS certificate for the rig loadings.

7.4.2 Development Foundations for the Northern Area Outside of the Tip Area

The proposed finished levels in the northern end of the site outside of the former tip are to be raised by up to 1m from the existing site levels. Therefore, if founding strata are found to be deeper than about 2m bgl then spread foundations would be inappropriate and a piling solution would be required.

A review of the historic exploratory holes in the area show the depth to competent founding strata ranges from 0.2 to 3m bgl with no obvious spatial pattern.

As a result of the variable ground conditions, a combination of spread foundations and piled foundations would be appropriate in this area. This would need to be assessed by a plot by plot basis.

Both the spread and pile foundation solutions should be designed to penetrate into the stiff clay of the Charmouth Mudstone.

The clays in the Charmouth Mudstone Formation are subject to moderate to high volume change potential these issues should be taken into account in the separate Geotechnical Design Report.

The depth of spread foundations should be designed and the formations inspected by a geotechnical engineer. Any sub-formation materials deemed as unsuitable such as soft or loose zones should be excavated and replaced with well compacted suitable granular fill or lean mix concrete.

Spread foundation excavations should be protected from water and inclement weather including frost and any water should be removed by pumping from a sump in the base of the excavation.

Spread foundations which span founding materials of different stiffness should have mesh reinforcement placed top and bottom of the foundation.

7.4.3 Development Foundations for the Southern Area of the Site

The proposed finished levels in the southern part of the site are to be raised by up to approximately 0.15m from the existing levels.

The Wardell Armstrong Report 2012 states that as strip foundations up to 1.0m depth below existing ground levels with a minimum a safe bearing pressure of 100kPa would be considered appropriate for properties within the south of the site. Depending upon local conditions and the type of building and loadings proposed higher bearing pressures may be appropriate. Localised softer zones may dictate the requirement for deepened foundations and or excavation / removal / controlled replacement operations to be carried out.

In response to the ground conditions that have been identified at the site, it is considered that a spread foundation solution is likely to be appropriate for the proposed development in the south of the site.

In accordance with NHBC Standards Chapter 4.2 a minimum foundation depth of 0.9m will be required for strip and trench fill foundations extending through any topsoil or Made Ground into the Marlstone Rock Bed low volume change potential clays.

The foundations should be placed within the firm to stiff clay of the Marlstone Rock Bed. Within these materials a safe bearing pressure of 125kPa can be assumed which includes a factor of safety of 3.0 against general shear failure and will limit total foundation settlement to less than 25mm for foundation widths up to 1m.

On the basis of the site investigation, founding strata is anticipated to be at between 0.25m bgl and 0.4m bgl. However, this is subject to confirmation by a suitable competent person during excavation.

The depth of foundations should be designed and the formations inspected by a geotechnical engineer. Any sub-formation materials deemed as unsuitable such as soft or loose zones should be excavated and replaced with well compacted suitable granular fill or lean mix concrete.

Foundation excavations should be protected from water and inclement weather including frost and any water should be removed by pumping from a sump in the base of the excavation.

Foundations which span founding materials of different stiffness should have mesh reinforcement placed top and bottom of the foundation.

7.5 Foundations and Plants

Deepening of spread foundations in accordance with NHBC Standards will be required where foundations are within the zone of influence of existing or proposed trees and proposed shrub planting in accordance with the measured soil shrinkage on each clay soil type. Where foundations are within the influence of trees and are deeper than 1.5m bgl, a suitable compressible material or void former will be required.

Where foundations require deepening to greater than 2.5m below ground level, they must be designed by an engineer, as specified in NHBC Technical Requirement R5.

7.6 Ground Floor Slabs

In the northern part of the site associated with the tip area as Made Ground is greater than 600mm thick and clay soils of moderate to high volume change potential are present at the site, it is recommended that suspended floor slabs should be adopted, in accordance with NHBC Standards.

Ground bearing slabs may be used in the south of the site if the following criteria are satisfied:

- the foundation depth (such as due to the influence of trees) is less than 1.5m;
- any fill is suitable, well-compacted granular material and less than 600mm thick; and
- it is demonstrated that desiccation is not present and soils are at their equilibrium moisture content.

Prior to the placement of the founding materials and the construction of the ground bearing floor slab, the sub-formation and formation will need to be inspected and checked by a geotechnical engineer to ensure the ground conditions are as expected. This is likely to include sufficient appropriate testing, carried out in accordance with the DMRB IAN 73/06, to confirm the ground conditions at time of construction are consistent with the previous design parameters derived from this ground investigation.

If low bearing and soft strata are identified at the formation, this should be reported to the Geotechnical Engineer immediately and remedial actions agreed.

Ground floor slabs should be designed to incorporate any gas mitigation measures that may be required as discussed within the previous sections of this report.

7.7 Roads and Pavements

As part of the Wardell Armstrong 2012 report a total of ten CBR tests were undertaken across the site area generally within the locations of the proposed roads to be installed as part of the development works. The results of the testing indicate that CBR results at depths of *circa* 0.5m below existing ground level may be expected to vary from 3.0% to 12.0% within the southern section of the site close to Oxford Road (CBR104 to CBR110) with CBR values of between 0.9% and 1.6% within the smaller development area in the northern section of the site adjacent to the Oxford Canal.

The results of the CBR testing may be used to inform the detailed pavement design and appropriate sub-grade thicknesses.

Based on the test results, it is considered likely a CBR of 5% will be achievable over the south of the site of the site and can be used for preliminary design, subject to *in situ* testing during construction.

Proof rolling of the formation level will be required and any loose or soft spots to be removed and replaced with an engineered fill, in accordance with a suitable Specification. The formation level will also need to be protected during inclement weather from deterioration; all slopes shall be trimmed to falls to shed rain water and the surface sealed to limit infiltration.

Prior to the placement of the founding materials and the construction of the road pavement, the sub-formation and formation will need to be inspected and checked in accordance with a suitable Specification to ensure the ground conditions are as expected. All testing should be carried out in accordance with DMRB IAN 73/06 and confirm that the ground conditions at time of construction are consistent with the previous design parameters.

In the northern part of the site where the CBR is found to be less than 2.5%, the sub-grade may be unsuitable for both the trafficking of site plant and as support for a permanent foundation, without improvement works being undertaken. Improvement works should be carried out in accordance with DMRB IAN 73/06 Rev 1 Chapter 5. In summary, consideration may be given to the following potential remedial techniques:

- excavation and re-engineering or replacement of weaker soils;
- the inclusion of geosynthetic reinforcement within the unbound layers of the capping and sub-grade;
- where cohesive soils are present and they are deemed suitable for treatment with hydraulic binders, to employ modification and/or stabilisation techniques on the formation; and
- where granular soils are present, de-watering and re-engineering the formation.

7.8 Soakaways and Drainage

The 2012 Wardell Armstrong highlights that limited soakaway testing was undertaken at the site but details are not available and it is possible that further soakaway testing may be required at the site.

7.9 Buried Concrete

Wardell Armstrong report 2012 undertook testing to assess the nature of the materials at the site in relation to the BRE Special Digest SD-1 – Concrete in Aggressive Ground. Twenty samples of soils were scheduled for geochemical testing to determine the sulphate content and pH of the materials at the site. The results were assessed in accordance with the methodology set out within the BRE Special Digest SD-1. The results indicate that the materials at the site would be classified as Design Sulfate Class DS-1 and Aggressive Chemical Environment for Concrete (ACEC) Class AC-1d.

7.10 Interaction Between Geotechnical and Geo-environmental Recommendations

An integrated approach to geo-environmental and geotechnical design solutions is required in order to derive the best option for site development.

From a geo-environmental perspective the tip area in the northern end of the site will require a 600 mm capping layer. The ground level is also to be raised to produce suitable final levels. The imported fill should be designed to serve both of these purposes. In order to ensure a minimum cover of 600 mm, some re-profiling of the Made Ground will be necessary.

Where piles are required, a risk assessment will have to be undertaken to demonstrate that no new contaminant migration pathways will be created by piling.

8.0 UNCERTAINTIES AND LIMITATIONS

8.1 General Comments

This report details the findings of work carried out in November 2012 and March 2013. The report has been prepared by Hydrock on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, all potential environmental constraints or liabilities associated with the site may not have been revealed.

The report has been prepared for the exclusive benefit of Bovis Homes, Barratt Homes and Taylor Wimpey Homes and those parties designated by them for the purpose of providing geotechnical and geo-environmental recommendations for the site. The report contents should only be used in that context. Furthermore, new information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

Hydrock has used reasonable skill, care and diligence in the design of the investigation of the site. The inherent variation of ground conditions allows only definition of the actual conditions at the locations and depths of trial pits and boreholes at the time of the investigation. At intermediate locations, conditions can only be inferred.

Groundwater findings described are only representative of the dates on which they were made and levels may vary.

Information provided by third parties has been used in good faith and is taken at face value; however, Hydrock cannot guarantee its accuracy or completeness.

The work has been carried out in general accordance with recognised best practice as detailed in guidance documents such as the CLR 11 Model Procedures (Environment Agency 2004), BS5930:1999 +A2:2010 and BS10175:2011. Important aspects of the risk assessment process are transparency and justification. The rationale behind the assessments carried out for this report is given in Appendix D. Unless otherwise stated, no assessment has been made for the presence of radioactive substances or unexploded ordnance. Where the phrase “suitable for use” is used in this report, it is in keeping with the terminology used in planning control and does not imply any specific warranty or guarantee offered by Hydrock.

The chemical analyses reported were scheduled for the purposes of risk assessment with respect to human health, plant life, ecosystems and controlled waters as discussed in the report. Whilst the results may be useful in applying the Hazardous Waste Assessment Methodology given in Environment Agency Technical Guidance WM2, they are not primarily intended for that purpose and additional analysis may be required should waste classification be required for consideration of off-site disposal of contaminated soils. Separate analyses will be required to meet the Waste Acceptance Criteria for specific landfill sites.

Unless otherwise stated, the chemical testing carried out for this report was not scoped to comply with the requirements of the water supply company and further work may be required.

The preliminary risk assessment process may identify potential risks to site demolition and redevelopment workers. However, consideration of occupational health and safety issues is beyond the scope of this report.

Please note that notwithstanding any site observations concerning the presence or otherwise of archaeological sites, asbestos-containing materials or invasive weeds such as Japanese knotweed, this report does not constitute a formal survey of these potential hazards.

Any site boundary line depicted on plans does not imply legal ownership of land.

8.2 Site-Specific Comments

Risks to human health from naturally occurring vanadium is not considered significant, but at the time of writing this has yet to be confirmed with the Local Authority.

Asbestos-containing materials were identified in a single sample from the tip area during one of the previous investigations. None was encountered by Hydrock, but the possibility remains that these materials may be present in the Made Ground.

Risks to the surface water environment are based mainly on eluate chemistry and although the EQS for copper and PAHs are exceeded in the Made Ground, the conceptual site model does not suggest a significant risk. Similarly, exceedances of the EQS for metals and PAHs from the natural soils are not considered a significant risk and would be no different from other areas of similar natural geology. These assessments should be confirmed with the Environment Agency. A piling risk assessment is likely to be required in the tip area to demonstrate the lack of establishing any new contaminant pathway.

The recommended use of standard water supply pipe over most of the site and barrier pipe within the Made Ground will require confirmation from the water supply company.

There is the potential for running sand conditions to develop in excavations close to the canal where silty or sandy soils are combined with a high water table. In these conditions it may be necessary to employ well-point dewatering before stable excavations can be formed.

The practical cut-off between trenchfill and piled foundations is normally taken to be a founding depth of 2-2.5 mbgl. It has been shown that potential foundation depths exceed this threshold in the northern part of the site. The areas where piling is likely to be required have been highlighted, but this is a provisional finding and more detailed assessment will be needed on a ploy by plot basis.

Existing CBR testing is sufficient for preliminary design, but confirmatory testing will be required in actual road foundation locations.

The 2012 Wardell Armstrong highlights that limited soakaway testing was undertaken at the site but details are not available and it is possible that further soakaway testing may be required at the site.

9.0 RECOMMENDATIONS FOR FURTHER WORK

- Liaison with the NHBC, Contaminated Land Officer and Environment Agency concerning the findings of this report in respect of contamination.
- Confirmation with the water company with respect to water supply pipe materials.
- Provision of a piling contamination risk assessment.
- Provision of a Geotechnical Design Report including design and possible further geotechnical investigation for (a) spread footings (including suitability of plots, safe bearing pressure and mitigation of the effects of trees and shrubs); and (b) piled foundations (including specialist sub-contractor design and design of a piling mat for tracked plant).
- Soakaway testing in areas where these may be feasible, ie granular soils without high water table.
- Provision of a Materials Management Plan for re-use of site arisings.
- Provision of a Remedial Method Statement for the cover over the tip area and agreement with the regulatory authorities; and
- Verification of the remedial works on completion.

10.0 REFERENCES

ALLEN, D. L., BREWERTON, L. J., COLEBY, L. M., GIBBS, B. R., LEWIS, M. A., MACDONALD, A. M., WAGSTAFF, S. J. and WILLIAMS, A.T. 1997. The physical properties of major aquifers in England and Wales. *British Geological Survey Technical Report WD/97/34.* 312pp. Environment Agency R&D Publication 8.

BARNES, B., GLENNIE, E., DAVEY, A,. and THOMAS, J. 2010. Cheby or not Cheby? Is that the question? Land Contamination and Reclamation, 18(2), 121-33.

BOYLE, R. and WITHERINGTON, P. JANUARY 2007. Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present. Report No. 10627-R01(04). NHBC, Milton Keynes. 93pp + apps.

BRE. 1991. Soakaways. *BRE Digest 365*. BRE, Garston.

BRE. 2004. Working platforms for tracked plant: good practice guide to the design, installation, maintenance and repair of ground-supported working platforms. *BR470*. BRE, Garston.

BRE. 2005. Concrete in aggressive ground. *BRE Special Digest 1, 3rd Edition.* BRE, Garston.

BREWARD, N. 2007. Arsenic and presumed resistate trace element geochemistry of the Lincolnshire (UK) sedimentary ironstones, revealed by a regional geochemical survey using soil, water and stream sediment sampling. *Applied Geochemistry*, Vol. 22, 1970–1993.

BRITISH STANDARDS INSTITUTION. 1999. Code of practice for Site Investigations. *BS 5930 Incorporating Amendment No.2:2010.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2011. Code of Practice for Investigation of Potentially Contaminated sites. *BS 10175.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2002. Characterisation of waste : leaching : compliance test for leaching of granular waste materials and sludges one stage batch test at liquid to solid ratio of 10 l/kg for materials with particle size below 4 mm : without or with size reduction. *BS EN 12457: Part 2*. BSI, London.

BRITISH STANDARDS INSTITUTION. 2003. Geotechnical investigation and testing - Identification and classification of rock - Part 1: Identification and description. *BS EN ISO 14689-1 Incorporating Corrigendum No.1.* BSI, London

BRITISH STANDARDS INSTITUTION. 2004. Soil quality. Characterization of soil related to groundwater protection. *ISO 15175.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2004. Eurocode 7 – Geotechnical design - Part 1: General rules. *BS EN 1997-1. Incorporating Corrigendum No.1.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2006. Concrete – complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance to the specifier. *BS 8500-1.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2007. Code of practice for the characterization and remediation from ground gas in affected developments. *BS 8485.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2007. Eurocode 7 – Geotechnical design - Part 2: Geotechnical investigation and testing. *BS EN 1997-2.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2009. Code of practice for earthworks. *BS 6031 Incorporating Corrigendum No.1:2010.* BSI, London.

CIEH and CL:AIRE. May 2008. *Guidance on comparing soil contamination data with a critical concentration.* Chartered Institute of Environmental Health and Contaminated Land: Applications in Real Environments, London, 66pp.

CL:AIRE. March 2011. *The Definition of Waste: Development Industry Code of Practice, Version 2*. Contaminated Land: Applications in the Real Environment (CL:AIRE), London.

DCLG. March 2012. *National Planning Policy Framework*. DCLG, London.

DCLG. March 2012. *Technical Guidance top the National Planning Policy Framework.* DCLG, London.

DEFRA. 1 September 2005. Soil Guideline Values and the Determination of Land as Contaminated Land under Part IIA. Guidance Note CLAN 2/05. DEFRA/LEQ, London.

DEFRA. April 2012. *Contaminated Land Statutory Guidance*. DEFRA, London.

EIC, AGS and CL:AIRE. 2009. The EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment. Environmental Industries Commission, Association of Geotechnical and Geoenvironmental Specialists and Contaminated Land: Applications in Real Environments. Available from <www.claire.co.uk>.

ENVIRONMENT AGENCY. 2003. Hazardous Waste. Interpretation of the definition and classification of hazardous waste. Technical Guidance WM2. The Environment Agency.

ENVIRONMENT AGENCY. 2004. Model procedures for the management of land contamination. *Contaminated Land Report 11.* The Environment Agency.

ENVIRONMENT AGENCY. 2006. *Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.* The Environment Agency, Bristol, 123pp.

EXPERT GROUP ON VITAMINS AND MINERALS. May 2003. *Safe Upper Levels for Vitamins and Minerals.* COT Secretariat, Food Standards Agency, London.

HEALY, P.R. & HEAD, J.M. 1984. Construction over abandoned mine workings. *CIRIA Special Publication SP32.* CIRIA, London.

HIGHWAYS AGENCY. 1994. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 5, HA 70/94, Construction of Highway Earthworks. *HA 70/94*. Highway Agency, London.

HIGHWAYS AGENCY. 1994. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 6, HA 74/07, Treatment of Fill and Capping Materials using either Lime or Cement or Both. *HA 74/07*. Highway Agency, London.

HIGHWAYS AGENCY. 2008. Manual of Contract Documents for Highway Works, *Specification for Highway Works: Volume 1*. Highway Agency, London.

HIGHWAYS AGENCY. 2009. Design Guidance for Road Pavement Foundations (Draft HD25). *Interim Advice Note 73/06. Rev 1.* Highway Agency, London.

HOLLINGSWORTH, S. C.. 2004. *Cover systems for land regeneration*. BRE, Garston. 88pp + CD-ROM.

JOHNSON, R. 2001. Protective measures for housing on gas contaminated land. Building Research Establishment Report BR 414. BRE, Garston.

JONES, H. K., MORRIS, B. L., CHENEY, C. S., BREWERTON, L. J., MERRIN, P. D., LEWIS, M. A., MACDONALD, A. M., COLEBY, L. M., TALBOT, J. C., MCKENZIE, A. A., BIRD, M. J., CUNNINGHAM, J. and ROBINSON, V. K. 2000. The physical properties of minor aquifers in England and Wales. *British Geological Survey Technical Report WD/00/04.* 234pp. Environment Agency R&D Publication 68.

MILES, J. C. H., APPLETON, J. D., REES, D. M., GREEN, B. M. R., ADLAM. K. A. M. and MYRES. A. H. 2007. Indicative Atlas of Radon in England and Wales. Health Protection Agency and British Geological Survey. Report HPA-RPD-033.

NATHANAIL, P., McCAFFREY, C., ASHMORE, M., CHENG, Y., GILLETT, A., OGDNE, R. and SCOTT, D. 2009. The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd ed.). Land Quality Press, Nottingham.

NHBC. 2011. *NHBC Standards, Part 1 Introduction and Technical Requirements.* NHBC, Milton Keynes.

NHBC. 2011. *NHBC Standards, Part 4 Foundations.* NHBC, Milton Keynes.

NHBC. 2011. *NHBC Standards, Chapter 4.2 Building near trees.* NHBC, Milton Keynes.

OPRESKO, D. M. 1991. Toxicity summary or vanadium and vanadium compounds. Oakridge National Laboratory, Oak Ridge, Tennessee. 21pp.

RAWLINS, B. G., McGRATH, S. P., SCHEIB, A. J., CAVE, N., LISTER, T. R., INGHAM, M., GOWING, C. and CARTER, S. 2012 .*The advanced geochemical atlas of England and Wales.* British Geological Survey, Keyworth.

RUDLAND, D. J., LANCEFIELD, R. M. and MAYELL, P. N. 2001. Contaminated land risk assessment. A guide to good practice. *CIRIA Report C552*. CIRIA, London. 158 pp.

SCIVYER, C. 2007. Radon: Guidance on protective measures for new buildings, extensions, conversions and refurbishment (2007 edition). Building Research Establishment Report BR 211. BRE, Garston.

STONE, K., MURRAY, A., COOKE, S., FORAN, J. and GOODERHAM, L. 2009. Unexploded ordnance (UXO), a guide to the construction industry. *CIRIA Report C681*. CIRIA, London. 141 pp.

STROUD, M. A. 1975. The standard penetration test in insensitive clays and soft rocks. *Proceedings of the European Symposium on penetration testing*, **2**, 367-375.

UK WATER INDUSTRY RESEARCH (UKWIR). 2010 re-issued. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites. *Report 10/WM/03/21*.

USEPA. 2005. Partition coefficients for metals in surface water, soil and waste. EPA/600/R-05/074. US Environmental Protection Agency, Washington DC.

WELSH ASSEMBLY GOVERNMENT. July 2004. Development and flood risk. Planning Policy Wales, Technical Advice Note 15.

WILSON, S.A. and CARD, G.B. 1999. Reliability and risk in gas protection design. *Ground Engineering,* February 1999, 33-36, plus letters in March 1999.

WILSON, S. and HAINES, S. 2005. Site investigation and monitoring for ground gas assessment – back to basics. *Land Contamination and Reclamation* **13(3),** 211-222.

WILSON, S., OLIVER, S., MALLETT, H., HUTCHINGS, H. and CARD, G. 2007. Assessing risks posed by hazardous ground gases to buildings. *CIRIA Report C665*. CIRIA, London. 182pp.

Appendix A

DRAWINGS

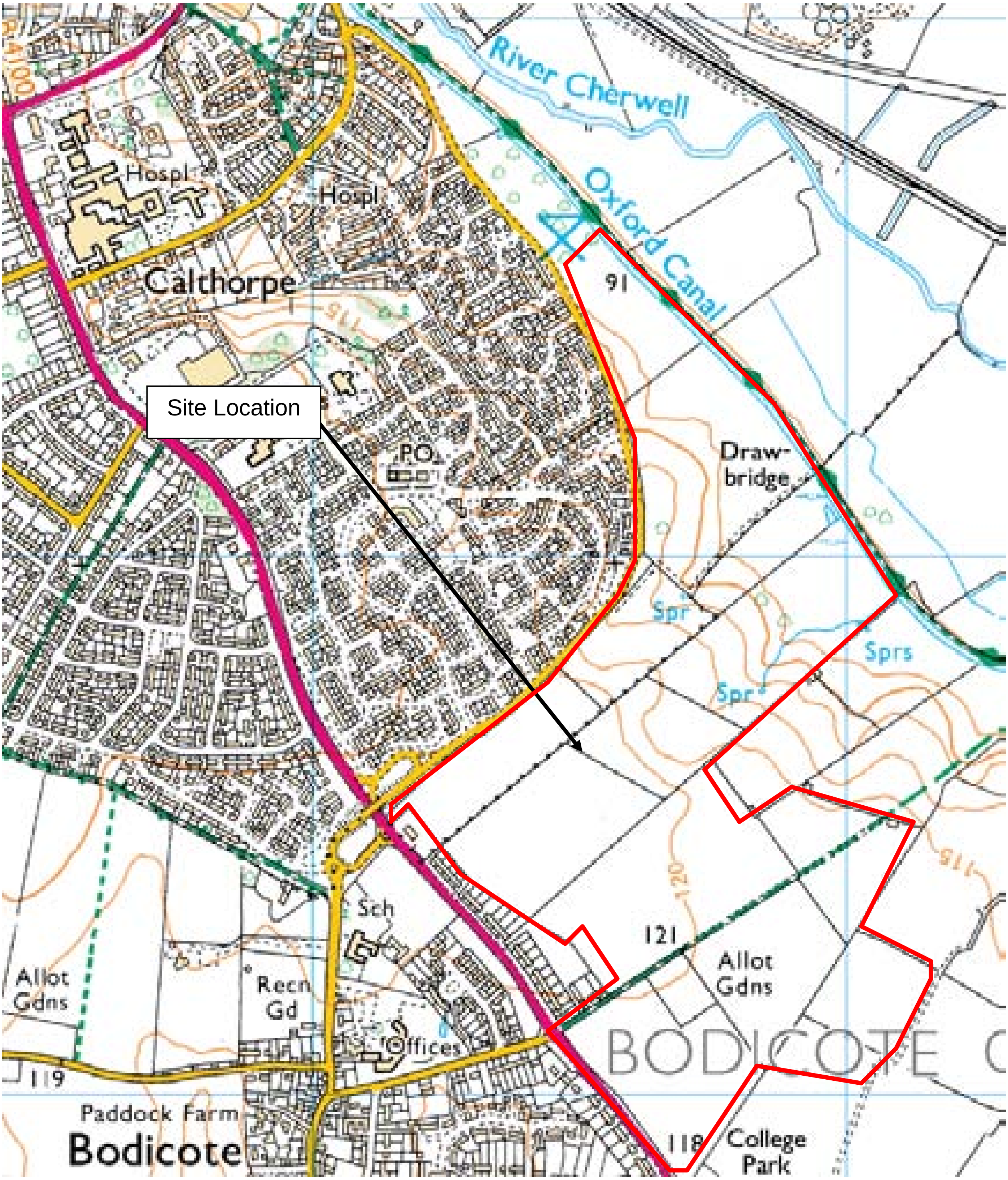
Drawings Included in this report:

C12702/G001 – Site Location Plan

C12702/G002B – Exploratory Hole Location Plan

C12702/G003B – Geo-environmental Zonation Plan

C12702/G004 – Foundation Zonation Plan



#

Client: Bovis Homes, Barratt Homes and Taylor Wimpey Homes

Site: Land at Bankside Banbury

Drawing No: C12702/G001

Title: Site Location Plan

Scale: NTS

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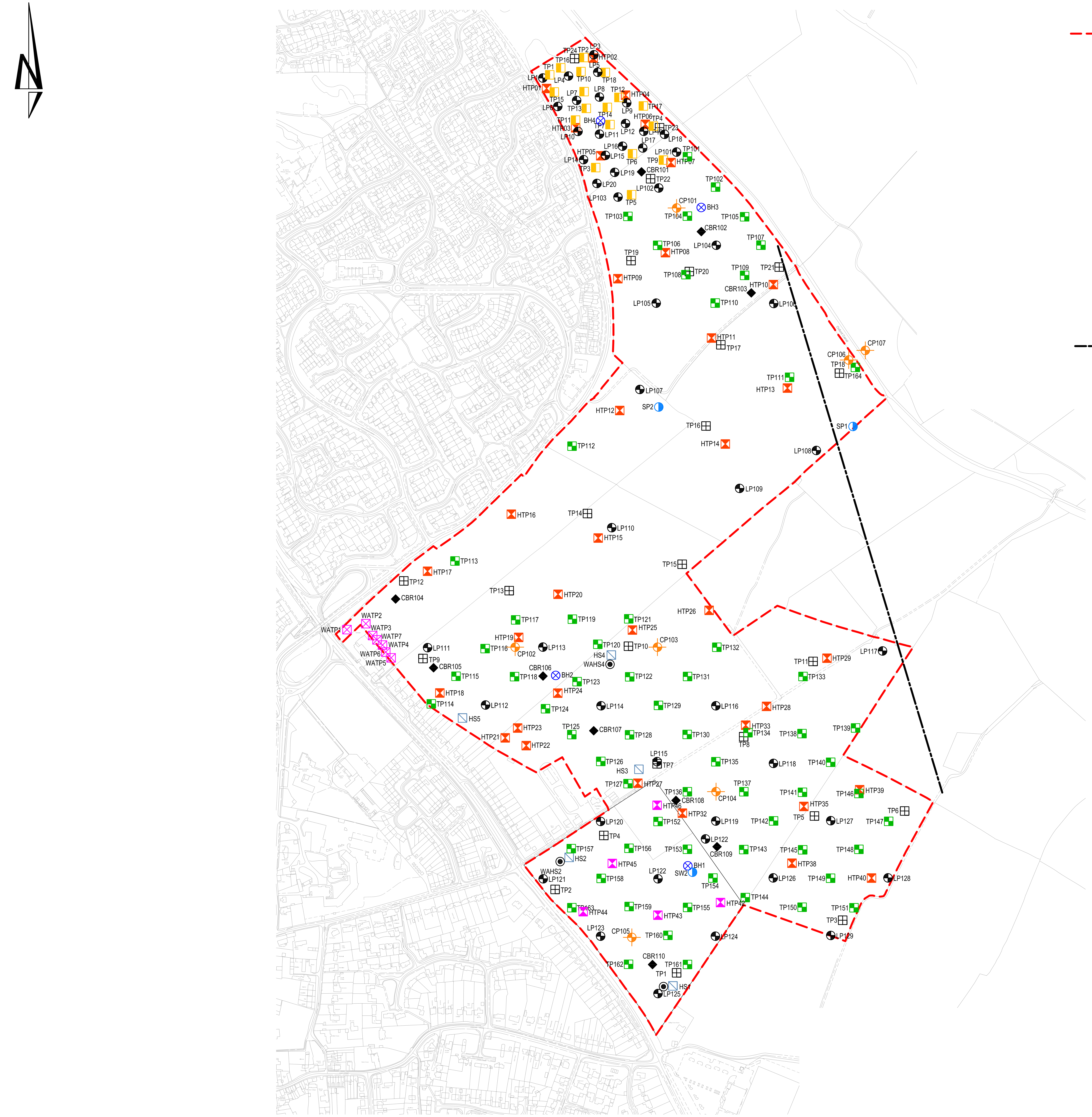

HYDROCK APRIL 2013 TRIAL PIT
SITE BOUNDARY
TRIAL PIT - HYDROCK 2012
HISTORICAL WELL
HISTORICAL TRIAL PIT - 2012
HISTORICAL TRIAL PIT - APRIL 2006
HISTORICAL TRIAL PIT - 2005
HISTORICAL TRIAL PIT - MAY 2007
HISTORICAL HAND SAMPLE - JUNE 2007
HISTORICAL TRIAL PIT - DEC 2011
HISTORICAL BOREHOLE - APRIL 2006
CABLE PERCUSSION BOREHOLE
CBR TEST
WATER SAMPLE
RISING MAIN (ASSUMED ROUTE)

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.
This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Notes:

Rev	Date	Description	By	Ckd
B	05.04.13	Trial Pits Attached	NG	RH
A	18/01/13	Information	NG	RS

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Project
LAND AT BANKSIDE, BANBURY

Title
Exploratory Hole Location Plan

Drawing Status
INFORMATION

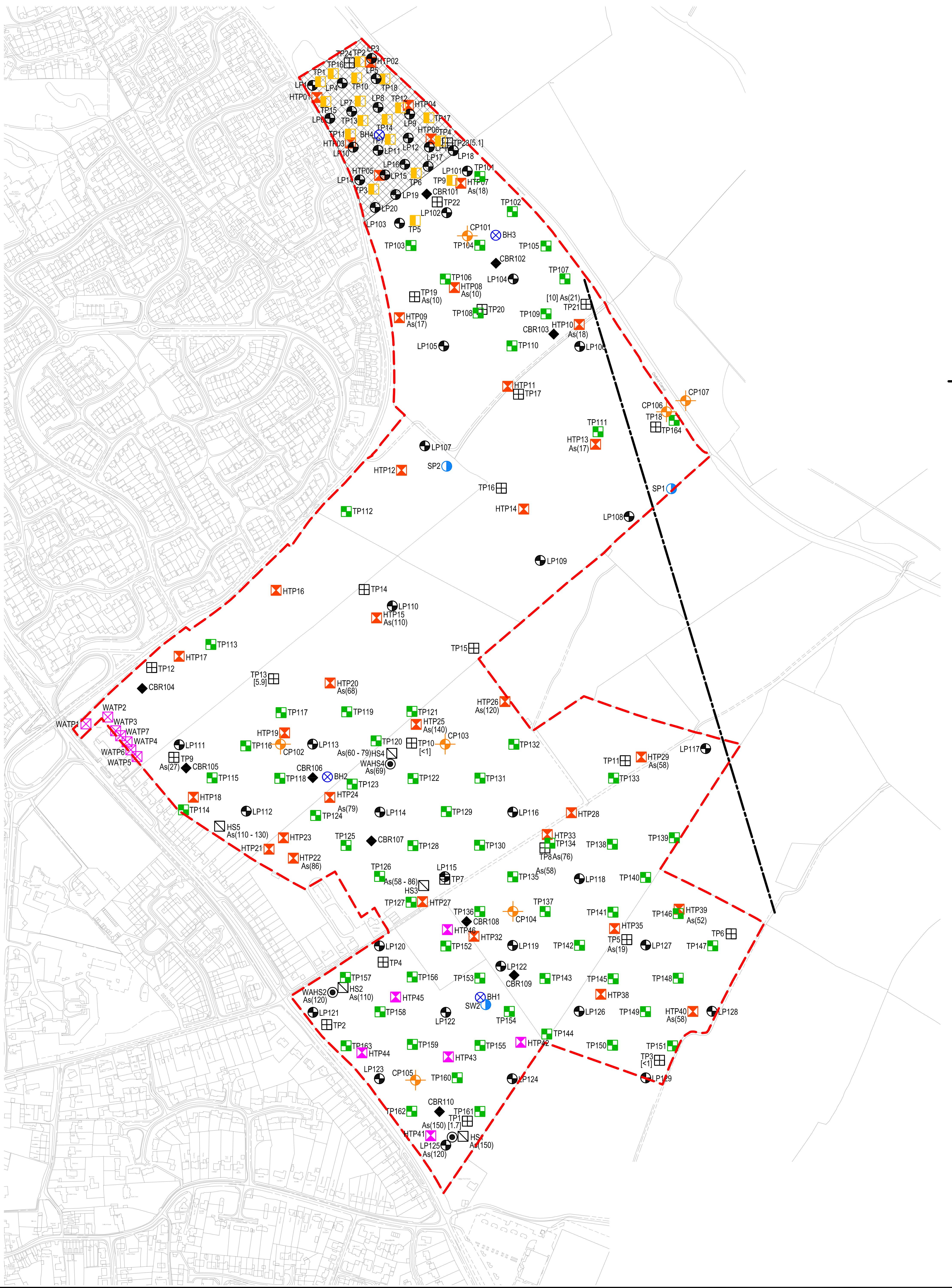
Job No.
C12702

Drawn	Checked	Scale at A2	Date	Issue Date
NG	RH	1:5000	18/01/13	05/04/13

Drawing No. C12702 - G002

Revision B

N



HYDROCK APRIL 2013 TRIAL PIT
SITE BOUNDARY
TRIAL PIT - HYDROCK 2012
HISTORICAL WELL
HISTORICAL TRIAL PIT - 2012
HISTORICAL TRIAL PIT - APRIL 2006
HISTORICAL TRIAL PIT - 2005
HISTORICAL TRIAL PIT - MAY 2007
HISTORICAL HAND SAMPLE - JUNE 2007
HISTORICAL TRIAL PIT - DEC 2011
HISTORICAL BOREHOLE - APRIL 2006
CABLE PERCUSSION BOREHOLE
CBR TEST
WATER SAMPLE
RISING MAIN (ASSUMED ROUTE)
As(21) ARSENIC (mg/kg)
[5.1] PBET (%)
TIP AREA

GEOLOGY

GEOLOGICAL BOUNDARY
WHITBY MUDSTONE FORMATION (MAINLY CLAY)
MARLSTONE ROCK BED
DYRHAM FORMATION (CLAYS & SILTS)
CHARMOUTH MUDSTONE FORMATION (MAINLY CLAY)

NOTE - GEOLOGY BASED ON WARDELL ARMSTRONG 2012 REMEDIATION GROUND INVESTIGATION REPORT.

Notes:
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Notes:

Rev	Date	Description	By	Ckd
B	05.04.13	Trial Pits Added	NG	RS
A	18/01/13	Issued for Information	NG	RS

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Project
LAND AT BANKSIDE, BANBURY

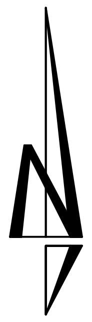
Title
Geo-environmental Zonation Plan

Drawing Status
INFORMATION

Job No.
C12702

Drawn	Checked	Scale at A2	Date	Issue Date
NG	RH	1:5000	18/01/13	05/04/13

Drawing No. C12702 - G003
Revision B



ZONE WHERE SPREAD FOUNDATIONS MAY BE APPROPRIATE SUBJECT TO DETAILED ASSESSMENT

ZONE WHERE PILED FOUNDATIONS ARE NECESSARY

ZONE WHERE PILED FOUNDATIONS OR SPREAD FOUNDATIONS MAY BE APPROPRIATE BECAUSE OF VARIABLE GROUND CONDITIONS, SUBJECT TO DETAILED ASSESSMENT

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.
This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.

Notes:

Rev	Date	Description	By	Ckd
A	18/01/13	Information	NG	RS

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Project
LAND AT BANKSIDE, BANBURY

Title
Foundation Zonation Plan

Drawing Status
INFORMATION

Job No.
C12702

Drawn	Checked	Scale at A2	Date	Issue Date
NG	RS	1:5000	18/01/13	18/01/13

Drawing No.	Revision
C12702 - G004	A

Appendix B

SITE PHOTOGRAPHS

This appendix may not be included in the printed report to reduce the document size.

It is presented in the PDF version of the report on the CD enclosed with the printed report.

Figure 1: Showing arisings from HTP01.

Figure 2: Showing arisings from HTP01.

Figure 3: Showing arisings from HTP01.

Figure 4: Showing arisings from HTP01.

Figure 5: Showing HTP01.

Figure 6: Showing arisings from HTP02.

Figure 7: Showing arisings from HTP02.

Figure 8: Showing HTP02.

Figure 9: Showing arisings from HTP03.

Figure 10: Showing arisings from HTP03.

Figure 11: Showing HTP03.

Figure 12: Showing arisings from HTP04.

Figure 13: Showing arisings from HTP04.

Figure 14: Showing HTP04.

Figure 15: Showing arisings from HTP05.

Figure 16: Showing arisings from HTP05.

Figure 17: Showing arisings from HTP05.

Figure 18: Showing HTP05.

Figure 19: Showing arisings from HTP06.

Figure 20: Showing arisings from HTP06.

Figure 21: Showing HTP06.

Figure 22: Showing arisings from HTP07.

Figure 23: Showing HTP07.

Figure 24: Showing arisings from HTP08.

Figure 25: Showing arisings from HTP08.

Figure 26: Showing arisings from HTP08.

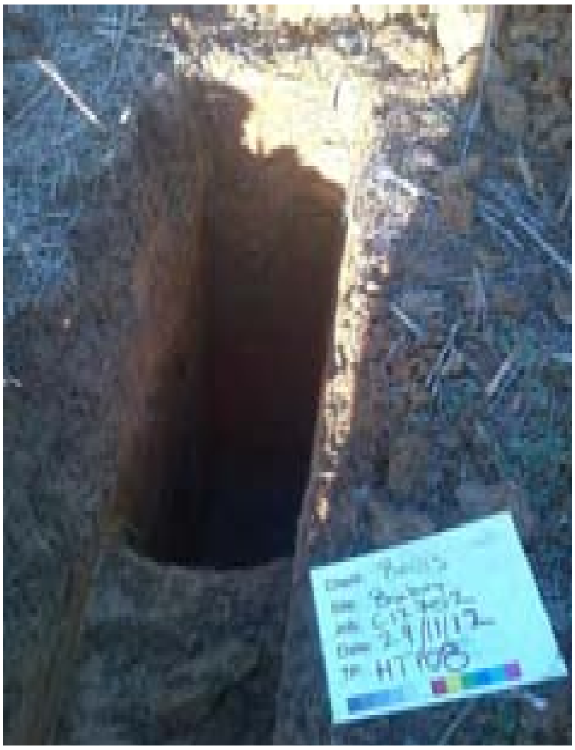

Figure 27: Showing HTP08.

Figure 28: Showing arisings from HTP09.

Figure 29: Showing arisings from HTP09.

Figure 30: Showing arisings from HTP09.

Figure 31: Showing HTP09.

Figure 32: Showing arisings from HTP10.

Figure 33: Showing arisings from HTP10.

Figure 34: Showing HTP10.

Figure 35: Showing HTP10.

Figure 36: Showing arisings from HTP11.

Figure 37: Showing arisings from HTP11.

Figure 38: Showing arisings from HTP11.

Figure 39: Showing HTP11.

Figure 40: Showing arisings from HTP12.

Figure 41: Showing HTP12.

Figure 42: Showing arisings from HTP13.

Figure 43: Showing HTP13.

Figure 44: Showing arisings from HTP14.

Figure 45: Showing HTP14.

Figure 46: Showing arisings from HTP15.

Figure 47: Showing HTP15.

Figure 48: Showing arisings from HTP16.

Figure 49: Showing HTP16.

Figure 50: Showing arisings from HTP17.

Figure 51: Showing HTP17.

Figure 52: Showing arisings from HTP18.

Figure 53: Showing HTP18.

Figure 54: Showing arisings from HTP19.

Figure 55: Showing HTP19.

Figure 56: Showing arisings from HTP20.

Figure 57: Showing HTP20.

Figure 58: Showing arisings from HTP21.

Figure 59: Showing HTP21.

Figure 60: Showing arisings from HTP22.

Figure 61: Showing HTP22.

Figure 62: Showing arisings from HTP23.

Figure 63: Showing arisings from HTP23.

Figure 64: Showing arisings from HTP24.

Figure 65: Showing HTP24.

Figure 66: Showing arisings from HTP25.

Figure 67: Showing HTP25.

Figure 68: Showing arisings from HTP26.

Figure 69: Showing HTP26.

Figure 70: Showing HTP27

Figure 71: Showing arisings from HTP28.

Figure 72: Showing HTP28.

Figure 73: Showing arisings from HTP29.

Figure 74: Showing HTP29.

Figure 75: Showing arisings from HTP32.

Figure 76: Showing HTP32.

Figure 77: Showing arisings from HTP33.

Figure 78: Showing HTP33.

Figure 79: Showing arisings from HTP35.

Figure 80: Showing HTP35.

Figure 81: Showing arisings from HTP38.

Figure 82: Showing HTP38.

Figure 83: Showing arisings from HTP39.

Figure 84: Showing HTP39.

Figure 85: Showing arisings from HTP40.

Figure 86: Showing HTP40.

Figure 87: Showing the Rising Main manhole at the northern end of the site adjacent to the canal.

Figure 88: Showing the Rising Main manhole at the northern end of the site adjacent to the canal (RM1).

Figure 89: Showing the 7.5m deep Rising Main manhole at the northern end of the site adjacent to the canal (RM1).

Figure 90: Showing the Rising Main manhole at the southern end of the site (RM3).

Figure 89: Showing the 7.5m deep Rising Main manhole at the northern end of the site adjacent to the canal (RM1).

Figure 90: Showing the Rising Main manhole at the southern end of the site (RM3).

Figure 91: Showing HTP41.

Figure 92: Showing arisings from HTP41.

Figure 93: Showing HTP42.

Figure 94: Showing arisings from HTP42.

Figure 95: Showing HTP43.

Figure 96: Showing arisings from HTP43.

Figure 97: Showing HTP44.

Figure 98: Showing arisings from HTP44.

Figure 99: Showing HTP45.

Figure 100: Showing arisings from HTP45.

Figure 101: Showing HTP46.

Figure 102: Showing arisings from HTP46.

Appendix C

EXPLORATORY HOLE LOGS

This appendix may not be included in the printed report to reduce the document size.

It is presented in the PDF version of the report on the CD enclosed with the printed report.

Hydrock	Project: Land at Bankside, Banbury	Trial Pit No. HTP01 Page No. 1 of 1

Method: Trial Pit	Date: 28/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446506.05,239471.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:95.27mAOD	Plant: JCB 3CX	

Samples and In Situ Testing			Groundwater	Stratum Description
Depth (m)	Type	Results		
0.20	D			Brown clayey gravelly TOPSOIL with occasional cobbles and boulders. Gravel cobbles and boulders are medium to coarse angular brick. (MADE GROUND)
0.50	D			Soft to firm brown slightly gravelly CLAY with some cobbles with occasional cobble sized pockets of very soft to soft grey gravelly CLAY. Gravel and cobbles are medium to coarse angular brick white polystyrene and plastic sheeting. (MADE GROUND)
1.00	HSV	100kPa		High strength stiff orange brown and grey mottled residual CLAY. (CHARMOUTH MUDSTONE)
1.50	D			
1.50	B			
2.00	HSV	100kPa		
2.00	D			
				Firm dark brown mottled orange brown and grey residual CLAY with frequent fine to medium extremely weak lithorelicts. (CHARMOUTH MUDSTONE)
3.00	D			Firm blue grey orange brown and dark rusty brown mottled residual CLAY with frequent fine to medium extremely weak lithorelicts. (CHARMOUTH MUDSTONE)

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury

Trial Pit No. HTP02

Method: Trial Pit	Date: 28/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446587.06,239524.00	Pit Stability: Unstable	Dimensions:
Hydrock Project No: C12702	Elevation:90.11mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description	Depth (m)	Thickness (m)	Level (mAOD)	Legend
0.20	D			Brown clayey sandy TOPSOIL. (TOPSOIL)	[illegible]	[illegible]	[illegible]	
0.50	D			Soft brown fine very sandy residual CLAY. (CHARMOUTH MUDSTONE)	[illegible]	[illegible]	[illegible]	
			▽	Very soft red brown fine very sandy residual CLAY. (CHARMOUTH MUDSTONE)	[illegible]	[illegible]	[illegible]	
1.50 1.50	D B			Moderately packed light orange brown residual fine SAND with occasional gravel. Gravel is medium angular dark red brown mudstone. (CHARMOUTH MUDSTONE)	[illegible]	[illegible]	[illegible]	
				End of trial pit due to trial pit collapse.				

End of Trial Pit at [illegible] m

General Remarks:

Trial Pit was unstable. Water seepage at 0.9m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No.
HTP03

Method: Trial Pit	Date: 28/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446556.66,239403.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:98.25mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.10	D			Dark brown clayey TOPSOIL with roots. (MADE GROUND)
0.50 0.50	D B		▽	Soft and occasionally firm brown sandy gravelly residual CLAY with occasional cobbles. Gravel and cobbles are angular medium to coarse bricks concrete brick fragments and plastic. (MADE GROUND)
1.60	HSV	100kPa		High strength stiff blue grey and yellow brown mottled residual CLAY with thin veins of black decomposed grass. (MADE GROUND)
2.00 2.00	HSV D	95kPa		High strength stiff blue grey and yellow brown mottled residual CLAY. (CHARMOUTH MUDSTONE)
2.50	HSV	100kPa		
3.00 3.00	HSV D	110kPa		
				End of Trial Pit at 3.50 m

General Remarks:

Trial Pit was stable. Water seepage at 0.7m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP04**

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Method: Trial Pit	Date: 28/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446643.71,239459.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:90.87mAOD	Plant: JCB 3CX	

Samples and In Situ Testing

Depth (m)	Type	Results
0.10	D	
0.50	HSV	88kPa
0.50	D	
1.00	D	
1.00	B	
2.00	D	
2.60	D	

Stratum Description

Soft brown clayey TOPSOIL with occasional boulders. Boulders are angular bricks and concrete.
(MADE GROUND)

High strength firm to stiff mottled grey and orange brown slightly fine sandy CLAY.
(CHARMOUTH MUDSTONE)

Moderately packed brown fine SAND.
(CHARMOUTH MUDSTONE)

Moderately packed red brown clayey gravelly fine SAND. Gravel is angular medium extremely weak mudstone siltstone and dark red mudstone.
(CHARMOUTH MUDSTONE)

End of Trial Pit at 2.60 m

General Remarks:

Trial Pit was stable. Water seepage at 1.8m bgl.

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Hydrock	Project: Land at Bankside, Banbury	Trial Pit No. HTP05 Page No. 1 of 1

Method: Trial Pit	Date: 28/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446600.36,239354.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:98.78mAOD	Plant: JCB 3CX	

Samples and In Situ Testing

Depth (m)	Type	Results	Groundwater
0.20	D		
0.50	D		
0.90	HSV	160kPa	▽
1.00	D		
1.50	HSV	90kPa	
1.50	D		
2.00	HSV	110kPa	
2.00	D		
2.50	HSV	90kPa	
2.50	D		

Stratum Description	Depth (m)	Level (mAOD)
Very soft very dark brown slightly gravelly clayey TOPSOIL. Gravel is medium angular concrete and brick fragments. (MADE GROUND)	0.20	[illegible]
Firm light brown orange brown and grey mottled fine sandy slightly gravelly CLAY. Gravel is fine to coarse angular concrete and brick. (MADE GROUND)	0.90	97.88
Stiff brown dark red brown and orange brown mottled residual CLAY. (CHARMOUTH MUDSTONE)	1.40	97.38
High strength firm to stiff slightly orange brown mottled grey residual CLAY. (CHARMOUTH MUDSTONE)	1.90	96.88
High strength firm to stiff orange brown and grey mottled residual CLAY. (CHARMOUTH MUDSTONE)	2.60	96.18
Firm to stiff orange brown grey and dark red residual CLAY with frequent fine to medium extremely weak lithorelicts. (CHARMOUTH MUDSTONE)	2.80	[illegible]

End of Trial Pit at 2.80 m

General Remarks:

Trial Pit was stable. Water seepage at 0.9m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP06**

Method: Trial Pit	Date: 28/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446678.01,239409.00	Pit Stability: Unstable	Dimensions:
Hydrock Project No: C12702	Elevation:91.46mAOD	Plant: JCB 3CX	

Depth (m)	Type	Results	Groundwater	Stratum Description
0.10	D			Dark brown clayey TOPSOIL. (MADE GROUND)
0.50	D		▽	Soft light brown fine sandy gravelly CLAY. Gravel is angular medium to coarse brick fragments concrete fragments and a very large boulder of brick wall laid on its side. (MADE GROUND)
1.20	D			Moderately packed orange brown and brown clayey fine SAND. (CHARMOUTH MUDSTONE)
2.00	D			
2.40	D			End of trial pit due to trial pit collapse.

End of Trial Pit at 2.40 m

General Remarks:

Trial Pit was unstable. Water seepage at 0.9m bgl.

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Method: Trial Pit	Date: 28/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446722.76,239342.00	Pit Stability: Unstable	Dimensions:
Hydrock Project No: C12702	Elevation:91.27mAOD	Plant: JCB 3CX	

Samples and In Situ Testing			Groundwater	Stratum Description
Depth (m)	Type	Results		
				Soft red brown fine sandy clay TOPSOIL (TOPSOIL)
0.50 0.50	HSV D	60kPa	▽	Medium strength soft to firm red brown slightly fine sandy residual CLAY (CHARMOUTH MUDSTONE)
1.00 1.00	HSV D	125kPa		High strength stiff orange brown and grey mottled residual CLAY (CHARMOUTH MUDSTONE)
2.00	D			Moderately packed orange brown fine SAND (CHARMOUTH MUDSTONE)
				End of Trial Pit at 2.30 m

General Remarks:

Trial Pit was unstable. Water seepage at 0.8m bgl.

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Project: Land at Bankside, Banbury	Trial Pit No. HTP08
	Page No. 1 of 1

Method: Trial Pit	Date: 29/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446713.12,239185.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:99.87mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description	Depth (m)	Thickness (m)	Level (mAOD)	Legend
0.10	D			Brown clayey TOPSOIL. (TOPSOIL)	[illegible]	[illegible]	[illegible]	
0.50 0.50 0.50	HSV D B	90kPa		High strength stiff orange brown and grey mottled residual CLAY. (CHARMOUTH MUDSTONE)	[illegible]	[illegible]	[illegible]	
1.00 1.00	HSV D	110kPa	▽					
2.00	D			Firm to stiff orange brown and grey mottled residual CLAY with frequent fine to medium extremely weak lithorelicts with occasional dark red lithorelicts at 1.7m bgl. (CHARMOUTH MUDSTONE)	[illegible]	[illegible]	[illegible]	
				End of Trial Pit at [illegible] m				

General Remarks:

Trial Pit was stable. Water seepage at 1m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP09**

Page No. 1 of 1

Method: Trial Pit	Date: 29/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446630.30,239140.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:106.08mAOD	Plant: JCB 3CX	

Samples and In Situ Testing			Groundwater	Stratum Description
Depth (m)	Type	Results		
				Medium strength firm light brown fine sandy clay TOPSOIL. (TOPSOIL)
0.20	D			
0.30	HSV	60kPa		
				High strength firm to stiff orange brown and grey mottled slightly fine sandy residual CLAY getting less sandy with depth. (DYRHAM FORMATION)
0.70	HSV	120kPa		
0.70	D			
0.70	B			
1.50	HSV	100kPa		
				Firm to stiff brown dark red and grey mottled residual CLAY with frequent medium extremely weak lithorelicts. (DYRHAM FORMATION)
2.00	D		▽	
				Firm orange brown and grey mottled residual CLAY. (DYRHAM FORMATION)
2.50	D			
				Stiff brown silty residual CLAY with occasional white grey medium gravel sized of very soft CLAY and occasional medium gravel sized pockets of grey CLAY with decomposed black wood matter. (DYRHAM FORMATION) Refusal.
2.70	D			
				End of Trial Pit at 2.70 m

General Remarks:

Trial Pit was stable. Water seepage at 2.1m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP10**

Method: Trial Pit	Date: 29/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446901.12,239129.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 90.35mAOD	Plant: JCB 3CX	

Samples and In Situ Testing			Groundwater	Stratum Description
Depth (m)	Type	Results		
				Soft to firm brown slightly silty clay TOPSOIL. (TOPSOIL)
0.50	HSV	90kPa		
0.50	D			
0.50	B			
				High strength firm to stiff orange brown and grey mottled residual CLAY. (CHARMOUTH MUDSTONE)
			▽	
1.00	HSV	92kPa		
1.00	D			
1.20	HSV	130kPa		
				Firm to stiff grey and slightly orange brown mottled residual CLAY with frequent medium extremely weak lithorelicts. (CHARMOUTH MUDSTONE)
2.00	D			
				End of Trial Pit at [illegible] m

General Remarks:

Trial Pit was stable. Field drain inflow at 0.9m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP11**

Method: Trial Pit	Date: 29/11/2012	Logged By: RS	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446793.40,239036.00	Pit Stability: Unstable	Dimensions:
Hydrock Project No: C12702	Elevation:94.66mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
				Firm slightly silty clay TOPSOIL. (TOPSOIL)
0.50 0.50 0.50	HSV D B	80kPa		Medium to high strength firm to stiff brown slightly silty residual CLAY. (CHARMOUTH MUDSTONE)
1.00 1.10	HSV D	85kPa		Medium to high strength firm orange brown and grey brown mottled residual CLAY with occasional gravel. Gravel is fine to medium dark red black mudstone. (CHARMOUTH MUDSTONE)
1.50	D		▽	Moderately to tightly packed light orange brown gravelly fine SAND. Gravel is fine to medium angular mudstone and sandstone. (CHARMOUTH MUDSTONE)
2.00 2.00	HSV D	140kPa		High strength stiff blue grey residual CLAY with a slight orange brown mottle and occasional dark brown rotted plant matter. (CHARMOUTH MUDSTONE)
3.50	D			Stiff dark grey residual CLAY with frequent medium extremely weak lithorelicts. (CHARMOUTH MUDSTONE)

End of Trial Pit at 3.50 m

General Remarks:

Trial Pit was unstable. Water seepage at 1.4m bgl.

Logged in general accordance with BS5930: 1999, incorporating Amendment 1.

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Project: Land at Bankside, Banbury	Trial Pit No. HTP12
	Page No. 1 of 1

Method: Trial Pit	Date: 30/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446633.43,238910.00	Pit Stability: Unstable	Dimensions:
Hydrock Project No: C12702	Elevation: 104.55mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.20	D			Soft to firm brown slightly sandy slightly gravelly clay TOPSOIL with abundant rootlets. (TOPSOIL)
0.50 0.50-0.60	HSV B	40kPa		Low strength soft orange brown silty residual CLAY. (DYRHAM FORMATION)
1.00	HSV	35kPa	▽	
1.30	HSV	15kPa		Very low strength very soft grey wet very silty residual CLAY. (DYRHAM FORMATION)
1.50	D			
2.50 2.50	HSV D	7kPa		
				End of trial pit due to trial pit collapse.
				End of Trial Pit at 2.80 m

General Remarks:

Trial Pit was unstable. Water seepage at 1.2m bgl.

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Hydrock	Project: Land at Bankside, Banbury	Trial Pit No. HTP13
Over Court Barns Over Lane Almondsbury Bristol BS32 4DF E-mail: bristol@hydrock.com Tel: 01454 619 533		Page No. 1 of 1

Method: Trial Pit	Date: 30/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446925.66,238949.00	Pit Stability: Unstable	Dimensions:
Hydrock Project No: C12702	Elevation:92.62mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
				Soft dark brown slightly sandy silty clay TOPSOIL. (TOPSOIL)
0.20	D		▽ (0.3 m)	
0.40	HSV	16kPa		Low strength soft yellow brown silty residual CLAY. (CHARMOUTH MUDSTONE)
0.60-0.70	B			
0.80	HSV	35kPa		
				Firm light brown and grey mottled sandy silty residual CLAY with occasional 0.1 to 0.2m thick sand layers. Running sand from 1.1m to 1.6m bgl making pit very unstable. (CHARMOUTH MUDSTONE)
1.40	D			
				Medium strength firm brown and grey mottled slightly sandy silty residual CLAY. (CHARMOUTH MUDSTONE)
2.00	D			
2.10	HSV	55kPa		
				Moderately packed light brown silty fine SAND with occasional fine to medium gravel. (CHARMOUTH MUDSTONE)
3.00	D			End of trial pit due to trial pit collapse.

End of Trial Pit at 3.00 m

General Remarks:

Trial Pit was unstable. Water seepage at 0.3m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP14**

Method: Trial Pit	Date: 30/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446817.47,238851.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:104.61mAOD	Plant: JCB 3CX	

Samples and In Situ Testing

Depth (m)	Type	Results	Groundwater
0.15	D		
0.40	HSV	25kPa	
0.80	HSV	55kPa	
1.30 1.30-1.40	HSV B	80kPa	
1.80 1.80	HSV D	70kPa	
2.40	HSV	80kPa	
2.80	D		▽

Stratum Description

Soft to firm brown slightly sandy silty clay TOPSOIL with abundant rootlets.
(TOPSOIL)

Low to medium strength soft becoming firm brown silty residual CLAY.
(CHARMOUTH MUDSTONE)

High strength stiff orange brown and grey mottled silty residual CLAY becoming sandy below 2.5m bgl.
(CHARMOUTH MUDSTONE)

End of hole.

End of Trial Pit at 2.90 m

General Remarks:

Trial Pit was stable. Water seepage at 2.8m bgl.

Hydrock

Project: Land at Bankside, Banbury

Trial Pit No. **HTP15**

Page No. 1 of 1

Method: Trial Pit	Date: 29/11/2012
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446595.91,238688.00
Hydrock Project No: C12702	Elevation:119.30mAOD
Logged By: AH	Checked By:
Pit Stability: Stable	Dimensions
Plant: JCB 3CX	

Samples and In Situ Testing			Groundwater	Stratum Description	Depth / Level / Thickness
Depth (m)	Type	Results			
0.25	D			Soft to firm dark red brown slightly sandy silty clay TOPSOIL with abundant rootlets and rare limestone gravels. (TOPSOIL)	[illegible]
0.40	HSV	40kPa		Medium strength firm red brown slightly sandy slightly gravelly residual CLAY. Gravel is fine to medium sub angular limestone and ironstone. (MARLSTONE ROCK BED)	[illegible]
0.40-0.50	B				
0.60	HSV	55kPa			
0.90	HSV	65kPa			
1.00	D				
1.40	HSV	115kPa		High strength stiff grey and orange brown mottled residual CLAY. (MARLSTONE ROCK BED)	[illegible]
1.60	D				
2.60	D			Very stiff grey with some orange mottling very silty residual CLAY. (MARLSTONE ROCK BED)	[illegible]
				Moderately strong fine grained thinly bedded red brown shelly partially weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.	[illegible]

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury			Trial Pit No. HTP16
			Page No. 1 of 1
Method: Trial Pit	Date: 29/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446444.55,238729.00	Pit Stability: Unstable	Dimensions:
Hydrock Project No: C12702	Elevation: 122.33mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.15	D			Firm brown slightly sandy slightly gravelly silty clay TOPSOIL with abundant rootlets. (TOPSOIL)
0.35-0.45	B			Brown slightly sandy clayey destructured GRAVEL. Gravel is fine to coarse sub angular limestone with abundant cobbles. (MARLSTONE ROCK BED)
1.00	D			
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.

General Remarks:

Trial Pit was unstable. No groundwater encountered.

Logged in general accordance with BS5930: 1999, incorporating Amendment 1.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP17**

Method: Trial Pit	Date: 29/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446298.59,238630.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 123.49mAOD	Plant: JCB 3CX	

Samples and In Situ Testing			Groundwater	Stratum Description
Depth (m)	Type	Results		
0.15	D			Firm dark brown slightly sandy slightly gravelly clay TOPSOIL with abundant rootlets. Gravel is fine limestone and rare brick. (TOPSOIL)
0.50	HSV	60kPa		Medium to high strength firm to stiff brown gravelly silty residual CLAY. Gravel is medium to coarse sub angular limestone with abundant cobbles from 0.6m to 0.8m bgl. (MARLSTONE ROCK BED)
1.00	HSV	130kPa		
1.20	D			
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.

End of Trial Pit at 1.30 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

Logged in general accordance with BS5930: 1999. Incorporating Amendment 1.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP18**

Method: Trial Pit	Date: 29/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446320.05,238418.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 122.09mAOD	Plant: JCB 3CX	

Samples and In Situ Testing			Groundwater	Stratum Description
Depth (m)	Type	Results		
0.15	D			Dark brown slightly sandy silty clay TOPSOIL with abundant rootlets and rare gravels. (TOPSOIL)
0.50	HSV	80kPa		High strength firm to stiff orange brown slightly sandy gravelly residual CLAY. Gravels of fine to coarse sub angular limestone. (MARLSTONE ROCK BED)
0.70-0.80	B			
1.00	D			
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal
				End of Trial Pit at 1.15 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

Logged in general accordance with BS5930: 1999, incorporating Amendment 1.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP19**

Method: Trial Pit	Date: 28/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446457.42,238514.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 122.22mAOD	Plant: JCB 3CX	

Samples and In Situ Testing			Groundwater	Stratum Description
Depth (m)	Type	Results		
0.20	D			Soft to firm brown slightly sandy silty clay TOPSOIL with abundant rootlets and rare gravels of lime stone. (TOPSOIL)
0.40	HSV	40kPa		Medium to high firm to stiff light brown gravelly residual CLAY. Gravel is fine to coarse sub angular limestone becoming very gravelly below 1.2m bgl. (MARLSTONE ROCK BED)
0.80	HSV	125kPa		
1.00	D			
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.
				End of Trial Pit at 1.50 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury

Trial Pit No.
HTP20

Method: Trial Pit	Date: 30/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446525.98,238590.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 121.64mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description	Depth (mbgl)	Thickness (m)	Level (mAOD)	Legend
0.15	D			Soft to firm brown slightly gravelly silty clay TOPSOIL with abundant rootlets. (TOPSOIL)	[illegible]	[illegible]	[illegible]	
0.50	HSV	70kPa		Medium strength firm to stiff orange brown slightly sandy gravelly residual CLAY. Gravel is fine to coarse sub angular limestone. (MARLSTONE ROCK BED)	[illegible]	[illegible]	[illegible]	
0.80	D							
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED)	[illegible]	[illegible]	[illegible]	

End of Trial Pit at [illegible] m

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP21**

Method: Trial Pit	Date: 30/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446433.90,238339.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:121.48mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.20	D			Soft to firm brown slightly sandy slightly gravelly clay TOPSOIL with abundant rootlets. Gravel is fine to medium sub rounded limestone. (TOPSOIL)
0.50	HSV	85kPa		High strength stiff light yellow brown slightly sandy gravelly residual CLAY becoming destructured very gravelly below 0.8m bgl. (MARLSTONE ROCK BED)
0.60	HSV	130kPa		
0.60	D			
1.10	D			
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal

End of Trial Pit at 1.30 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury

Trial Pit No.
HTP22

Method: Trial Pit	Date: 30/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446470.59,238326.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:121.31mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
				Yellow brown and grey sandy clayey GRAVEL. Gravel is fine to coarse angular brick concrete and rare ash. (TOPSOIL)
0.20	D			
				High strength stiff slightly gravelly residual CLAY becoming destructured very gravelly below 0.8m bgl. Gravel is fine to coarse sub angular limestone. (MARLSTONE ROCK BED)
0.50	HSV	95kPa		
0.60	D			
0.90-1.00	B			
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal

End of Trial Pit at 1.30 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury	Trial Pit No. HTP23
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Method: Trial Pit	Date: 30/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446455.70,238356.00	Pit Stability: Stable	Dimensions
Hydrock Project No: C12702	Elevation: 121.71mAOD	Plant: JCB 3CX	

Depth (m)	Type	Results	Groundwater	Stratum Description
0.20	D			Firm brown slightly gravelly slightly sandy silty clay TOPSOIL with abundant rootlets. (TOPSOIL)
0.40-0.50	B			High strength stiff yellow brown silty residual CLAY with rare gravel below 0.40m bgl. (MARLSTONE ROCK BED)
0.50	HSV	95kPa		
1.20	D			Stiff yellow brown slightly sandy very gravelly residual CLAY. (MARLSTONE ROCK BED)
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury

Trial Pit No. HTP24

Method: Trial Pit	Date: 28/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446525.56,238417.00	Pit Stability: Unstable	Dimensions:
Hydrock Project No: C12702	Elevation: 121.79mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.20	D			Brown slightly sandy slightly gravelly silty clay TOPSOIL. Wet with abundant rootlets. (TOPSOIL)
0.40	HSV	45kPa		Medium to high strength firm to stiff yellow brown and grey brown slightly sandy slightly gravelly silty residual CLAY. Gravel is fine to coarse sub angular limestone. Becoming very gravelly below 1.20m bgl. (MARLSTONE ROCK BED)
0.60	HSV	70kPa		
0.70	D			
0.70-0.80	B			
0.80	HSV	60kPa		
1.20	D			
				Moderately strong fine grained red brown shelly partially weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.

End of Trial Pit at 1.45 m

General Remarks:

Trial Pit was unstable. No groundwater encountered.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP25**

Method: Trial Pit	Date: 28/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446655.55,238527.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:120.86mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description	Depth (m)	Level (mAOD)
0.15	D			Firm dark brown slightly sandy slightly gravelly silty clay TOPSOIL with abundant rootlets. (TOPSOIL)	[illegible]	[illegible]
0.30	HSV	50kPa				
0.40	D			Medium strength firm to stiff red brown sandy residual CLAY. (MARLSTONE ROCK BED)	[illegible]	[illegible]
0.50	HSV	70kPa				
0.60	HSV	75kPa				
0.60	D			High strength stiff yellow brown gravelly residual CLAY. Gravel is fine to coarse sub angular limestone and abundant cobbles. Becoming very gravelly below 1.20m bgl. (MARLSTONE ROCK BED)	[illegible]	[illegible]
1.40	D			Moderately strong fine to coarse grained blue grey and red brown banded occasionally shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.	[illegible]	[illegible]

End of Trial Pit at 1.50 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

Logged in general accordance with BS5930: 1999, incorporating Amendment 1.

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Project: Land at Bankside, Banbury			Trial Pit No. HTP26
			Page No. 1 of 1
Method: Trial Pit	Date: 28/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446789.29,238562.00	Pit Stability: Stable	Dimensions
Hydrock Project No: C12702	Elevation: 118.89mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.10	D			Medium strength firm dark brown slightly sandy slightly silty clay TOPSOIL with occasional small fragments of blue and white pottery and abundant rootlets. (TOPSOIL)
0.30	HSV	50kPa		
0.50	D			High strength firm to stiff red brown slightly sandy slightly silty residual CLAY with occasional gravel. Gravel is fine to medium sub angular ironstone. Becoming gravelly below 0.7m bgl. (MARLSTONE ROCK BED)
0.50-0.60	B			
0.60	HSV	100kPa		
				Very stiff orange brown very gravelly destructured CLAY. Gravel is fine to coarse sub angular limestone and mudstone with abundant cobbles. (MARLSTONE ROCK BED)
2.50	D			Very weak thinly bedded grey partially weathered MUDSTONE with occasional shells. (DYRHAM FORMATION)
				Refusal.
				End of Trial Pit at 2.80 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

Logged in general accordance with BS5930: 1999. Incorporating Amendment 1.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP27**

Method: Trial Pit	Date: 28/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446664.97,238260.00	Pit Stability: Stable	Dimensions
Hydrock Project No: C12702	Elevation:120.78mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
				Firm brown slightly sandy slightly gravelly silty clay TOPSOIL. (TOPSOIL)
0.20	D			
0.40	HSV	50kPa		
				Medium to high strength firm to stiff light brown slightly sandy slightly gravelly silty residual CLAY. Gravel is fine to coarse sub angular limestone. (WHITBY MUDSTONE FORMATION)
0.60	D			
0.70	HSV	90kPa		
			▽	
1.30	D			
				Moderately strong fine grained thinly bedded red brown shelly weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.
				End of Trial Pit at 1.50 m

General Remarks:

Trial Pit was stable. Field drain inflow at 0.9m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP28**

Method: Trial Pit	Date: 29/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446889.31,238394.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 119.69mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.20	D			Soft to firm brown slightly sandy slightly gravelly clay TOPSOIL with abundant rootlets. (TOPSOIL)
0.40	HSV	45kPa		Medium to high strength firm to stiff light brown slightly gravelly silty residual CLAY. Gravel is fine to medium sub angular limestone with occasional calcareous concretions. (WHITBY MUDSTONE FORMATION)
0.70 0.70 0.70-0.80	HSV D B	95kPa		
1.30	D			Very stiff light brown gravelly residual CLAY. Gravel is fine to coarse sub angular limestone with abundant cobbles. (MARLSTONE ROCK BED)
				Moderately strong fine grained thinly bedded red brown shelly partially weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal.

End of Trial Pit at 1.50 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury		Trial Pit No. HTP29
		Page No. 1 of 1
Method: Trial Pit	Date: 29/11/2012	Logged By: AH
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446994.60,238478.00	Pit Stability: Stable
Hydrock Project No: C12702	Elevation:117.52mAOD	Plant: JCB 3CX

Checked By:

Dimensions:

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.15 0.20	D HSV	25kPa		Low strength soft brown sandy gravelly clay TOPSOIL. Gravel is fine to coarse sub angular limestone with abundant rootlets. (TOPSOIL)
0.40-0.50 0.80	B D			Orange brown slightly sandy clayey destructured GRAVEL. Gravel is fine to coarse sub angular limestone with abundant cobbles. (MARLSTONE ROCK BED)
				Moderately strong fine grained medium bedded red brown weathered LIMESTONE. (MARLSTONE ROCK BED) Refusal. End of Trial Pit at 1.15 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury			Trial Pit No. HTP32 Page No. 1 of 1
Method: Trial Pit	Date: 28/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446742.63,238208.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 120.10mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
				Firm light brown slightly sandy silty clay TOPSOIL. (TOPSOIL)
0.20	D			
0.40 0.40-0.50	HSV B	90kPa		High strength stiff yellow brown gravelly residual CLAY. Gravel is fine to coarse sub angular to sub rounded Limestone. (MARLSTONE ROCK BED)
0.60	HSV	100kPa		
1.00 1.00	HSV D	110kPa	▽	High strength stiff brown grey brown and yellow mottled slightly sandy gravelly residual CLAY. Gravel is fine to coarse sub angular limestone with occasional cobbles. (MARLSTONE ROCK BED)
1.35	D			Medium strong fine to coarse grained with thin to medium bedded blue grey calcareous partially weathered LIMESTONE with shelly layers and red brown ironstone bands. (MARLSTONE ROCK BED) Refusal.
				End of Trial Pit at 1.40 m

General Remarks:

Trial Pit was stable. Water seepage at 1.2m bgl.

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Project: Land at Bankside, Banbury

Trial Pit No. HTP33

Method: Trial Pit	Date: 28/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446852.95,238361.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 119.80mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater
0.25	D		
0.40	HSV	80kPa	
0.80	HSV	75kPa	
1.00-1.10	B		
1.20	D		
1.40	D		

Stratum Description
Firm brown slightly sandy silty clay TOPSOIL with abundant rootlets. (TOPSOIL)
High strength stiff yellow brown slightly sandy silty residual CLAY with occasional decayed rootlets. (WHITBY MUDSTONE FORMATION)
Stiff yellow brown slightly sandy gravelly residual CLAY. Gravel is fine to coarse sub angular to sub rounded limestone. (MARLSTONE ROCK BED)
Medium strong fine to coarse grained with thin to medium bedded blue grey calcareous partially weathered LIMESTONE with abundant shells. (MARLSTONE ROCK BED) Refusal.

End of Trial Pit at 1.45 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury

Trial Pit No. HTP35

Method: Trial Pit	Date: 28/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords: 446954.21,238220.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation: 119.26mAOD	Plant: JCB 3CX	

Samples and In Situ Testing								
Depth (m)	Type	Results	Groundwater	Stratum Description	Depth (mbgl)	Thickness (m)	Level (mAOD)	Legend
				Soft to firm light brown silty clay TOPSOIL. (TOPSOIL)	[illegible]	[illegible]	[illegible]	
0.50	HSV	70kPa		Medium strength firm light yellow brown slightly sandy silty residual CLAY with occasional angular limestone cobbles from 0.7m bgl and rare ironstone cobbles below 1.20m bgl. (WHITBY MUDSTONE FORMATION)	[illegible]	[illegible]	[illegible]	
0.60	D							
0.60-0.70	B							
1.10	HSV	90kPa						
1.10	D							
			▽					
				Stiff yellow brown gravelly residual CLAY. Gravel is fine to coarse sub angular to angular ironstone with abundant cobbles. (MARLSTONE ROCK BED)	[illegible]	[illegible]	[illegible]	
				Medium strong fine to coarse grained red brown IRONSTONE. (MARLSTONE ROCK BED) Refusal.	[illegible]	[illegible]	[illegible]	

End of Trial Pit at 1.80 m

General Remarks:

Trial Pit was stable. Water seepage at 1.6m bgl.

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Project: Land at Bankside, Banbury		Trial Pit No. HTP38 Page No. 1 of 1
Method: Trial Pit	Date: 29/11/2012	Logged By: AH
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:446933.62,238121.00	Pit Stability: Stable
Hydrock Project No: C12702	Elevation:119.11mAOD	Plant: JCB 3CX

Checked By:

Dimensions

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.15	D			Soft to firm dark brown slightly sandy slightly gravelly silty clay TOPSOIL. (TOPSOIL)
0.40	HSV	65kPa		
0.60	D			Medium to high strength firm to stiff brown and yellow brown gravelly residual CLAY. Gravel is fine to coarse sub angular limestone with abundant cobbles. (MARLSTONE ROCK BED)
0.70	HSV	85kPa		
1.10	D			Very stiff grey and yellow brown mottled slightly gravelly silty residual CLAY. Gravel is fine to coarse sub angular limestone. (MARLSTONE ROCK BED)
				Moderately strong fine grained fine to medium bedded red brown partially weathered shelly LIMESTONE. (MARLSTONE ROCK BED) Refusal.
				End of Trial Pit at [illegible] m

General Remarks:

Trial Pit was stable. No groundwater encountered.

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP39**

Method: Trial Pit	Date: 29/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:447051.52,238249.00	Pit Stability: Stable	Dimensions: [illegible]
Hydrock Project No: C12702	Elevation:118.40mAOD	Plant: JCB 3CX	

Samples and In Situ Testing

Depth (m)	Type	Results	Groundwater
0.20	D		
0.40	HSV	40kPa	
0.50	D		
0.50-0.60	B		
0.60	HSV	60kPa	
1.50	D		

Stratum Description

Firm slightly sandy slightly gravelly clay TOPSOIL with abundant rootlets. Gravel is fine to medium sub angular limestone.
(TOPSOIL)

Medium strength firm brown and yellow brown mottled silty residual CLAY.
(WHITBY MUDSTONE FORMATION)

Stiff yellow brown very gravelly residual CLAY. Gravel is fine to coarse sub angular limestone with abundant cobbles.
(MARLSTONE ROCK BED)

Medium strong fine grained thin to medium bedded red brown weathered LIMESTONE with abundant shells and calcite in filled shells.
(MARLSTONE ROCK BED)
Refusal.

End of Trial Pit at [illegible] m

General Remarks:

Trial Pit was stable. No groundwater encountered.

Hydrock

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Project: Land at Bankside, Banbury

Trial Pit No. **HTP40**

Method: Trial Pit	Date: 29/11/2012	Logged By: AH	Checked By:
Client: Bovis, Barratt and Taylor Wimpy	Co-Ords:447072.22,238095.00	Pit Stability: Stable	Dimensions:
Hydrock Project No: C12702	Elevation:118.32mAOD	Plant: JCB 3CX	

Samples and In Situ Testing: Depth (m)	Type	Results	Groundwater	Stratum Description
0.20	D			Soft to firm dark brown slightly sandy slightly gravelly silty clay TOPSOIL with abundant rootlets. Gravel is fine to medium sub angular limestone. (TOPSOIL)
0.40 0.40-0.50 0.60 0.60	HSV B HSV D	75kPa 80kPa 		High strength stiff yellow brown slightly gravelly residual CLAY. Gravel is fine to coarse sub angular limestone. Becoming gravelly below 0.7 with abundant limestone cobbles. (MARLSTONE ROCK BED)
1.50	D			Moderately strong fine grained thinly bedded red brown weathered shelly LIMESTONE. (MARLSTONE ROCK BED) Refusal End of Trial Pit at 1.60 m

General Remarks:

Trial Pit was stable. No groundwater encountered.

Logged in general accordance with BS5930: 1999, incorporating Amendment 1.

Appendix D

HYDROCK METHODOLOGY

Hydrock Report Appendix on Hydrock Methodology, version 02 updated 21-12-12 applies to this report.

This appendix may not be included in the printed report to reduce the document size.

It is presented in the PDF version of the report on the CD enclosed with the printed report. Alternatively, it can be supplied on request by quoting the version number and date.

1.0 HYDROCK REPORT APPENDIX ON HYDROCK METHODOLOGY

This appendix provides additional background information on certain approaches and methods used by Hydrock Consultants Ltd in the preparation of this report.

Throughout the report the term ‘geotechnical’ is used to describe aspects relating to the physical nature of the site (such as foundation requirements) and the term ‘geo-environmental’ is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation and these two main aspects are inter-related. The geo-environmental sections are written in broad agreement with BS 10175:2011.

The **first stage** of a two-staged investigation and assessment of a site is the Preliminary Investigation (BS 10175:2011), often referred to as the Phase 1 Study[1], comprising desk study and walk-over survey, which culminates in the Preliminary Risk Assessment. A preliminary conceptual site model (CSM) is developed. From this are identified any geotechnical and geo-environmental hazards and the qualitative degree of risk associated with them. From the geo-environmental perspective, the Hazard Identification process uses professional judgement to evaluate all the hazards in terms of **possible contaminant linkages** (of source-pathway-receptor). Possible contaminant linkages are potentially unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and generic risk assessment.

The **second stage** is the Ground Investigation, Generic Risk Assessment and Geotechnical Interpretation. This represents the further assessment mentioned above. The Ground Investigation comprises field work and laboratory testing based on the findings of the Preliminary Risk Assessment, to reduce uncertainty in the geotechnical and geo-environmental hazard identification. This may include the Exploratory, Main and Supplementary Investigations described in BS 10175:2011.

For the geotechnical aspects of the report, the general requirements of Eurocode 7 (BS EN 1997-2:2007) are to produce a Ground Investigation Report (GIR) which shall form part of the Geotechnical Design Report (GDR). The geotechnical section of this report is intended to fulfil the general requirements of the GIR as outlined in BS EN 1997-2, Section 6.

The GIR contains the factual information including geological features and relevant data, and a geotechnical evaluation of the information stating the assumptions made in the interpretation of the test results.

[1] Please note that it does not refer to a site development phase.

2.0 SITE INVESTIGATION INFORMATION

2.1 Unexploded Ordnance

Clients have a legal duty under the CDM 2007 Regulations to provide designers and contractors with project-specific health and safety information needed to indentify hazards and risks. This includes the possibility of unexploded ordnance (UXO) being encountered on the site. Further details are given in CIRIA report C681 (Stone *et al* 2009).

A non-UXO specialist screening exercise has been carried out for the site by considering (a) any evidence of UK defence activities on or near the site evident from the gathered desk study information and (b) the unexploded aerial delivered bomb (UXB) regional risk maps produced by Zetica. Other data sources are available, but as a first stage screening exercise the freely available Zetica maps have been used. The level of risk stated is that determined by Zetica, a company experience in the desk study, field investigation and clearance of UX0/UXB.

2.2 Hydrogeology

Under the Water Framework Directive the designations of principal and secondary aquifers is based on the Environment Agency interactive aquifer designation map. Where aquifers have been mapped, and they are capable of sustaining a yield of 10 m^3/day or supplying 50 people on a continuous basis, the Environment Agency has designated a number of Groundwater Bodies to help manage water quality under the River Basin Management Plans. Groundwater bodies are defined based on their support for ecosystems as well as their capacity to supply drinking water. Note that some localised small aquifers capable of supporting the above supply may be too small to map and can be identified only by investigation.

Where an aquifer exists and it contains groundwater but is incapable of sustaining the above supply, the groundwater is not part of a Groundwater Body and is not considered a strategic resource. In which case the groundwater is not a receptor, but can be a pathway to other receptors by virtue of its ability to transport contaminants.

2.3 Geotechnical Testing

Derived values of geotechnical parameters and/or coefficients are obtained from test results, by theory, correlation or empiricism in line with BS EN 1997-2:2007, Section 1.6.

Where derived geotechnical parameters are to be used in designs in accordance with EC7, there are two further stages of interpretation that will be carried out by the geotechnical designer. The first of these is the selection of **characteristic values** for geotechnical parameters using the derived values and complemented by well-established experience as per EN BS 1997-1:2004, Section 2.4.5.2. The characteristic value is a cautious estimate of the value affecting the occurrence of the limit state. Consequently, any particular material type may have more than one characteristic value for each parameter because there may be more than one limit state depending what is being designed.

The second stage is the selection of **design values** as per EN BS 1997-1:2004, Section 2.4.6.2. The design values is either derived from the characteristic value by applying the relevant partial factor or is assessed directly. Similarly, there can be several design values for the same material type.

In the event that geotechnical designs are include in this report, selection of the characteristic and design values is included. Otherwise, it is the duty of the geotechnical designer to determine these within a separate design report.

3.0 RISK ASSESSMENT RATIONALE

The work presented in this report has been carried out in general accordance with recognised best practice as detailed in guidance documents such as in the CLR 11 Model Procedures (Environment Agency 2004a), BS5930:1999+A2:2010 and BS10175:2011. Important aspects of the risk assessment process are transparency and justification. The particular rationale behind the risk assessments presented is given in this appendix.

A preliminary risk assessment is made of both geotechnical and geo-environmental hazards identified at the desk study stage and confirmed (or amended) at the ground investigation stage. In the case of geo-environmental hazards this is based on a simple matrix of probability of occurrence versus the consequence, as explained below, and is referred to as the **exposure model**. In the case of the geotechnical hazard identification, this is referred to as the **ground model**.

The geo-environmental risk assessment process proceeds to the next level, the generic risk assessment, in which actual contaminant concentrations are considered.

3.1 Preliminary Risk Assessment

In line with the CLR 11 Model Procedures (Environment Agency 2004a), the Preliminary Risk Assessment includes a geo-environmental Hazard Identification, which seeks to list all the suspected contaminant **sources**, the **receptors** that might be harmed by those sources and the **pathways** via which the sources might reach the receptors to cause the harm. The source-pathway-receptor concept is known as a contaminant linkage (formerly a pollutant linkage) and only when a linkage is complete is there any possibility of risk of harm arising.

The Hazard Identification process uses professional judgement to evaluate all the hazards in terms of **possible contaminant linkages**. Possible contaminant linkages are potentially unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and the chemical analysis of soil and water samples.

Where no ground investigation has been carried out (i.e. in a desk study only report) there is greater uncertainty in the information available and so a geoenvironmental consequences and probability assessment is undertaken.

Some linkages may be identified which constitute a theoretical connection between a source and a receptor, but professional judgement shows them not to be possible for some reason. These are labelled ‘no linkage’ in the summary table and no further action is required. If a linkage is possible, a comparison is made of consequence against probability in general accordance with the guidance given in CIRIA Report C552 (Rudland *et al* 2001).

Classification of consequences and probability are given in CIRIA C552 Tables 6.3 and 6.4, respectively, but there are a number of inconsistencies in the original Table 6.3, in particular relating to 'significant harm or significant possibility of significant harm' (SH/SPOSH). Consequently, the table has been updated by Hydrock in line with current practice and the revision presented in R&D Publication 66, Annex 4 (NHBC and Environment Agency. 2008, and is given in Table 3.1 below.

The basis of the classification is that 'severe' and 'medium' are likely to result in SH/SPOSH as defined by the EPA 1990, Part 2A, with 'severe' resulting in acute harm. 'Mild' lies below the level of SH/SPOSH but above the level of 'no harm' as implied by the relevant Generic assessment criterion (GAC, see below). Minor lies below the 'no harm' level.

Table 3.1: Classification of Consequences of Geo-environmental Risks

Classification of Consequences for Geo-environmental Risks		
Classification	**Definition**	**Examples**
Severe	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of unacceptable intake or contact. Highly elevated concentrations **likely** to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. I.e. >>SH/SPOSH, concentrations are high enough to cause acute (short-term) effects. Equivalent to EA **Category 1** pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.	Human health: short-term (acute) effects likely to result in significant harm. E.g. high conc. of cyanide on the surface of an informal recreational area. Significant harm to humans is defined as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Planting: complete and rapid die-back of landscaped areas. Controlled waters: short-term pollution, e.g. major spillage into controlled water. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity). Buildings etc.: catastrophic damage, e.g. explosion causing collapse. (can also equate to immediate human health risk if buildings are occupied). Ecosystems: acute risk to a particular ecosystem or organism forming part of that ecosystem in a designated protected area, e.g. by contamination spillage. Damage to a protected area of international significance (e.g. Ramsar site). Site workers: risk assessment required to determine PPE and this may involve USEPA Level A, B or C protection.

Classification of Consequences for Geo-environmental Risks		
Classification	**Definition**	**Examples**
Medium	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of unacceptable intake or contact. Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. I.e. >SH/SPOSH. Equivalent to **EA Category 2** pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.	Human health: long-term (chronic) effects likely to result in significant harm. E.g. high conc. of contaminants close to the surface of a development site. Significant harm to humans is defined as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Planting: stressed or dead plants in landscaped areas. Controlled waters: pollution of sensitive water resources, e.g. leaching into principal or secondary aquifers or rivers. Buildings etc.: damage renders unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes. Ecosystems: chronic death of species in a particular ecosystem in a designated protected area, e.g. by contamination spillage. Damage to a protected area of national significance (e.g. Site of Special Scientific Interest). Site workers: risk assessment required to determine PPE and this may involve USEPA Level B, C or D protection.
Mild	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of no harm but not unacceptable intake or contact. Exposure to human health **unlikely** to lead to "significant harm". I.e. >SVG/GAC but <SH/SPOSH. Equivalent to **EA Category 3** pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population. Minor damage to crops, buildings or property.	Human health: harm but probably not significant harm unless particularly sensitive individual within the receptor group. May be aesthetic/olfactory impacts. Exposure could lead to slight short-term effects (e.g. mild skin rash). Planting: damage to plants in landscaped areas, e.g. stunted growth, discoloration. Controlled waters: pollution of non-sensitive water bodies e.g. leaching into non-classified groundwater or minor ditches. Buildings etc.: damage to sensitive buildings etc. Surface spalling of concrete. Ecosystems: minor change in a particular ecosystem in a designated protected area, but not significant harm. Damage to a locally important area. Site workers: risk assessment required to determine PPE and this may involve USEPA Level C or D protection.

Classification of Consequences for Geo-environmental Risks		
Classification	**Definition**	**Examples**
Minor	Concentration of contaminants is likely to (or is known from previous data to) be less than that indicative of no harm. No measurable effects on humans. I.e. <SGV/GAC. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.	No measurable effects, but simple PPE required (USEPA Level D protection, i.e. overalls, boots, goggles, hard hat). The loss of plants in a landscaping scheme. Discoloration of concrete.

CIRIA Table 6.4 is reproduced as Table 3.2 below. This provides an estimate of the probability that the event described by the contaminant linkage will occur. For example, the likelihood that pollution of groundwater will occur by leaching of metals into the aquifer.

Table 3.2: Classification of Probability of Geo-environmental Risks

Classification of Probability of Geo-environmental Risks	
Classification	**Definition**
High Likelihood	There is a contaminant linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a contaminant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event in not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a contaminant linkage and circumstances are possible under which an event could occur. However, it is no means certain that even over a longer period such event could take place, and is less likely in the shorter term.
Unlikely	There is a contaminant linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

The perceived level of risk for each pathway is then derived from the probability versus consequences matrix, modified after CIRIA C552 Table 6.5, given in Table 3.3 below. Note that by definition, no contaminant linkage equates to no risk.

Table 3.3: Qualitative Risk Level from Consequence and Probability

		Consequence			
Probability	*product*	**Severe**	**Medium**	**Mild**	**Minor**
	High Likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Low risk	Very low risk
	Low Likelihood	Moderate risk	Low risk	Low risk	Very low risk
	Unlikely	Low risk	Very low risk	Very low risk	Very low risk
	No Linkage	No risk			

This approach assumes an equivalence between probability and consequences and ignores the difficulty that can arise where to probability of occurrence appears to be almost negligible but the consequences are very severe. In such conditions there is a degree of subjectivity in assessing the level of risk and it could be low, moderate or high. Such risks may require specialist consideration beyond the scope of this standard report.

Finally, a description of the classified risks and the likely action required can be determined from Table 3.4 below.

Table 3.4: Description of the Classified Risks and Likely Action Required

Description of Classified Risks and Likely Action Required	
Very High Risk	A significant contaminant linkage, including actual evidence of significant harm or significant possibility and significant harm, is clearly identifiable at the site (e.g. from visual or documentary evidence) under current conditions, with potential for legal and/or financial consequences for the site owner or other Responsible Person. Remediation advisable based on acute impacts being likely. Immediate action should be considered.
High Risk	A contaminant linkage is identifiable at the site under current and future use conditions. Although likely, there is no obvious actual evidence of significant harm or significant possibility and significant harm under current conditions. Extent of risk is therefore subject to confirmation by investigation and risk assessment and most likely to be deemed significant. Realisation of the risk is likely to present a substantial liability to the site owner or other Responsible Person. Remediation required for redevelopment and may also be required under Part 2A for existing receptors.
Moderate Risk	A contaminant linkage is identifiable at the site under current and future use conditions. However, it is not likely to be a significant linkage under current conditions. It is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Actual extent of risk subject to confirmation by additional investigation and risk assessment and most likely to lie between no possibility of harm (under current conditions) and significant possibility of significant harm (under conditions created by new use). Remediation may be required for redevelopment.
Low risk	Potential pathways and receptors exist but history of contaminative use or site conditions indicates that contamination is likely to be of limited extent and below the level of no possibility of harm. It is unlikely that the site owner or other Responsible Person would face substantial liabilities from suck a risk. Precautionary investigations and risk assessment advisable on change of use. Any subsequent remedial works are likely to be relatively limited.
Very Low Risk	No contaminant linkage likely to exist under current or future conditions, but this cannot be completely discounted. If harm is realised, it is likely at worst to be mild or minor. Site not capable of being determined under Part 2A where the local authority inspects the site. No further action recommended.
No Risk	No contaminant linkage exists.

3.2 <u>Contaminant Analysis of Samples</u>

The Model Procedures of CLR 11 provide guidance on key information sources with respect to potential contamination arising from past land uses of a site. In particular, the now withdrawn CLR 8 (Environment Agency 2002b), the DoE Industry Profile documents and ISO10381-5 provide good summaries of priority pollutants for UK sites. Additionally, the Environment Agency (2004b) has produced a list of priority pollutants for ecological risk assessment. These documents have been used, with the findings of the Phase 1 investigation, to scope the analyses of chemicals of potential concern. It should be noted that whilst CLR 8 was withdrawn in August 2008 it was not replaced and its findings are still considered useful.

Hydrock considers there to be a minimum requirement for soil chemical analysis, even for greenfield sites, in order to satisfy the ‘suitable for use’ criterion of the planning regime. This is represented by the ‘Hydrock default list of determinands for solids’. The default list is derived from the above guidance, particularly Tables 2.1 and 2.2 of CLR 8, listing potential inorganic and organic contaminants on typical former **industrial** land in the UK.

Since not all redevelopment sites have former industrial land uses, the default list designed to screen for unacceptable risks to property development and future occupiers comprises those substances with human, vegetation and construction materials receptors. The list includes common metals, metalloids and inorganic species, pH, asbestos fibres and screening tests for common organic compound groups which are deemed chemicals of potential concern. Sulfate is a contaminant whose principal receptor is concrete in the ground and is not considered toxic except in extreme conditions. Sulfate analysis is included in the list of geotechnical tests. Some common determinands such as elemental sulfur and sulfide are not included because there is insufficient information available to calculate meaningful assessment criteria.

The Hydrock default list of determinands for water or soil leaching samples is based on the prevailing UK drinking water standards and the environmental quality standards (EQS) values specified by DEFRA (2009) under the UK’s obligations under the European Water Framework Directive (WFD). It includes the most common contaminants for use as a screening exercise but does not represent a complete list.

The two Hydrock default lists of determinands are used as a minimum requirement whatever the findings of the Phase 1 investigation. Added to this may be other suites of determinands based on the findings and review of the aforementioned documents.

Assessment is made of all chemicals of potential concern recorded on the site above the laboratory reporting limit. The reporting limits are less than the generic assessment criteria where this is possible. There are two main reasons why this may not be the case.

Firstly, low-level detection may be available using a more detailed analysis method, but this would be disproportionally expensive for routine screening purposes. More detailed testing may be recommended in some instances as an additional phase of investigation once the results of the screening exercise are known.

Secondly, there may be no suitable laboratory method available. In which case it is impossible to give a definitive opinion.

3.3 Generic Risk Assessment Criteria for Human Health

3.3.1 Policy

Generic assessment criteria (GAC) are criteria derived using largely generic assumptions about the characteristics and behaviour of sources, pathways and receptors. These assumptions will be conservative in a defined range of conditions. The Contaminated Land Exposure Assessment (CLEA) framework uses Soil Guideline Values (SGV) in assessing risks to human health from exposure to soils contaminated with selected contaminants. It has been assumed in this report that the exposure conditions are within the generic conditions used to derive the SGVs.

It should be noted that exceedance of GACs does not automatically mean that the soil is “contaminated”. The derivation of GACs includes a number of precautionary assumptions such that non-exceedance will indicate that risk to human health is acceptable and that the land is suitable for use, with regard to the contaminant in question. SGVs are not binding standards, but may be used to inform judgments about the need for action and the selection of remediation standards or target values for individual sites.

However, the legal test for land contamination under the statutory guidance of Part 2A of the Environment Protection Act 1990 (i.e. “significant harm or significant possibility of significant harm”) is **unacceptable** intake or direct bodily contact. DEFRA (September 2005 and July 2008) has made it clear that exceedance of a GAC does not necessarily meet this legal test, i.e. exceedance of a GAC does not necessarily equate to unacceptable risk. Consequently, the GACs must be considered as screening values only. The situation was clarified by DEFRA (July 2008) in its guidance on the legal definition of contaminated land and in 2012 by the publication of revised contaminated land statutory guidance. One of the key policy aspects of this revision is to clarify that GACs are only one tool in the decision-making process and that background concentrations and a number of other relevant factors should also be taken into account. The aim is to prevent over-cautious determination of land as being contaminated.

The Environment Agency (2009a) has stated that the Health Criteria Values (HCV) used to derive GACs represent minimal or tolerable risk for long-term human exposure to chemicals in the soil. “Science alone cannot answer the question of whether or not a given *possibility of significant harm* is *significant*, since what is either *significant* or *unacceptable* is a matter of socio-political judgement, and the law entrusts decisions on this to the enforcing authorities (DEFRA July 2008).”

The Health Protection Agency (2009) also describes how HCVs do not represent unacceptable intake and that unacceptable intake is not a toxicological parameter. It further asserts that “unacceptable intake is a policy decision which can only be taken by the local authority.” Pointers provided to local authorities in this regard are provided by the following: “The HCVs, and GACs based upon them represent trigger values above which there might be a possibility of significant harm. Whether there is a significant possibility will be linked to factors such as the margin of exceedance, the duration and frequency of exposure, and other site-specific factors.”

The 2012 National Planning Policy Framework states that the standard of remediation to be achieved through the grant of planning permission for new development, including permission for land remediation activities, is the removal of unacceptable risk and making sure the site is suitable for its new use. As a minimum, after carrying out the development and commencement of its use, the land should not be capable of being determined as contaminated under Part 2A. The requirements for planning are, therefore, the same as for Part 2A.

The 2012 contaminated land statutory guidance says that GAC represent cautious estimates of levels of contaminants in soil at which there is considered to be no risk to health or, at most, a minimal risk to health. They may be used to indicate when land is very unlikely to pose a significant possibility of significant harm to human health. They should not:

- be used as direct indicators of whether a significant possibility of significant harm to human health may exist. Also, the local authority should not view the degree by which GACs are exceeded (in itself) as being particularly relevant to this consideration, given that the degree of risk posed by land would normally depend on many factors other than simply the amount of contaminants in soil.
- be seen as screening levels which describe the boundary between Categories 3 and 4 (see below);
- be viewed as indicators of levels of contamination above which detailed risk assessment would automatically be required under Part 2A or, under the planning system, in relation to ensuring that land affected by contamination does not meet the Part 2A definition of contaminated land after it has been developed; nor
- be used as generic remediation targets under the Part 2A regime.

Where it is judged that significant uncertainties remain following assessment against generic criteria, there are two options for the developer: either the implementation of an agreed remedial strategy, or to undertake additional testing and/or a detailed quantifiable risk assessment to determine whether remediation is indeed necessary.

3.3.2 Methodology

The sample analyses are divided into representative data sets for the assessment, based on the conceptual model and taking into account such characteristics as variation in soil properties or historical, existing or proposed land uses. The ‘averaging area’ is the area of soil to which a receptor is exposed or which otherwise contributes to the creation of hazardous conditions.

The determination of averaging areas is clarified in the CLEA Frequently Asked Questions (30 January 2006) document available from the Agency CLEA web pages. In applying statistical tests, the risk assessor is asking the question “are mean (95 percentile upper confidence limit) soil concentrations within the averaging area equal to, or greater than, the SGV/GAC?” If a garden lies within a larger averaging area, but that averaging area is representative of conditions within the garden, then this is the average concentration a receptor using the garden will be exposed to. An averaging area can, therefore, be larger than a single garden and part of a larger zoned area if:

- contaminant concentrations are within the same statistical population, the sample data being representative of the averaging area and the mean concentration of the averaging area;
- hot spots are treated as separate zones or averaging areas; and
- the sampling strategy takes into account uncertainty (spatial heterogeneity) in contaminant concentration.

The approach taken in this report is to characterize the materials that are likely to form the ground cover in garden areas by zoning the site. Each averaging area has been chosen to describe the area(s) of the site, zoned according to material type and existing conditions, within which assessment against GACs has taken place. As pointed out in P5-066/TR (Environment Agency 2000) and by Nathanail (2004), this is a logical way of investigating a large plot of land that is intended for residential use, particularly if the development layout may not have been finalised.

The original Soil Guideline Values were all withdrawn in August 2008 and the Agency started a programme of publishing replacements using its 'new approach', which involves a number of changes to the way exposure is assessed. This was started using the CLEA 1.04 software. The current version is CLEA 1.06. This programme was put in abeyance when DEFRA started to re-draft the Part 2A statutory guidance.

A significant change in the new approach is to publish SGVs only at 6% soil organic matter (SOM) content. This appears to be counter productive because in cases where the SGV varies with the SOM, the published SGV report states that "at a lower SOM, they may not be sufficiently protective." The SGV introduction report *Using Soil Guideline Values* states that in such circumstances a new GAC can be produced by adjusting the SGV.

Furthermore, the SGVs are no longer published for the residential without plant uptake land use.

Consequently, the approach taken by Hydrock is to take the various input parameters from the SGV reports and produce GACs for various SOM and for the residential without plant uptake land use, using CLEA 1.06. The GACs adopted by Hydrock for the standard CLEA land uses are given in Table 3.5 together with the source of the GAC. The table also lists GACs for open space (see below).

The absence of published SGVs for certain chemicals of potential concern has been addressed by the derivation of GAC using generic assumptions about the characteristics and behaviour of sources, pathways and receptors and the CLEA 1.06 software. Input data have been derived either from published GAC lists (EIC/AGS/CL:AIRE and LQM/CIEH) or by in-house research of the recommended data sources.

Please note also that CLEA 1.06 allows for other variations, most notably of soil type (9 options) and building type (5 residential options). The defaults are a sandy loam soil, a small terraced house in the residential setting and a pre-1970s office block in the commercial setting. These are generally conservative and the resultant SGV/GAC are protective of other combinations (unlike the default SOM mentioned above). It is not practical to include all permutations in Table 3.5 and in the cases where specific GACs have been derived, this is referred to in the text of the report and the relevant values included in the assessment tables.

Lead is a special case as the former SGV was not based on the CLEA model, but equations utilising blood lead concentrations. There is currently no guidance on how to risk assess lead and the work-in-progress by the Environment Agency under to derive a new methodology using CLEA is in abeyance. Consequently, the former SGVs for lead have been retained by Hydrock until this has been clarified.

Further details including data sources can be obtained on request. It is Hydrock's policy to continually review GACs and updates are made in response to the latest Government guidance or as more data on the substances becomes available. The date of the last update of the table is indicated.

Table 3.5: Soil GACs Adopted by Hydrock (mg/kg) - on following pages

Updated 20/07/11

Contaminant	Source of GAC	Human health - residential without plant uptake (1%SOM)	Human health - residential without plant uptake (2.5%SOM)	Human health - residential without plant uptake (6%SOM)	Human health - residential with plant uptake (1%SOM)	Human health - residential with plant uptake (2.5%SOM)	Human health - residential with plant uptake (6%SOM)	Human health - allotments (1%SOM)	Human health - allotments (2.5%SOM)	Human health - allotments (6%SOM)	Human health - commercial (1%SOM)	Human health - commercial (2.5%SOM)	Human health - commercial (6%SOM)	Human health - open space (1%SOM)	Human health - open space (2.5%SOM)	Human health - open space (6%SOM)
		Human Health Generic Assessment Criteria (mg/kg)														
							Default for SGV			Default for SGV			Default for SGV			
Hydrock Default Suite																
Arsenic	SGV report + CLEA 1.06	35	35	35	32	32	32	43	43	43	640	640	640	590	590	590
Beryllium	LQM/CIEH + CLEA 1.06	51	51	51	51	51	51	55	55	55	420	420	420	8600	8600	8600
Boron	LQM/CIEH + CLEA 1.06	1000	1000	1000	290	290	290	45	45	45	190000	190000	190000	45000	45000	45000
Cadmium	SGV report + CLEA 1.06	85	85	85	11	11	11	1.9	1.9	2	230	230	230	860	860	860
Chromium (III)	LQM/CIEH + CLEA 1.06	630	630	630	630	630	630	15000	15000	15000	8800	8800	8800	660000	660000	660000
Chromium (VI)	LQM/CIEH + CLEA 1.06	4.3	4.3	4.3	4.3	4.3	4.3	2.2	2.2	2.2	35	35	35	4400	4400	4400
Copper	LQM/CIEH + CLEA 1.06	6200	6200	6200	2300	2300	2300	520	520	520	72000	72000	72000	400000	400000	400000
Lead	SGV 10 (old method)	450	450	450	450	450	450	450	450	450	750	750	750	450	450	450
Lead	CLEA 1.06 (not yet in use)	220	220	220	220	220	220	590	590	590	5100	5100	5100	11000	11000	11000
Mercury, inorganic	SGV report + CLEA 1.06	240	240	240	170	170	170	80	80	80	3600	3600	3600	9900	9900	9900
Nickel	SGV report + CLEA 1.06	130	130	130	130	130	130	230	230	230	1800	1800	1800	38000	38000	38000
Selenium	SGV report + CLEA 1.06	600	600	600	350	350	350	120	120	120	13000	13000	13000	29000	29000	29000
Vanadium	LQM/CIEH + CLEA 1.06	190	190	190	74	74	74	18	18	18	3200	3200	3200	13000	13000	13000
Zinc	LQM/CIEH + CLEA 1.06	40000	40000	40000	3700	3700	3700	620	620	620	670000	670000	670000	1000000	1000000	1000000
Cyanide (free)	Hydrock + CLEA 1.06	760	760	760	750	750	750	2300	2300	2300	16000	16000	16000	21000	21000	21000
Phenol	SGV report + CLEA 1.06	310	420	520	180	290	420	66	140	280	3200	3200	3200	3000	3000	3000
Acenaphthene	LQM/CIEH + CLEA 1.06	2000	3100	3900	210	480	1000	34	85	200	85000	98000	100000	39000	39000	39000
Acenaphthylene	LQM/CIEH + CLEA 1.06	2000	3000	3900	170	400	850	28	69	160	84000	97000	100000	39000	39000	39000
Anthracene	LQM/CIEH + CLEA 1.06	20000	22000	23000	2300	4900	9200	380	950	2200	520000	540000	540000	200000	200000	200000
Benz(a)anthracene	LQM/CIEH + CLEA 1.06	3.7	5.2	6.2	3.1	4.7	5.9	2.5	5.5	10	89	95	97	89	89	89
Benzo(a)pyrene	LQM/CIEH + CLEA 1.06	1.0	1.0	1.0	0.83	0.94	1.0	0.60	1.2	2.1	14	14	14	13.0	13.0	13.0
Benzo(b)fluoranthene	LQM/CIEH + CLEA 1.06	7.0	7.3	7.4	5.6	6.5	7.0	3.5	7.4	13	100	100	100	92	92	92
Benzo(ghi)perylene	LQM/CIEH + CLEA 1.06	47	47	47	44	46	47	70	120	160	650	660	660	590	590	590
Benzo(k)fluoranthene	LQM/CIEH + CLEA 1.06	10	10	10	8.5	9.6	10	6.8	14	23	140	140	140	130	130	130
Chrysene	LQM/CIEH + CLEA 1.06	8.8	9.7	10	6.0	8.0	9.3	2.6	5.8	12	140	140	140	130	130	130
Dibenz(ah)anthracene	LQM/CIEH + CLEA 1.06	0.86	0.91	0.93	0.76	0.86	0.90	0.76	1.5	2.3	13	13	13	12.0	12.0	12.0
Fluoranthene	LQM/CIEH + CLEA 1.06	970	990	1000	260	460	670	52	130	290	23000	23000	23000	8100	8100	8100
Fluorene	LQM/CIEH + CLEA 1.06	1900	2500	2900	160	380	780	27	67	160	64000	69000	71000	26000	26000	26000
Indeno(123cd)pyrene	LQM/CIEH + CLEA 1.06	4.2	4.4	4.4	3.2	3.9	4.2	1.8	3.8	7.1	60	61	62	56	56	56
Naphthalene	LQM/CIEH + CLEA 1.06	1.6	3.9	9.3	1.5	3.7	8.7	4.1	9.9	23	200	480	1100	13000	13000	13000
Phenanthrene	LQM/CIEH + CLEA 1.06	840	930	970	92	200	380	16	38	90	22000	22000	23000	8100	8100	8100
Pyrene	LQM/CIEH + CLEA 1.06	2300	2400	2400	560	1000	1600	110	270	620	54000	54000	55000	20000	20000	20000
TPH fractions																
TPH ali EC05-EC06	LQM/CIEH + CLEA 1.06	30	55	110	30	55	110	740	1700	3900	300	560	1200	1000000	1000000	1000000
TPH ali >EC06-EC08	LQM/CIEH + CLEA 1.06	73	160	370	73	160	370	2300	5600	13000	140	320	740	1000000	1000000	1000000
TPH ali >EC08-EC10	LQM/CIEH + CLEA 1.06	19	46	110	19	46	110	320	770	1700	78	190	450	41000	41000	41000
TPH ali >EC10-EC12	LQM/CIEH + CLEA 1.06	48	120	280	48	120	280	2200	4400	7300	48	120	280	41000	41000	41000
TPH ali >EC12-EC16	LQM/CIEH + CLEA 1.06	24	59	140	24	59	140	11000	13000	13000	24	59	140	41000	41000	41000
TPH ali >EC16-EC35	LQM/CIEH + CLEA 1.06	45000	64000	77000	45000	64000	76000	260000	270000	270000	1000000	1000000	1000000	81000	81000	81000
TPH ali >EC35-EC44	LQM/CIEH + CLEA 1.06	45000	64000	77000	45000	64000	76000	260000	270000	270000	1000000	1000000	1000000	81000	81000	81000
TPH aro EC05-EC07	LQM/CIEH + CLEA 1.06	260	480	980	65	130	280	13	27	57	1200	2300	4700	180000	180000	180000
TPH aro >EC07-EC08	LQM/CIEH + CLEA 1.06	610	1300	2700	120	270	610	22	51	120	870	1900	4400	180000	180000	180000
TPH aro >EC08-EC10	LQM/CIEH + CLEA 1.06	33	81	190	27	65	150	8.6	21	51	610	1500	3600	16000	16000	16000
TPH aro >EC10-EC12	LQM/CIEH + CLEA 1.06	180	420	870	69	160	350	13	31	74	360	900	2200	16000	16000	16000
TPH aro >EC12-EC16	LQM/CIEH + CLEA 1.06	1250	1600	1700	140	310	590	23	57	130	36000	37000	38000	16000	16000	16000
TPH aro >EC16-EC21	LQM/CIEH + CLEA 1.06	1300	1300	1300	250	480	770	46	110	260	28000	28000	28000	12000	12000	12000
TPH aro >EC21-EC35	LQM/CIEH + CLEA 1.06	1300	1300	1300	890	1100	1200	370	820	1600	28000	28000	28000	12000	12000	12000
TPH aro >EC35-EC44	LQM/CIEH + CLEA 1.06	1300	1300	1300	890	1100	1200	370	820	1600	28000	28000	28000	12000	12000	12000
TPH >EC44-EC70	LQM/CIEH + CLEA 1.06	1300	1300	1300	1200	1300	1300	1200	2100	3000	28000	28000	28000	12000	12000	12000
VOCs - BTEX & MTBE																
Benzene	SGV report + CLEA 1.06	0.27	0.49	1.0	0.08	0.16	0.33	0.017	0.035	0.075	28	50	95	240	240	240
Toluene	SGV report + CLEA 1.06	610	1300	2700	120	270	610	22	51	120	870	1900	4400	180000	180000	180000
Ethylbenzene	SGV report + CLEA 1.06	170	380	840	65	150	350	16	39	91	520	1200	2800	81000	81000	81000
Xylene, o-	SGV report + CLEA 1.06	60	140	320	45	110	250	28	67	160	480	1100	2600	150000	150000	150000
Xylene, m-	SGV report + CLEA 1.06	55	130	300	44	100	240	31	74	180	630	1500	3500	150000	150000	150000
Xylene, p- (use this for combined m & p)	SGV report + CLEA 1.06	53	130	290	42	98	230	29	70	160	580	1400	3200	150000	150000	150000
MTBE	EIC/AGS/CL:AIRE + CLEA 1.06	73	120	220	49	84	160	23	44	90	7900	13000	24000	240000	240000	240000
VOCs - other benzenes																
Iso-propylbenzene	EIC/AGS/CL:AIRE + CLEA 1.06	12	28	67	11	27	64	32	79	190	390	950	2300	81000	81000	81000
Propylbenzene	EIC/AGS/CL:AIRE + CLEA 1.06	40	97	230	34	82	190	34	83	200	400	980	2300	81000	81000	81000
1,2,4-Trimethylbenzene	EIC/AGS/CL:AIRE + CLEA 1.06	0.41	0.99	2.3	0.35	0.86	2.0	0.38	0.93	2.2	42	99	220	810	810	810
VOCs - chlorobenzenes																
Bromobenzene	EIC/AGS/CL:AIRE + CLEA 1.06	0.91	2.1	4.9	0.88	2.0	4.7	3.2	7.6	18	97	220	520	19000	19000	19000
Chlorobenzene	LQM/CIEH + CLEA 1.06	0.33	0.74	1.7	0.33	0.73	1.7	5.9	14	32	59	130	310	59000	59000	59000
1,2-Dichlorobenzene	LQM/CIEH + CLEA 1.06	17	40	94	16	39	91	94	230	540	570	1400	3200	1000000	1000000	1000000
1,3-Dichlorobenzene	LQM/CIEH + CLEA 1.06	0.31	0.74	1.7	0.29	0.70	1.7	0.25	0.61	1.5	32	77	180	1300	1300	1300
1,4-Dichlorobenzene	LQM/CIEH + CLEA 1.06	42	100	230	30	72	170	15	37	88	230	540	1300	57000	57000	57000
Hexachlorobenzene	LQM/CIEH + CLEA 1.06	0.20	0.50	1.7	0.20	0.50	1.4	0.18	0.42	0.92	0.2	53	55	24	24	24
Pentachlorobenzene	LQM/CIEH + CLEA 1.06	14	21	27	5.2	10	17	1.2	3.1	7.0	43	110	830	370	370	370
1,2,3-trichlorobenzene	LQM/CIEH + CLEA 1.06	1.1	2.6	6.2	1.0	2.6	6.1	4.7	12	28	110	270	630	6200	6200	6200
1,2,4-trichlorobenzene	LQM/CIEH + CLEA 1.06	1.8	4.5	11	1.8	4.5	11	31	75	180	230	560	1300	44000	44000	44000
1,3,5-trichlorobenzene	LQM/CIEH + CLEA 1.06	0.23	0.57	1.4	0.23	0.57	1.4	4.7	12	28	24	590	140	6100	6100	6100
1,2,3,4-tetrachlorobenzene	LQM/CIEH + CLEA 1.06	17	39	84	12	29	62	4.4	11	26	120	300	730	2700	2700	2700
1,2,3,5-tetrachlorobenzene	LQM/CIEH + CLEA 1.06	0.53	1.3	3.0	0.49	1.2	2.8	0.38	0.94	2.2	39	98	240	290	290	290
1,2,4,5-tetrachlorobenzene	LQM/CIEH + CLEA 1.06	0.51	1.2	2.4	0.30	0.68	1.4	0.064	0.16	0.37	20	49	97	41	41	41
VOCs - chloroalkanes & alkanes																
Bromodichloromethane	EIC/AGS/CL:AIRE + CLEA 1.06	0.019	0.034	0.07	0.016	0.03	0.061	0.016	0.032	0.068	2.1	3.7	7.6	240	240	240
Bromoform	EIC/AGS/CL:AIRE + CLEA 1.06	5.2	11	2.3	2.8	6.0	13	0.95	2.1	4.6	760	1500	3100	15000	15000	15000

Updated 20/07/11		Human Health Generic Assessment Criteria (mg/kg)														
Contaminant	**Source of GAC**	Human health - residential without plant uptake (1%SOM)	Human health - residential without plant uptake (2.5%SOM)	Human health - residential without plant uptake (6%SOM)	Human health - residential with plant uptake (1%SOM)	Human health - residential with plant uptake (2.5%SOM)	Human health - residential with plant uptake (6%SOM)	Human health - allotments (1%SOM)	Human health - allotments (2.5%SOM)	Human health - allotments (6%SOM)	Human health - commercial (1%SOM)	Human health - commercial (2.5%SOM)	Human health - commercial (6%SOM)	Human health - open space (1%SOM)	Human health - open space (2.5%SOM)	Human health - open space (6%SOM)
Chloroethane	EIC/AGS/CL:AIRE + CLEA 1.06	8.4	11	18	8.3	11	18	110	210	380	960	1300	2100	1000000	1000000	1000000
Chloroethene (aka vinyl chloride)	LQM/CIEH + CLEA 1.06	0.00054	0.00070	0.0011	0.00047	0.00064	0.00099	0.00055	0.0010	0.0018	0.063	0.081	0.12	11	11	11
Chloromethane	EIC/AGS/CL:AIRE + CLEA 1.06	0.0085	0.0099	0.013	0.0083	0.0098	0.013	0.066	0.13	0.23	1.0	1.2	1.6	2000	2000	2000
1,1-Dichloroethane	EIC/AGS/CL:AIRE + CLEA 1.06	2.5	4.1	7.7	2.4	3.9	7.4	9.2	17	35	280	450	850	160000	160000	160000
1,2-Dichloroethane	LQM/CIEH + CLEA 1.06	0.0065	0.0093	0.016	0.0053	0.0080	0.014	0.0046	0.0083	0.016	0.71	1.0	1.8	97	97	97
1,1-Dichloroethene	EIC/AGS/CL:AIRE + CLEA 1.06	0.23	0.41	0.82	0.23	0.40	0.82	2.8	5.6	12	26	46	92	37000	37000	37000
Cis 1,2 Dichloroethene	EIC/AGS/CL:AIRE + CLEA 1.06	0.12	0.20	0.39	0.11	0.19	0.37	0.26	0.50	1.0	15	24	47	4700	4700	4700
Trans 1,2 Dichloroethene	EIC/AGS/CL:AIRE + CLEA 1.06	0.19	0.35	0.71	0.19	0.34	0.70	0.93	1.9	4.0	22	40	81	14000	14000	14000
Dichloromethane	EIC/AGS/CL:AIRE + CLEA 1.06	2.1	2.8	4.5	0.58	0.98	1.7	0.10	0.19	0.34	270	360	560	3500	3500	3500
1,2-Dichloropropane	EIC/AGS/CL:AIRE + CLEA 1.06	0.024	0.042	0.085	0.024	0.042	0.085	0.62	1.2	2.6	3.3	5.9	12	9400	9700	10000
Hexachloroethane	EIC/AGS/CL:AIRE + CLEA 1.06	0.22	0.54	1.3	0.20	0.48	1.1	0.27	0.67	1.6	8.2	20	48	410	410	410
Tetrachloroethene	LQM/CIEH + CLEA 1.06	1.0	2.3	5.3	0.94	2.1	4.8	1.6	3.7	8.7	130	290	660	11000	11000	11000
1,1,1,2-Tetrachloroethane	LQM/CIEH + CLEA 1.06	1.1	2.5	5.8	0.89	2.1	4.8	0.78	1.9	4.4	120	260	590	4700	4700	4700
1,1,2,2-Tetrachloroethane	LQM/CIEH + CLEA 1.06	2.9	5.8	13	1.4	2.9	6.5	0.41	0.89	2.0	300	600	1200	4700	4700	4700
Tetrachloromethane	LQM/CIEH + CLEA 1.06	0.018	0.040	0.09	0.018	0.039	0.089	0.16	0.37	0.85	3.0	6.7	15	1200	1200	1200
Trichloroethene	LQM/CIEH + CLEA 1.06	0.11	0.23	0.51	0.11	0.22	0.49	0.43	0.95	2.2	12	25	55	4200	4200	4200
1,1,1-Trichloroethane	LQM/CIEH + CLEA 1.06	6.3	13	28	6.2	13	28	48	110	240	700	1400	3100	480000	480000	480000
1,1,2 Trichloroethane	EIC/AGS/CL:AIRE + CLEA 1.06	0.88	1.8	3.9	0.60	1.2	2.7	0.28	0.61	1.4	95	190	400	3200	3200	3200
Trichloromethane	LQM/CIEH + CLEA 1.06	0.92	1.6	3.2	0.75	1.3	2.7	0.36	0.70	1.5	110	190	370	8100	8100	8100
Other phenols & chlorophenols																
2-Chlorophenol	LQM/CIEH + CLEA 1.06	65	94	120	3.7	8.4	18	0.58	1.4	3.2	3600	4000	4300	1000	1000	1000
2,4-Dichlorophenol	LQM/CIEH + CLEA 1.06	58	85	110	0.88	2.0	4.4	0.13	0.30	0.70	3500	4000	4200	1000	1000	1000
2,4-Dimethylphenol	EIC/AGS/CL:AIRE + CLEA 1.06	210	410	730	19	43	97	3.1	7.2	17	1400	3100	7200	16000	16000	16000
2-Methylphenol	EIC/AGS/CL:AIRE + CLEA 1.06	3700	5400	6900	82	180	400	13	28	64	160000	180000	180000	81000	81000	81000
3-Methylphenol	EIC/AGS/CL:AIRE + CLEA 1.06	4700	6300	7500	81	180	400	12	28	63	170000	180000	180000	81000	81000	81000
4-Methylphenol	EIC/AGS/CL:AIRE + CLEA 1.06	3800	5500	7000	81	180	400	12	28	63	160000	180000	180000	38000	38000	38000
Pentachlorophenol	LQM/CIEH + CLEA 1.06	22	31	35	0.55	1.3	3.0	0.084	0.21	0.49	1200	1300	1400	320	320	320
2,3,4,6-Tetrachlorophenol	LQM/CIEH + CLEA 1.06	82	110	130	0.87	2.0	4.7	0.13	0.31	0.73	3900	4200	4400	1000	1000	1000
2,4,6-Trichlorophenol	LQM/CIEH + CLEA 1.06	82	110	130	1.4	3.3	7.5	0.22	0.51	1.2	3900	4200	4400	1000	1000	1000
Phthalates																
Bis (2-ethylhexyl) phthalate	EIC/AGS/CL:AIRE + CLEA 1.06	2700	2800	2800	280	610	1100	48	120	280	85000	86000	86000	36000	36000	36000
Butyl benzyl phthalate	EIC/AGS/CL:AIRE + CLEA 1.06	43000	44000	44000	1400	3400	7300	220	550	1300	940000	940000	950000	410000	410000	410000
Diethyl Phthalate	EIC/AGS/CL:AIRE + CLEA 1.06	14	29	65	120	260	570	19	41	94	14	29	65	160000	160000	160000
Di-n-butyl phthalate	EIC/AGS/CL:AIRE + CLEA 1.06	4.7	11	450	13	31	67	2.0	5.0	12	4.7	15000	15000	6100	6100	6100
Di-n-octyl phthalate	EIC/AGS/CL:AIRE + CLEA 1.06	3400	3400	3400	2300	2800	3100	940	2100	3900	89000	89000	89000	37000	37000	37000
Pesticides																
Aldrin	LQM/CIEH + CLEA 1.06	2.1	2.1	2.2	1.7	2.0	2.1	1.3	2.6	4.0	54	54	54	23	23	23
Atrazine	LQM/CIEH + CLEA 1.06	31	32	32	0.24	0.56	1.3	0.037	0.085	0.20	870	880	880	370	370	370
DDE	Hydrock + CLEA 1.06	1300	1300	1300	860	1100	1200	380	770	1300	22000	22000	22000	33000	33000	33000
DDT	Hydrock + CLEA 1.06	1100	1200	1200	770	940	1000	330	660	1100	21000	21000	21000	20000	20000	20000
Dichlovos	LQM/CIEH + CLEA 1.06	25	32	37	0.29	0.60	1.3	0.044	0.091	0.20	840	870	890	400	400	400
Dieldrin	LQM/CIEH + CLEA 1.06	3.5	3.8	3.9	0.69	1.4	2.2	0.13	0.32	0.73	90	91	92	39	39	39
Endosulfan - alpha	LQM/CIEH + CLEA 1.06	44	78	110	2.9	7.0	16	0.47	1.2	2.7	2300	3000	3400	1600	1600	1600
Endosulfan - beta	LQM/CIEH + CLEA 1.06	53	89	120	2.8	6.6	15	0.44	1.1	2.6	2600	3200	3500	1600	1600	1600
Hexachlorocyclohexanes - alpha (inc. Lindane)	LQM/CIEH + CLEA 1.06	460	580	650	19	46	100	3.0	7.4	18	14000	15000	15000	6500	6500	6500
Hexachlorocyclohexanes - beta (inc. Lindane)	LQM/CIEH + CLEA 1.06	50	52	52	1.7	3.9	8.5	0.26	0.64	1.5	1100	1100	1100	490	490	490
Hexachlorocyclohexanes - gamma (inc. Lindane)	LQM/CIEH + CLEA 1.06	18	22	23	0.58	1.4	3.0	0.089	0.22	0.52	530	550	550	240	240	240
Dioxins, furans & dioxin-like-PCBs																
Total dioxins, furans & DL-PCB (aerial dep.)	SGV report + CLEA 1.06	0.0099	0.0099	0.0099	0.0085	0.0087	0.0087	0.0073	0.008	0.0083	0.24	0.24	0.24	0.15	0.15	0.15
Non-dioxin-like PCBs																
PCB-28	Hydrock + CLEA 1.06	0.39	0.39	0.39	0.20	0.27	0.32	0.058	0.13	0.23	9.0	9.0	9.0	3	3	3
PCB-52	Hydrock + CLEA 1.06	0.39	0.39	0.39	0.20	0.28	0.34	0.062	0.14	0.28	9.0	9.0	9.0	3	3	3
PCB-101	Hydrock + CLEA 1.06	0.39	0.39	0.39	0.34	0.37	0.38	0.030	0.53	0.76	9.0	9.0	9.0	3	3	3
PCB-138	Hydrock + CLEA 1.06	0.39	0.39	0.39	0.36	0.37	0.38	0.41	0.67	0.89	9.0	9.0	9.0	3	3	3
PCB-153	Hydrock + CLEA 1.06	0.39	0.39	0.39	0.36	0.38	0.38	0.51	0.77	0.96	9.0	9.0	9.0	3	3	3
PCB-180	Hydrock + CLEA 1.06	0.39	0.39	0.39	0.37	0.38	0.39	0.60	0.87	1.1	9.0	9.0	9.0	3	3	3
Explosives																
HMX	LQM/CIEH + CLEA 1.06	6500	6500	6500	5.7	13	26	0.86	1.9	3.9	110000	110000	110000	190000	190000	190000
RDX	LQM/CIEH + CLEA 1.06	370	370	370	3.5	7.4	16	0.52	1.1	2.5	6400	6400	6400	8500	8500	8500
2,4,6-Trinitrotoluene	LQM/CIEH + CLEA 1.06	57	57	58	1.6	3.7	7.8	0.24	0.58	1.4	1000	1000	1100	940	940	940
Other inorganics																
Antimony	EIC/AGS/CL:AIRE + CLEA 1.06	370	370	370	180	180	180	52	52	52	6800	6800	6800	23000	23000	23000
Barium	EIC/AGS/CL:AIRE + CLEA 1.06	1300	1300	1300	780	780	780	260	260	260	22000	22000	22000	50000	50000	50000
Mercury, elemental	SGV report + CLEA 1.06	0.17	0.42	1.0	0.17	0.42	1.0	4.3	11	26	4.3	11	26	4.3	11	26
Molybdenum	EIC/AGS/CL:AIRE + CLEA 1.06	670	670	670	250	250	250	58	58	58	18000	18000	18000	37000	37000	37000
Thiocyanate	Hydrock + CLEA 1.06	8.9	8.9	8.9	8.8	8.8	8.8	28	28	28	190	190	190	81	81	81
Other organics																
Biphenyl	EIC/AGS/CL:AIRE + CLEA 1.06	34	84	200	34	84	200	14	35	84	34	84	200	31000	31000	31000
Carbon disulphide	LQM/CIEH + CLEA 1.06	0.10	0.20	0.44	0.10	0.20	0.44	4.8	10	23	12	23	50	40000	40000	40000
2,4-Dinitrotoluene	EIC/AGS/CL:AIRE + CLEA 1.06	170	170	170	1.5	3.2	7.2	0.22	0.49	1.1	3700	3800	3800	1600	1600	1600
2,6-Dinitrotoluene	EIC/AGS/CL:AIRE + CLEA 1.06	78	84	87	0.78	1.7	3.9	0.12	0.27	0.61	1900	1900	1900	820	820	820
Hexachloro-1,3-butadiene	LQM/CIEH + CLEA 1.06	0.22	0.55	1.3	0.21	0.51	1.2	0.25	0.61	1.4	32	69	120	110	110	110
Mercury, methyl	SGV report + CLEA 1.06	8.4	11	14	7.4	9.6	11	7.9	8.0	8.0	370	390	410	180	180	180
Styrene	EIC/AGS/CL:AIRE + CLEA 1.06	35	78	170	8.1	19	43	1.6	3.7	8.7	630	1400	3400	9700	9700	9700
Tributyl tin oxide	EIC/AGS/CL:AIRE + CLEA 1.06	8.4	9.8	11	0.27	0.64	1.4	0.042	0.10	0.25	230	230	240	100	100	100
2-Chloronaphthalene	EIC/AGS/CL:AIRE + CLEA 1.06	3.8	9.3	22	3.7	9.2	22	40	98	230	390	960	2200	6100	6100	6100
Insufficient data to derive GAC																
n butylbenzene	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sec butylbenzene	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbazole	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Updated 20/07/11		Human Health Generic Assessment Criteria (mg/kg)														
Contaminant	**Source of GAC**	Human health - residential without plant uptake (1%SOM)	Human health - residential without plant uptake (2.5%SOM)	Human health - residential without plant uptake (6%SOM)	Human health - residential with plant uptake (1%SOM)	Human health - residential with plant uptake (2.5%SOM)	Human health - residential with plant uptake (6%SOM)	Human health - allotments (1%SOM)	Human health - allotments (2.5%SOM)	Human health - allotments (6%SOM)	Human health - commercial (1%SOM)	Human health - commercial (2.5%SOM)	Human health - commercial (6%SOM)	Human health - open space (1%SOM)	Human health - open space (2.5%SOM)	Human health - open space (6%SOM)
Dimethyl phthalate	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isopropyltoluene	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1-Methylnaphthalene	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur (elemental)	Insufficient data (Hydrock)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3,5-Trimethylbenzene	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tert butylbenzene	Insufficient data (EIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NOTES																
If >1,000,000 is calculated, 1,000,000 is adopted.																
Red text - liquid at ambient temperature, calculated GAC exceeds saturation value and highlighed in red in CLEA - saturation value adopted for GAC																
Orange text - solid at ambient temperature, calculated GAC exceeds saturation value and highlighted red in CLEA - manual calculation not possible as only one HCV - saturated vapour concentration exceed, so saturation value adopted for GAC.																
Blue text - solid at ambient temperature, calculated GAC exceeds saturation value and highlighted red in CLEA - manual calculation not possible as only one HCV - aqueous solubility exceed, so original red-highlighted value adopted for GAC.																
Green text - solid at ambient temperature, calculated GAC exceeds saturation value and highlighted red in CLEA - manual calculation undertaken but result is greater than original red-highlighted value, so original red-highlighted value adopted for GAC.																

3.3.3 Exceedance of Saturation Limits

In some instances the CLEA 1.06 model produces GACs with a warning that the value exceeds the saturation value, which is either the solubility of the substance in water or the vapour saturation limit. Limited guidance is given in SR4 (Section 4.12) on how to assess the GAC in these circumstances. Precedence is also set in a number of SGV reports, to date those dealing with the BTEX compounds. These two sets of documentation are contradictory. The original issue of SR4 (CLEA 1.04) (Environment Agency 2009b) gives an example of how to carry out a manual calculation using data for ethylbenzene, whereas the BTEX SGV reports (e.g. Environment Agency March 2009) state that the GAC should be limited to the saturation level. The revised version of SR4 (CLEA 1.05/6) (Environment Agency 2009c) retains the example, but the name ethylbenzene has been removed.

There are three options: to adopt the value as calculated, to limit the GAC to the saturation value, or to undertake a manual calculation as per Section 4.12 of SR4. Again, the guidance is confusing. SR3 (Environment Agency 2009b) cautions against adopting the saturation limit, which is the most conservative, saying that it may be over-conservative. However, this is the approach taken in the BTEX SGV reports.

Clearly, the adoption of a GAC under conditions where the saturation level is exceeded is subjective and professional judgement is involved. With this in mind, the protocol adopted by Hydrock is as follows, and has been derived at by considering the possible values from the three methods given above.

1. For substances where the GAC is highlighted in amber in CLEA, this is adopted as the GAC. For substances where the GAC is highlighted in red, the following apply.

2. For VOCs including BTEX and the volatile TPH Fractions (less than EC10), the saturation value is adopted in line with the latest recommendations in the BTEX SGV reports.

3. For substances which are liquid at ambient temperature, the saturation value is adopted.

4. For substances which are solid at ambient temperature, the manual calculation is undertaken provided there are both oral and inhalation HCVs. The result is compared with the red-highlighted GAC and the lower of the two adopted as the GAC. If there is only one HCV and the calculation cannot be performed, the red-highlighted value is adopted as the GAC where the saturation limit exceed the aqueous solubility, but the saturation value is adopted where the saturation limit exceed the saturated vapour concentration.

5. In some instances the GACs shows a large difference between different SOM where the saturation value has been taken for, say, 1% SOM and the calculated values for 2.5% and 6% SOM. Whilst this may appear inconsistent on first inspection, the results have been adopted as they are and the difference must be attributed to the physico-chemical influence of organic matter in the soil as modelled by CLEA.

3.3.4 GACs for Public Open Space

One of the main reasons why the originally intended SGVs for public open space have never been developed is the difficulty in defining generic exposure scenarios for people using such land. Consider the difference in exposure to soil contaminants by someone playing rugby on a muddy pitch compared with someone walking a dog in an urban park. The CLEA 1.06 model does not contain an open space land use and in order to calculate GACs with the same degree of assurance it would be necessary to fully define the exposure profile for a number of potential receptors, to use the basic equations contained in the model and to determine which of the receptors is the critical one.

This is clearly a significant body of work, probably involving research into the various exposure scenarios and is beyond the scope of this report. Determining a UK generic land use pattern is probably something only a national government can do as it will involve policy as well as technical decisions.

In the absence of GACs for open space it is common to refer to those for the residential without plant uptake land use and to acknowledge that these are conservative because (a) there is no building and (b) the exposure period is likely to be much less than in a residential setting.

In order to investigate the degree of conservatism in the above approach, Hydrock has endeavoured to produce GACs for open space by using the ‘site specific’ options in the CLEA 1.06 model, using the residential without plant uptake land use as a starting point. (In fact, the same results are obtained if the allotments land use is taken as the starting point.) It is recognised that these may not necessarily be representative of the most critical exposure scenario, but are considered suitable as a first screening assessment in the absence of a UK formalised approach.

Accordingly, the method has been to use CLEA 1.06 (except for lead) starting with the residential without plant uptake land use and deleting the indoor exposure pathways. The default soil-to-skin adhesion factor and soil/dust ingestion rates for lifetime exposure are taken from Table 3 of the cadmium SGV report (Environment Agency June 2009). Finally, the exposure times were modified. There is little published guidance on exposure times. The New Zealanders assume 350 days/yr and a duration of 30 years, and the Australians 2 hr/day, 365 days/year over 70 years for parklands and recreational land use. The Canadians take 24 hrs/day, 365 days/year but also include residential land use with parklands. Hydrock has adopted the Australian model of 2 hours every day (active) for the entire lifetime, as being a very conservative estimate, but one which could be said to include for the uncertainties in how the land is actually used.

In addition to changing the exposure time to 2 hours per day in CLEA 1.06, it is also necessary to adjust the dust ingestion rates. Since people are asleep for 8 hours and awake for 16 hours, it is assumed that the soil and dust ingestion takes place during the waking hours. Consequently, if someone in on site for 2 hours, this is 2/16 of the waking period. So it is logical to pro-rata the soil and dust intake (i.e. 1/8 times the default). The defaults are

0.1g/day in Age Classes 1-12 and 0.5 g/day in Age Classes 13-18 (the latter being based on the cadmium SGV report, Table 3); these are replaced with 0.0125 and 0.00625, respectively. In addition, the outside soil to skin adhesion factor for the Age Classes 13 to 18 have been changed to 0.3, as per the cadmium SGV report, Table 3.

The calculated GACs are presented in Table 3.5 and are based on the a 75 year lifetime (all 18 CLEA age classes) and the CLEA standard sandy loam soil of pH 7 su.

Contamination by lead is a special case and CLEA is not applicable. The equations in SGV10 (DEFRA and The Environment Agency 2002) have been used instead. There are separate equations for children and adults. The child equation is based on uptake not intake and the GAC is dependent on the slope of the blood lead level versus soil lead concentration graph so there is no scope for adjusting the GAC for different exposure conditions as these are not inputs to the model. The equation for adults does include an exposure factor which is 8.5 hrs/day for 230 days/yr under the standard commercial land use scenario (for 43 years of working life). The exposure factor can be modified, therefore, to represent different exposures (2 hrs/day for 365 days/yr is equivalent to 8.5 hrs/day for 85.9 days/yr and so 85.9 days was used in the equation). The adult open space GAC for 57 years of exposure (75 less 18 pre-adult years) is calculated as 1135 mg/kg but this is greater than the child SGV of 450 mg/kg so 450 is adopted as the GAC for open space.

3.4 Note on PAHs

A number of authors have used to concept of PAH double ratio plots to investigate the possible source of PAHs in environmental samples.

NAVFAC (Appendix A, April 2003) defines three major source type: petrogenic - generated from organic matter in ancient sediments by geologic conditions; pyrogenic – generated by combustion of organic matter (wood, coal, petroleum, wastes etc.); and biogenic – generated by modern biological processes or by diagenetic processes (e.g. oxidation of organic matter). The following broad trends in the data were recognised:

- a ratio of fluoranthene to pyrene (Fl/Py) of <1 is indicative petrogenic sources, and of >1 is indicative of pyrogenic sources; and
- a ratio of anthracene to phenanthrene (An/Ph) of <0.2 is indicative of pyrogenic sources and of >0.2 is indicative of petrogenic sources.

Yunker *et al* (2002) carried out a literature study of published PAH ratios for a number of petroleum sources, combustion sources and environmental sources. They identified the following broad trends in the data:

- a ratio of fluoranthene to fluoranthene plus pyrene (Fl/(Fl+Py)) of <0.4 is indicative of petroleum hydrocarbon sources; of 0.4-0.5 is indicative of liquid fossil fuel combustion products; and of >0.5 is indicative of grass, wood and coal combustion products;

- a ratio of benzo(a)anthracene to benzo(a)anthracene plus chyrsene (BaA/(BaA+Ch)) of <0.2 is indicative of petroleum hydrocarbon sources; of 0.2-0.35 is indicative of either petroleum hydrocarbon sources or combustion and of >0.35 is indicative of combustion products;

- a ratio of anthracene to anthracene plus phenanthrene (An/(An+Ph)) of <0.1 is indicative petroleum hydrocarbon sources, but can be emissions from lignite, diesel or oil combustion, and of >0.1 is indicative of combustion sources, but can be diesel, coal or some crude oil hydrocarbons;

- a ratio of indeno(1,2,3)pyrene to indeno(1,2,3)pyrene plus benzo(ghi)perylene (IP/(IP+Bghi)) of <0.2 is indicative of petroleum hydrocarbon sources; of 0.2-0.5 is indicative of petroleum hydrocarbon combustion; and >0.5 is indicative of grass, wood or coal combustion products.

Note that in these authors' study of these and a number of other ratios they cautioned there are exceptions to these generalisations on account of the variability and complexity of, for example, different crude oil sources.

Costa *et al* (2004) and Costa and Sauer (2005) used plots of fluoranthene to pyrene (Fl/Py) against benzo(a)anthracene to chrysene (BaA/Ch), benzo(a)anthracene to benzo(a)pyrene (BaA/BaP) and chrysene to benzo(a)pyrene (Ch/BaP) to distinguish coal tar and creosote contaminants from combustion products they referred to as urban background. They report distinctive areas on the plots relating to the sites being studied. Litton (2006) has also used these ratios to similar effect on other sites.

ALcontrol Laboratories (2006) also uses plots of fluoranthene to pyrene (Fl/Py) against benzo(a)anthracene to chrysene (BaA/Ch). Jones (2008) confirms that the following broad trends are derived from unpublished work at the laboratory:

- a ratio of Fl/Py of <0.65 is indicative of used engine oil when the ratio of BaA/Ch is higher (approaching 1.40) or other petroleum products when the ratio of BaA/Ch is lower (above about 0.35);

- a ratio of F/Py of 0.65-1 is indicative of petroleum combustion products; and

- a ratio of Fl/Py of <1 is indicative of coal when the ratio of BaA/Ch is higher (approaching 1.40) or other combustion soots when the ratio of BaA/Ch is lower (above about 0.35).

It is evident from the literature that if a cross plot is made of two ratios it is often possible to see a separation in samples from different sources and, together with other supporting information, gain a better understanding of the likely source of the PAHs. Different ratios may give differing degrees of separation and so trying several plots is often useful.

3.5 Note on Petroleum Hydrocarbons

Petroleum hydrocarbon contamination is complex. The type of crude oil, its distillation, processing and blending, and the subsequent weathering in the environment all result in the development of petroleum residues of extreme chemical complexity (Environment Agency, 2003). The laboratory analysis of petroleum hydrocarbons is highly method dependent. In addition to contaminants such as fuels and lubricating oils, the analyses also pick up a range of other chemicals such as PAHs and phenols, together with naturally occurring substances like humic and fulvic matter in organic soils. For example, TPH determination on dried oak leaves can give a result of 18,000 mg/kg of TPH.

TPH can only be used as a surrogate for estimating the petroleum load of a soil if a spill is well defined but is generally not a sound basis for risk management and regulatory control. International approaches for assessing risks from petroleum hydrocarbons focus on dividing the components into groups and assigning toxicologically potency and fate-transport to each group.

Approaches have been developed internationally, one such proposal is discussed by the Dutch National Institute of Public Health and the Environment (RIVM) (Franken *et al* 1999). The approach is broadly to sub-divide the TPH into fractions based on equivalent carbon length for aliphatic (straight chain) and aromatic (cyclic) compounds. The choice of the fractions is based on work carried out by, amongst others, the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). The Working Group is guided by a steering committee consisting of representatives from industry, government and academia, with the remit *to develop scientifically defensible information for establishing soil cleanup levels that are protective of human health at petroleum contaminated sites.*

Generic assessment criteria can be developed for each TPH fraction in the same way as they can be for named substances, providing certain assumptions are made regarding the applicability of the data to all the compounds in each fraction. A significant part of the TPHCWG activity has been in determining fraction boundaries to maximize confidence in the eventual criteria.

A modified TPHCWG approach has been adopted in a framework developed by the Environment Agency (2005) for use within the UK. The 13 original TPHCWG fractions have been adopted, with the addition of >EC35-EC44. An undifferentiated (i.e. without aliphatic – aromatic split) fraction of >EC44-EC70 has also been suggested but the Agency says it will be reviewing the need for this in due course, once research has been carried out into the toxicity of these heavy-end products like resins and asphaltenes.

The UK suggested approach to petroleum hydrocarbon risk assessment is summarised as follows:

- Measure indicator chemicals and compare with their GAC – these are chemicals which are considered as key risk drivers at petroleum hydrocarbon contaminated sites. The chemicals of potential concern depend on the type of hydrocarbon product, but a (non-exhaustive) list has been suggested by the Environment Agency (2005):

  Non-threshold: benzene, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3,cd)pyrene.

  Threshold: toluene, ethylbenzene, xylene, naphthalene, fluoranthene, phenanthrene, pyrene.

- Measure TPH fractions and compare with their GAC, based on threshold toxicity only.

  Aliphatic fractions: >EC5-EC6, >EC6-EC8, >EC8-EC10, >EC10-EC12, >EC12-EC16, >EC16-EC35, >EC35-EC44.

  Undifferentiated: >EC44-EC77 (subject to review and confirmation by Agency).

  Aromatic fractions: >EC5-EC7, >EC7-EC8, >EC8-EC10, >EC10-EC12, >EC12-EC16, >EC16-EC21, >EC21-EC35, >EC35-EC44.

- Carry out an additivity check on the TPH fractions if none of the individual fractions exceed their GAC. A Hazard Quotient is calculated for each fraction by dividing the measured concentration by the GAC and these are summed to give the Hazard Index. Where the Hazard Index exceeds unity, this can indicate a potentially significant risk to human health and consideration should proceed to the next stage (remediation or further assessment). Including all the fractions in a Hazard Index is conservative as it assumes all fractions add together in acting on the same target organ within the critical receptor. The Environment Agency (2005) has stated that fractions exhibiting different toxicological properties might be excluded from this process in due course, once research has been completed and further guidance published. The Louisiana Department of Environmental Quality (LDEQ) (2003) has published more detailed guidance, suggesting the following fractions be grouped: (a) aliphatic >EC8-EC10, >EC10-EC12 & >EC12-EC16, (b) aromatic >EC8-EC10, >EC10-EC12 & >EC12-EC16 and (c) aromatic >EC16-EC21 & >EC21-EC35.

Hydrock has adopted the first two points from above approach and has developed generic assessment criteria for the TPH fractions up to EC35. These are used for assessment where an appropriate level of sampling and laboratory analysis has been carried out, but cannot be used where more generalised TPH analysis has been scheduled (such as DRO/GRO only).

There is, however, some uncertainty concerning the validity of the additivity check. The Environment Agency (2002a) stated in the now withdrawn CLR 9, Section 4.4, “that it is not valid to simply calculate the sum of the fractions ‘soil concentration divided by SGV’, and compare this with 1.”, because total intake, not just intake from soil, needs to be included. It is assumed that the 2005 document takes this into account and that it is erring on the side of conservatism. Until this is formally resolved, Hydrock will report the additivity check for information, using the LDEQ groupings, but will caution against its use in setting remedial goals without further study or publication of definitive guidance. It is more realistic to carry out the additivity test on individual samples rather than on US_{95} values for the whole population, because it is unlikely that the TPH profile of the averaging area will be represented by the US_{95}s of every fraction. More likely, a sample high in one fraction will be low in another, particularly where a mixture of products is present in the ground.

The analysis required for the above methodology, using the aliphatic / aromatic split of TPH fractions, is referred to by Hydrock its "**TPH Level 2 suite**" of determinands. In instances where a full numerical risk assessment is not required, Hydrock carries out a screening analysis known as its "**TPH Level 1 suite**" of determinands. The TPH is divided into fractions, but without the aliphatic / aromatic split. This allows a semi-quantitative risk assessment on the basis of taking a worst case condition. The fraction split with the lowest GAC is deemed to apply to the whole fraction. For example, if the Level 1 analysis indicates the presence of >EC8-EC10, the result is compared to the GACs for the aliphatic >C8-C10 and the aromatic >EC8-EC10 fractions. The worst case would be to assume the whole fraction is aliphatic because this is the lower of the two GACs. This is a conservative approach, and if the test is passed, there is no need to proceed further. However, if the test is failed this does not necessarily indicate unacceptable risks and a more detailed risk assessment is required, with the full TPH Level 2 analysis suite.

3.6 Note on Cyanide

Cyanide toxicity is complicated but it is generally accepted that cyanide species exist in 'free' and 'complex' forms. Free cyanide species are toxic and it is generally agreed that free cyanide provides a more scientifically correct basis for the establishment of generic criteria. This approach has been followed in this report.

Metal-cyanide complexes (complex cyanide) are generally not considered toxic but in certain environmental fate reactions it is possible that dissociation may release toxic free cyanide into the water environment. This might occur where complex cyanides are exposed to direct sunlight and photolysis takes place. Such circumstances are considered very rare.

3.7 Note on Polychlorinated Biphenyls

PCBs fall into two groups, the dioxin-like (DL) and the non-dioxin-like (NDL), by virtue of their toxicity.

The Environment Agency methodology for DL-PCBs is included with dioxins and furans in the published dioxins SGV report (Science Report SC050021 / Dioxins SGV). The basis of this report is that because of the additive nature of these substances it is inappropriate to produce individual SGVs. The approach is to obtain speciated analyses of 12 DL-PCBs and, using an Agency spreadsheet, calculate a Hazard Index for a prescribed mixture of substances. SGVs can only be produced for atmospheric fall-out sites where the proportions of the individual substances are assumed to be uniform across the UK according to a table listed in the document.

For potentially industrially contaminated sites (such as where PCBs have escaped from transformers) only a Hazard Index can be produced. This can be converted into a GAC by calculation, but such a GAC is only applicable to conditions where the mixture of substances is unchanged. In effect, Hazard Indices will be calculated for each soil sample and provided these are all less than unity, the site poses no significant risk.

There is not Agency guidance with respect to NDL-PCBs. Hydrock has produced individual GACs for a number of these. A precautionary approach has been taken, in that the NDL-PCBs are assumed to have additive effects and the same approach is taken as with Hydrock's assessment of contamination by TPH fractions. Namely, each substance is compared with its GAC, but there is an additional stage in which a Hazard Index is also calculated. This is similar to the Agency's approach for DL-PCBs, but the Hazard Index calculation is performed at a different stage in the process.

Currently, these two approaches are separate. That is to say, there is no assumption of additvity of effect between DL- and NDL-PCBs. The logic for this is the fact that these two groups where established in the first place on account of their different effects.

The toxicity of the DL-PCBs is far greater than that of the NDL-PCBs. For example, the residential SGV for the full list of dioxins, furans and DL-PCBs under atmospheric fall-out conditions is 0.0087 mg/kg (NB: using only the 12 DL-PCBs in this list gives a GAC of 0.051 mg/kg), whist the lowest GAC for the NDL-PCBs is 0.32 mg/kg under the same exposure conditions. Analyses for DL-PCBs must be undertaken with very low laboratory reporting limits (typically 1ng/kg).

In real life examples, it is almost certain that both forms of PCBs will be present at a site. This is because the marketed products (known as Aroclors) were mixtures of many PCB congeners and they all appear to contain members from both groups (according to literature researched by Hydrock). Perhaps this is why the Agency has only issued guidance on the DL-PCBs.

Logically, if a site contains any PCBs (for example as a 'total' analysis) it is likely to contain DL-PCBs. In which case, the safe concentrations will be very low and can only be confirmed by re-analysing using low detection methods and following the Agency methodology on a sample-by-sample basis. This is effect means that GACs for NDL-PCBs are redundant. The implications of the Agency methodology have yet to be fully understood by the contaminated land community. For example, it would appear that standard laboratory tests for NDL-PCBs are irrelevant. Furthermore, standard reporting limits are far too high, typically 1ug/kg. The only instance where NDL-PCBs become the risk driver at a PCB contaminated site would be if for some reason the DL-PCBs had preferentially degraded.

The Hydrock methodology for PCB risk assessment is to carry out analyses for the 12 DL-PCBs (commonly referred to as the WHO-12) and the 7 most persistent NDL-PCBs (commonly referred to as the ICES-7) at a detection limit of 1 ng/kg (Table 3.6). This is considered conservative because it covers both groups even though the risk driver is most likely to be the DL-PCB group.

The WHO-12 are assessed using the Environment Agency SGV report methodology, to produce a Hazard Index, and the ICES-7 are compared to Hydrock-derived GACs with additivity check. Note that PCB118 appears in both lists and so in assessed under the Environment Agency methodology as a DL-PCB.

Table 3.6: PCB Suites

WHO-12 (Dioxin-Like)	ICES-7 (Most Persistent)
PCB-77 PCB-81 PCB-126 PCB-169 PCB-105 PCB-114 PCB-118 PCB-123 PCB-156 PCB-157 PCB-167 PCB-189	PCB-28 PCB-52 PCB-101 PCB-118 PCB-138 PCB-153 PCB-180 (Non-dioxin-like apart from PCB-118)

3.8 Note on the Use of Non-UK Assessment Criteria

In rare instances reference to assessment criteria or other trigger values published by other authoritative bodies (other than those concerned with the UK contaminated land regime) may provide background information on the likely degree of contamination of a substance. Trigger levels indicative of naturally occurring concentrations or risk-based guidance from other countries often help place site analysis results into context. It must be remembered that use of non-UK assessment criteria is not in compliance with the UK contaminated land assessment regime given in the Model Procedures. However, these criteria can be of use as an aid to professional judgement and can help in determining a cost-effective and sustainable remedial strategy for a site, in consultation with the regulatory authorities.

3.9 Site Specific Assessment Criteria for Volatile Substances

The CLEA methodology includes the inhalation of indoor vapours where there are occupied buildings in the standard land use scenarios. For volatile substances such as those listed in Table 3.7 the percentage contribution of the indoor vapour pathway to the average daily exposure (ADE) can be seen to be significant (up to 100%). Consequently, if this pathway can be severed by the installation of a suitably designed and installed organic vapour barrier in the buildings only the remaining CLEA exposure pathways need to be considered for the site. Assessment criteria can be calculated for the remaining exposure pathways.

Site Specific Assessment Criteria (SSAC) have been calculated using CLEA UK using the same input parameters etc. as for the Hydrock GACs but with the indoor vapour pathway turned off in the model. The resulting SSACs can be used to inform on risk from these contaminants in the same way as GACs are used, but apply only if suitable membranes are provided and verified.

Table 3.7: Derivation of Site Specific Assessment Criteria for Volatile Substances for CLEA Standard Land Uses *Excluding the Indoor Vapour Pathway* (mg/kg) – on following page(s)**.**

Updated 21/05/10	Human Health Generic Assessment Criteria (no indoor vapour pathway) (mg/kg)										
Contaminant	Human health - residential without plant uptake, no indoor vapour (1%SOM)	Human health - residential without plant uptake, no indoor vapour (2.5%SOM)	Human health - residential without plant uptake, no indoor vapour (6%SOM)	Human health - residential with plant uptake, no indoor vapour (1%SOM)	Human health - residential with plant uptake, no indoor vapour (2.5%SOM)	Human health - residential with plant uptake, no indoor vapour (6%SOM)	Human health - commercial, no indoor vapour (1%SOM)	Human health - commercial, no indoor vapour (2.5%SOM)	Human health - commercial, no indoor vapour (6%SOM)	Non-Threshold Substance (Y/N)	Notes
VOCs - chloroalkanes & alkanes											
Bromodichloromethane	26	26	26	0.11	0.21	0.45	510	520	540	Yes	
Bromoform	-	-	-	-	-	-	-	-	-	No	
Chloroethane	240000	240000	240000	760	1400	2500	2600	3500	5700	No	
Chloroethene (aka vinyl chloride)	1.2	1.2	1.2	0.0037	0.0066	0.012	26	26	26	Yes	
Chloromethane	220	220	220	0.44	0.86	1.6	1900	2200	3000	No	
1,1-Dichloroethane	17000	17000	17000	62	120	230	1800	3000	5600	No	
1,2-Dichloroethane	11	11	11	0.031	0.055	0.11	200	210	210	Yes	
1,1-Dichloroethene	3900	4000	4000	19	37	78	2200	3900	8000	No	
Cis 1,2 Dichloroethene	470	470	480	1.7	3.3	6.8	3900	6600	9900	No	
Trans 1,2 Dichloroethene	1500	1500	1500	6.2	12	26	3400	6200	13000	No	
Dichloromethane	270	270	270	0.68	1.2	2.3	7300	9000	9000	No	
1,2-Dichloropropane	850	890	930	4.1	8.1	17	1200	2100	11000	No	
Hexachloroethane	44	44	44	1.7	4	8.6	910	920	930	No	
Tetrachloroethene	1200	1200	1200	11	24	55	420	950	26000	No	
1,1,1,2-Tetrachloroethane	500	500	500	5.2	12	28	10000	11000	11000	No	
1,1,2,2-Tetrachloroethane	500	500	500	2.7	5.9	13	11000	11000	11000	No	
Tetrachloromethane	120	120	130	1.1	2.4	5.4	1500	2500	2500	No	
Trichloroethene	450	460	460	2.8	6.3	14	1500	3200	9000	Yes	
1,1,1-Trichloroethane	52000	52000	53000	320	700	1600	1400	2900	6400	No	
1,1,2 Trichloroethane	350	350	350	1.9	4	8.9	7200	7300	7400	No	
Trichloromethane	610	610	610	2.4	4.7	9.7	5200	9100	20000	No	
Other phenols & chlorophenols											
2-Chlorophenol	-	-	-	-	-	-	-	-	-	No	Additive, total chlorophenols
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-	No	Additive, total chlorophenols
2,4-Dimethylphenol	-	-	-	-	-	-	-	-	-	No	
2-Methylphenol	-	-	-	-	-	-	-	-	-	No	Additive, total cresols
3-Methylphenol	-	-	-	-	-	-	-	-	-	No	Additive, total cresols
4-Methylphenol	-	-	-	-	-	-	-	-	-	No	Additive, total cresols
Pentachlorophenol	-	-	-	-	-	-	-	-	-	No	
2,3,4,6-Tetrachlorophenol	-	-	-	-	-	-	-	-	-	No	Additive, total chlorophenols
2,4,6-Trichlorophenol	-	-	-	-	-	-	-	-	-	No	Additive, total chlorophenols
Phthalates											
Bis (2-ethylhexyl) phthalate	-	-	-	-	-	-	-	-	-	No	
Butyl benzyl phthalate	-	-	-	-	-	-	-	-	-	No	
Diethyl Phthalate	-	-	-	-	-	-	-	-	-	No	
Di-n-butyl phthalate	-	-	-	-	-	-	-	-	-	No	
Di-n-octyl phthalate	-	-	-	-	-	-	-	-	-	No	
Pesticides											
Aldrin	-	-	-	-	-	-	-	-	-	No	
Atrazine	-	-	-	-	-	-	-	-	-	No	
DDE	-	-	-	-	-	-	-	-	-	No	
DDT	-	-	-	-	-	-	-	-	-	No	
Dichlovos	-	-	-	-	-	-	-	-	-	No	
Dieldrin	-	-	-	-	-	-	-	-	-	No	
Endosulfan - alpha	-	-	-	-	-	-	-	-	-	No	
Endosulfan - beta	-	-	-	-	-	-	-	-	-	No	
Hexachlorocyclohexanes - alpha (inc. Lindane)	-	-	-	-	-	-	-	-	-	No	
Hexachlorocyclohexanes - beta (inc. Lindane)	-	-	-	-	-	-	-	-	-	No	
Hexachlorocyclohexanes - gamma (inc. Lindane)	-	-	-	-	-	-	-	-	-	No	
Dioxins, furans & dioxin-like-PCBs											
Total dioxins, furans & DL-PCB (aerial dep.)	-	-	-	-	-	-	-	-	-	No	
Non-dioxin-like PCBs											
PCB-28	-	-	-	-	-	-	-	-	-	No	
PCB-52	-	-	-	-	-	-	-	-	-	No	
PCB-101	-	-	-	-	-	-	-	-	-	No	
PCB-138	-	-	-	-	-	-	-	-	-	No	
PCB-153	-	-	-	-	-	-	-	-	-	No	
PCB-180	-	-	-	-	-	-	-	-	-	No	
Explosives											
HMX	-	-	-	-	-	-	-	-	-	No	
RDX	-	-	-	-	-	-	-	-	-	No	
2,4,6-Trinitrotoluene	-	-	-	-	-	-	-	-	-	Yes & No	
Other metals											
Antimony	-	-	-	-	-	-	-	-	-	No	
Barium	-	-	-	-	-	-	-	-	-	No	
Mercury, elemental	4.3	11	26	4.3	11	26	4.3	11	26	No	
Molybdenum	-	-	-	-	-	-	-	-	-	No	
Other organics											
Biphenyl	-	-	-	-	-	-	-	-	-	No	
Carbon disulphide	4300	4300	4400	32	67	150	2100	4200	75000	No	
2,4-Dinitrotoluene	-	-	-	-	-	-	-	-	-	No	
2,6-Dinitrotoluene	-	-	-	-	-	-	-	-	-	No	
Hexachloro-1,3-butadiene	8.9	8.9	8.9	1.4	2.8	4.7	290	290	290	No	
Mercury, methyl	-	-	-	-	-	-	-	-	-	No	
Styrene	1100	1100	1100	10	24	55	23000	23000	23000	No	
Tributyl tin oxide	-	-	-	-	-	-	-	-	-	No	
2-Chloronaphthalene	-	-	-	-	-	-	-	-	-	No	

3.10 Determination of Contaminated Land Under Part 2A of the Environmental Protection Act 1990

The legal test for land contamination under the statutory guidance of Part 2A of the Environment Protection Act 1990 (i.e. “significant harm or significant possibility of significant harm”) is **unacceptable** intake or direct bodily contact.

The situation was clarified by DEFRA (July 2008) in its guidance on the legal definition of contaminated land.

Part 2A does not prescribe number-based thresholds because it would be very difficult to produce numbers which are meaningful and proportionate, given the lack of scientific information about many substances and the site specific nature of risks. Instead, it relies on local authorities to assess risks posed on individual sites, then decide whether (in their view) the risks represent SPOSH, and thus whether land qualifies as *contaminated*.

The intention of the approach is that local authorities can use their judgement to ensure that Part 2A focuses on the SPOSH it was designed to address, whilst avoiding unnecessary burdens on land where contaminants may be present but there is no SPOSH.

In making Part 2A decisions, local authorities are likely to face some difficult decisions caused by uncertainty on the nature of risks. But they should be confident in exercising their judgement on the basis of available information. Part 2A clearly leaves judgements about what constitutes a SPOSH to local authorities, and it is up to them to make decisions.

GACs are not proxy thresholds for SPOSH, and should not be used as such. They describe levels (based on cautious estimates and assumptions in hypothetical example situations) at which concentrations of contaminants in soil may cease to pose *no appreciable/ minimal* risk. They do not seek to describe levels at which there might be a SPOSH.

Thus, if a GAC is exceeded, the assessor will usually need to conduct a detailed quantitative risk assessment to discover whether there is a *possibility of significant harm* and, if so, the nature of that risk. Whether or not SPOSH exists will depend on the results of risk assessment, the existence and nature of any pollutant linkages, and (ultimately) the judgement of the local authority.

As a general guide:

(i) For substances where there is a GAC, the more the GAC is exceeded, the more likely it is that an authority should consider the risks to be SPOSH.

(ii) Generally, the cautious nature of GACs means that local authorities may conclude that SPOSH is unlikely to exist at concentrations close to GACs.

(iii) In some cases, land with concentrations of contaminants which marginally exceed a GAC (say, up to a few times the GAC) might give rise to SPOSH if, for example, the receptor is particularly sensitive; or if further assessment finds that exposure is higher than that estimated in the GAC; or if there is little uncertainty in the underlying toxicology and HCV.

(iv) In other cases a GAC may be exceeded by tens of times and there might be no SPOSH (e.g. if further assessment found that exposure was much lower than that estimated using the GAC).

In view of the above, Hydrock has not to attempted to derive numerical SPOSH concentrations, but to use GACs as screening values. Where GACs are exceeded, it is recommended that the linkages and the uncertainties in the data are reviewed in consultation the regulatory authority to aid its judgment on determination.

A possible next phase would be to refine the generic risk assessment with a detailed risk assessment. This would involve using site-specific input parameters relevant to the particular site, in the CLEA model.

Revised contaminated land statutory guidance was published by DEFRA in 2012 with respect to Part 2A. The Act itself is unchanged. A new four category test (and associated classifications) has been introduced to ensure a high standard without being excessive. The aims are to make the regime target higher risk sites more efficiently, remove excessive cost burdens and facilitate the development of technical tools to increase consistency over time. This includes supporting non-technical guidance including a possible framework to aid in deciding into which of the proposed four new Categories of land a site should be placed.

Conversely, the regime is not intended to intervene where there is only a low level of risk, particularly in cases where it is difficult to demonstrate anything other than a very small hypothetical risk, as might be the case with vast swathes of land.

DEFRA states that there is a need for a more pragmatic approach. In practice, deciding when regulatory intervention is justified involves making decisions about when to act on a wide spectrum of risk, with varying levels of uncertainty over the precise nature of the risks. A number of the changes are intended to clarify when land is “contaminated land”. These are most likely to affect the assessment and remediation of contaminated land and are listed below.

1. Statutory explanation of broad objectives of the regime to explain that regulators should seek a reasonable balance between dealing with unacceptable risks whilst ensuring that burdens on businesses and society are manageable and sustainable. The regime should be seen as an option of last resort; that land is in effect “innocent until proven guilty”. This should give greater clarity for all concerned on what the regime seeks to achieve, and what it seeks to avoid.

2. Local Authorities to produce risk summaries before land may be determined as "contaminated". Summaries must be understandable to non-experts to provide greater transparency and accountability. Easier for all involved to understand what local authority considers risks to be. It should be easier for Local Authorities managers, lawyers and councillors to be involved in decision making, particularly more difficult sites where wider socio-economic effects need to be take into account. Easier to share experience between Local Authorities leading to greater consistency in decision making.

3. Clarification of the legal test of significant harm to human health to mean serious unhealthy conditions of the body or part of it, and not minor/trivial complaints. This is unlikely to have a major effect because, to date, no site in England and Wales has been determined on grounds that significant harm to human health has actually been caused. However, greater clarity on the meaning of significant harm is likely to help clarify the related legal test of significant possibility of significant harm.

4. Explanation of how to decide when land is (and is not) "contaminated land". A new four category test which recognises the spectrum of risk encountered by assessors, and the reality that some sites are clearly contaminated land (Category 1), some clearly are not (Category 4), and others need more detailed consideration before a decision can be taken (Categories 2 and 3). Greater clarity that decision making is a two stage process in which the regulator must first understand the risk before deciding whether the risk is sufficiently high to justify regulatory intervention. The aim is to create legal certainty around what definitely is, and is not, contaminated land, whilst leaving Local Authorities with discretion to exercise local judgement on less straightforward land.

5. Category 4 will include normal background levels of contamination unless there is some exceptional reason to consider otherwise. Clarification that land at SGV/GAC levels is likely to be well into Category 4. Statutory backing for the sector to develop new tests to describe the top of Category 4 (including the production of Category 4 Screening Levels). This should provide clarity on when land will not be caught, reduced uncertainty and costs for landowners and businesses and faster decision making on non-problematic land.

6. Clarify the status of GACs and how they should (and should not) be used including a legal backing for the use of robust GACs produced by reputable, non-governmental, organisations within the sector (LQM/CIEH, EIC/AGS/CL:AIRE). Backing the development of new GACs (or similar tools) as might be developed by the sector to help implement the new Guidance. Specific legal backing for the current set of SGVs/GACs, and clarity on how they can (and cannot) be used.

7. Category 1 land is clearly caught by the regime when there is clear evidence of an unacceptable risk (e.g. similar land is known to have caused significant harm). This should give clarity on when land is definitely "contaminated land", and help frame the spectrum of risk raised by land contamination.

8. New category of land under which Local Authorities would decide whether a site is in Category 2 (contaminated land) or Category 3 (not contaminated land). The new test would rest on whether or not the local authority believes there is a strong case for regulatory action, taking account of the scientific evidence, the objectives of the regime, and other factors. The local authority would start by considering health risks alone, and if they clearly tend towards the Category 4 or the Category 1 the decision could be taken at this point. However, if this does not lead to a decision, the local authority would consider wider socio-economic factors (e.g. cost, views of local people, etc) before deciding. If the local authority still cannot decide, the default decision is that the site is not contaminated land.

9. Reduce “regulatory creep” (excessive remediation of land forced by regulatory uncertainty) with greater clarity on what the enforcing authority can “reasonably” require by way of remediation. Clarity that SGVs/GACs must not be used as “one size fits all” remediation requirements; and that Part 2A can only be used to force remediation to a level where land is no longer contaminated land (i.e. to a point where land is in Category 3), but it should not be used to force remediation beyond this point.

10. Guidance on the process of risk assessment: the need to take a strategic approach; the aim of dismissing low risk sites as soon as possible in order to focus on finding higher risk sites; and the general need to ensure that risk assessment is conducted in a timely and efficient manner. Clarify that in considering possible future risks the local authority should consider likely future situations (e.g. rather than hypothetical worst possible case situations). Recognise that in practice there is often a need for authorities to bring in external experts and act in accordance with their advice. Recognise that scientific and technical uncertainty is an inevitable part of contaminated land risk assessment, and set out broadly how regulators should deal with it. It is important that this is recognised in the Guidance to support the regulators who have to make decisions in the face of uncertainty.

In deciding whether or not a significant possibility of significant harm to human health exists, the local authority should first understand the possibility of significant harm from the relevant contaminant linkage(s) and the levels of uncertainty attached to that understanding, before it goes on to decide whether or not the possibility of significant harm is significant.

The term “possibility of significant harm” means the risk posed by one or more relevant contaminant linkage(s) relating to the land. It comprises:

- the estimated likelihood that significant harm might occur to an identified receptor, taking account of the current use of the land in question; and
- the estimated impact if the significant harm did occur i.e. the nature of the harm, the seriousness of the harm to any person who might suffer it, and (where relevant) the extent of the harm in terms of how many people might suffer it.

Having completed its estimation of the possibility of significant harm, the local authority should produce a risk summary.

The decision on whether the possibility of significant harm being caused is significant (SPOSH) is a regulatory decision to be taken by the relevant local authority. In deciding whether the possibility of significant harm being caused is significant, the authority is deciding whether the possibility of significant harm posed by contamination in, on or under the land is sufficiently high that regulatory action should be taken to reduce it, with all that would entail.

In deciding whether or not land is contaminated land on grounds of significant possibility of significant harm to human health, the local authority should use the four categorisations.

The decision between Categories 2 and 3 is a positive legal test, which means that the starting assumption should be that land does not pose a significant possibility of significant harm unless there is reason to consider otherwise. Category 3 may include land where the risks are not low, but nonetheless the authority considers that regulatory intervention under Part 2A is not warranted.

The local authority should first consider its assessment of the possibility of significant harm to human health, including the estimated likelihood of such harm, the estimated impact if it did occur, the timescale over which it might occur, and the levels of certainty attached to these estimates. If the authority considers, on the basis of this consideration alone, that the strong case does or does not exist, the authority should make its decision on whether the land falls into Category 2 or Category 3 on this basis regardless of any other factors.

However, if the authority considers that it cannot make a decision, it should consider other factors which it considers are relevant, including:

- The likely direct and indirect health benefits and impacts of regulatory intervention including benefits of reducing or removing the risk posed by contamination, any risks from contaminants being mobilised during remediation and any indirect impacts such as stress-related health effects that may be experienced by affected people, particularly local residents. If it is not clear to the authority that the health benefits of remediation would outweigh the health impacts, the authority should presume the land falls into Category 3 unless there is strong reason to consider otherwise.

- The authority's initial estimate of what remediation would involve; how long it would take; what benefit it would be likely to bring; whether the benefits would outweigh the financial and economic costs; and any impacts on local society or the environment from taking action that the authority considers to be relevant.

Deregulatory change to definition of contaminated land as it relates to water pollution.

DEFRA will commence Section 86 of the Water Act 2003 so that in future this would only be the case if there is significant pollution of controlled waters or significant possibility of such pollution. To explain how to decide whether or not “significant” pollution is being caused, the Statutory Guidance introduced new Category 1-4 tests similar to those for deciding when there is a significant risk to human health as described above. There will be new technical guidance produced by the Environment Agency. In practice, this change is likely to have little effect on the practical implementation of the Part 2A regime because the Environment Agency has already been prioritising sites likely to meet the new “significance” test.

The ‘pollution of Controlled Waters’ means the entry into controlled Waters of any poisonous, noxious or polluting matter or any solid waste matter. Given that the Part 2A regime seeks to identify and deal with significant pollution (rather than lesser levels of pollution), the local authority should seek to focus on pollution which: (i) may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems; (ii) which may result in damage to material property; or (iii) which may impair or interfere with amenities and other legitimate uses of the environment.

In deciding whether significant pollution of Controlled Waters is being caused, the local authority should consider that this test is only met where it is satisfied that the substances in question are continuing to enter controlled Waters; or that they have already entered the waters and are likely to do so again in such a manner that past and likely future entry in effect constitutes on-going pollution.

3.11 Generic Risk Assessment Criteria for Risk to Plants

Soil contaminants, if present at sufficient concentrations, can have an adverse effect on the plant population. Phytotoxic effects can be manifested by a variety of responses, such as growth inhibition, interference with plant processes, contaminant-induced nutrient deficiencies and chlorosis (yellowing of leaves). All chemicals are probably capable of causing phytotoxic effects. Thus the phytotoxic potential of substances is dependent on the concentrations capable of having adverse effects on plants and the concentrations likely to be found at contaminated sites. Phytotoxicity is a difficult parameter to quantify given that experimental techniques vary widely and variations exist in plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals.

Contaminants may be taken up and accumulated by plants through a range of mechanisms. The principal pathways are active and/or passive uptake through the plant root, adsorption to root surfaces and volatilisation from the soil surface followed by foliar uptake. After plant uptake, contaminants may be metabolised or excreted, or they may be bioaccumulated.

Many of the substances capable of adversely affecting vegetation exert this effect because of their water solubility, a characteristic that could result in their transport from contaminated sites into adjacent locations where the chemical may generate a phytotoxic response. This could be important if, for example, the adjacent site has important conservation status.

Whilst many contaminants may be phytotoxic, data are limited. Some heavy metals are essential as trace elements for plant growth but may become toxic at higher concentrations.

Toxicity may be displayed in many forms, including signs of stress such as reduction in growth or yellowing of the tissue. The concentration in soil at which substances become phytotoxic depend on a range of factors including plant type, soil type, pH, the form and availability of the contaminant and other vegetation stress factors that may be present (such as drought).

Hydrock has carried out a review of a number of current and former guidance documents and other texts on phytotoxicity. It is not possible to produce a definitive list of phytotoxic substances on account of the variables mentioned above. However, a number of metals are repeatedly cited as commonly occurring priority pollutants. As a result, the following list is adopted as Hydrock's indicators of the potential for phytotoxicity: As, B, Cr, Cu, Ni and Zn.

As the CLEA framework is a risk based approach, applied to humans, an alternative strategy is required to assess the risk to plants from substances that are phytotoxic. Reference to published criteria and background concentrations can help put site data into context.

Published assessment criteria for the protection of plant life from a number of countries are given in Table 3.8. Also included in the table are some measures of natural background concentrations in typical soils.

The most authoritative source is the British Standard for topsoil, but this only lists three elements. CLR 11 states that the ICRCL Guidance Note 70/90 can be used for initial screening criteria. This approach has been adopted by Hydrock where BS3882 is lacking, but where an ICRCL 70/90 criterion is lacking, the lowest criterion in Table 3.8 from, firstly MAFF, and, secondly, another country has been adopted. The adopted criteria are highlighted in Table 3.8. The MAFF value of 250 mg/kg has been chosen for As over the ICRCL value of 50 mg/kg as MAFF explains the 50 is applicable to vegetables and human health, whereas 250 is applicable to the plants themselves.

Table 3.8: Published Assessment Criteria and Natural Background Concentrations for Phytotoxic Elements (mg/kg)

Reference	As	B	Cr (total)	Cr (III)	Cr (VI)	Cu	Ni	Zn
Published Assessment Criteria (mg/kg)								
British Standard for topsoil (BS3882:2007)						200 (pH>7) 135 (pH 6-7) 100 (pH 5.5-6.0)	110 (pH>7) 75 (pH 6-7) 60 (pH 5.5-6.0)	300 (pH>7) 200 (pH 6-7) 200 (pH 5.5-6.0)

Reference	As	B	Cr (total)	Cr (III)	Cr (VI)	Cu	Ni	Zn
MAFF Code of Good Agricultural Practice for the Protection of Soil (1998)	250			unlikely to be toxic except in v low pH. 400 for sites containing sewage sludge		500 (grass) but may fall to 250 for clover and sensitive species (at pH≥6)	110 (pH>7) 75 (pH 6-7) 60 (pH 5.5-6.0)	1000 (clover & grass at pH 6), may fall to 300 for sensitive species (at pH 6-7)
Australian Guideline B(1) (1999), Interim Urban Ecological Investigation Level (EIL). Soils not generally considered phytotoxic below these EILs.	20			400	1	100	60	200
Considered toxic to plants - Ponnamperuma *et al* (1979)		5 (hot water soluble)						
Dutch ecotoxicological intervention value (Swartjes 1993 & 1994) *	40	7	230			190		
Alberta Environment (1990) Tier 1 (draft) *	10 acid sandy soils			600 acid sandy soils	25 acid sandy soils	130 acid sandy soils		
Ontario MoE (1989) *	20 acid sandy soils 25 clay soils							
ICRCL 59/83 (1987) now withdrawn for human health assessment		3 (hot water soluble)				130	70	300
ICRCL 70/90 (1990) threshold trigger value	50				25	250		1000
New Zealand guidelines for timber treatment sites (1997), estimated based on Cu bioavailability *						500-1000 clay soils		
New Zealand guidelines for timber treatment sites (1997), soil criteria for protection of plant life (residential/agricultural setting)	10-20	3 (soluble)		600	25	130		
Natural Background Concentrations (mg/kg)								
Dutch background level (target value) (VROM 2000)	29		100			36	35	140
UK ICRCL 42/80 (2nd ed. 1983) - Normal conc. In agricultural soil	0.1-40	2-100	5-500			2-100	5-500	10-300

Reference	As	B	Cr (total)	Cr (III)	Cr (VI)	Cu	Ni	Zn
UK ICRCL 70/90 (1st ed. 1990) - Typical range (and mean) in agricultural soils	2.3 - 53 (11.0)					5.8-62 (19) [1.2-194.9) extractable]		29-210 (78.1) [1.5-21 (5.6) extractable]
Canadian assessment criteria (i.e. background) (CCME 1991)	5	1(hot water soluble)	20		2.5	30		60
New Zealand timber sites (1997) – background	2-30							
Australian Guideline B(1) (1999), typical background levels	1-50		5-1000			2-100	5-500	10-300
* cited in New Zealand Ministry for the Environment (1997) timber treatment chemicals guidelines.								

3.12 Generic Risk Assessment Criteria for Controlled Waters

The following aquifer definitions are adopted.

- **Principal aquifers** - These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

- **Secondary aquifers** - These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:

- **Secondary A** - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers; and

- **Secondary B** - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

- **Secondary undifferentiated** - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type

- **Unproductive strata** - These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

The European Water Framework Directive (2000/60/EC) (WFD) and its daughter Directives establish a consolidated way of controlling water quality. The UK Government has set out a timetable for the adoption of the WFD which formalises the way in which the quality of surface water and groundwater are to be assessed. This is set out in *The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2009.* The regime was established in December 2009, to be fully operational by December 2012. This involves the introduction of new regulations and water quality targets (WQT). The Environment Agency (July 2008) has issued a revised Groundwater Protection Policy (known as GP3). Parts 1-3 contain the high level policy, the technical background and the tools to be used. Part 4 sets out the legal framework and the detailed policies. There are a number of support documents produced by the UK Technical Advisory Group on the Water Framework Directive (UKTAG), including Paper 11B(iii) (September 2008) on standards for regulation.

A groundwater body is defined as groundwater in an aquifer capable of supporting an abstraction of 10 m^3/day or 50 people over a sustained period under the WFD. Groundwater bodies are a strategic resource, even if there is no current abstraction. Lesser amounts of groundwater in an aquifer are not considered as receptors in their own right, but may still be pathways to other receptors such as surface water bodies or aquatic ecosystems.

Hydrock has followed the guidance in these documents as far as possible, but because the regime is being introduced over a period of several years, it will not always be possible to 'second guess' the exact requirements of the Agency during the transitional period and so early liaison is recommended.

One of the main objectives of the Agency is to 'prevent or limit' inputs of substances. The List I and List II groupings of substances under the 1980 Groundwater Directive (GD) no longer apply. Substances are instead treated as either 'hazardous substances' (initially broadly equating to the former List I) or non-hazardous pollutants' (analogous to the former List II, but potentially applying to all other pollutants).

The 'limit' objective refers to limiting any inputs of all other pollutants into groundwater so as to prevent pollution, deterioration in status or sustained upward trends. The existing GD already implements the limit objective, but for a limited range of substances (List 2) and activities. The major change in regulation is that now the WFD covers all other pollutants.

For practical purposes, the Agency interprets prevention of inputs of hazardous substances in relation to former List 1 substances and any other substances which meet the criteria for persistence, toxicity and bioaccumulation taking into account those substances listed in WFD Annex VIII. List I substances are effectively a (large) subset of the potentially wider group of hazardous substances.

Note, however, that the 'prevent' objective applies to active inputs such as industrial discharges and *de minimus* concentrations are set as a series of minimum reporting values (MRV). Inputs to controlled waters from contaminated land sites are classed as passive inputs under the WFD and, as such, are regulated under the Agency's 'limit' objective.

Acceptable water quality targets are defined for protection of human health (based on drinking water standards (DWS)) and for protection of aquatic ecosystems (environmental quality standards (EQS)).

There are no longer finite lists of substances over which control may be exercised under the 2006 WFD and the 2009 Groundwater Regulations. All substances which are not determined to be hazardous are potentially non-hazardous pollutants. This enables control to be exercised over polluting substances which have hitherto been beyond control purely because, regardless of their impact, they were not listed in the 1980 Groundwater Directive. In practice the Agency will need to deal with substances which are current priorities of concern. It is clearly not necessary to expand the field to include all other substances in all circumstances unless they are liable to cause pollution.

The final say lies with the Environment Agency and whilst the indicator substances analysed for by Hydrock in this report may be indicative of the likely risk of pollution of Controlled Waters, this report may not be definitive and the Agency may require additional work.

The definition of pollution is *“the direct or indirect introduction, as a result of human activity, of substances or heat into the air water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment.”*

Pollution equates to harm. In order to protect receptors there is a regulatory regime. This involves setting an environmental standard at the receptor (i.e. minimum acceptable water quality). In recognition that pollutants may degrade *en route* to the receptor it is possible to set a limit value at the source of the pollution and compliance values at locations along the pathway, such that water reaching the receptor does not exceed the environmental standard. By definition, the target value is greater than or equal to the compliance value, which in turn is greater than or equal to the environmental standard, depending on the amount of degradation expected. This concept is used in the Remedial Targets Methodology (Environment Agency 2006) to determine how land contamination impacts on groundwater and surface water quality.

The applied environmental standards vary with the hydrogeological conditions and the perceived value of the water resource, and are subject to local assessment by the Agency. Note that protection of Controlled Waters may involve work over and above that required for ‘suitable use’ of a site for the proposed development.

Note also that Article 6.3(e)(ii) of the WFD enables the regulatory authorities to exempt measures from the prevent and limit requirements where it would be disproportionately costly to remove or control the further movement of pollutants that are already in the ground. Where a continuing source that has given rise in the past to land contamination this must be brought under control to prevent further unacceptable inputs to groundwater, but it is clear that the extent is limited by what is considered to be ‘reasonableness’.

This report provides an initial assessment of the risks of pollution of Controlled Waters using water quality targets (WQT) as screening values. These are the drinking water standards (DWS) and the environmental quality standards (EQS), the latter designed to protect the surface water ecosystems. EQS are available for inland surface waters (freshwater) and other surface waters (transitional and marine).

DWS are given in the Water Supply Regulations 2010 (which amends to Water Quality (Water Supply) Regulations 2000, Schedule 1, Table B, Part 1 (Directive requirements) and Part 2 (national requirements)). Where no UK or EU drinking water standard exists, reference is made to the World Health Organization (2011).

The primary list of EQS has been published recently in European Directive 2008/105/EC, Annex I, Part A and these have been adopted by DEFRA in *The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2009* (Part 5 Priority Substances).

In addition, each Member State has to define country-specific substances and their EQS. Those adopted by the UK are included in Part 4 (Specific Pollutants) of the above Directions. It should be noted that the UK Technical Advisory Group on the Water Framework Directive (UKTAG) is preparing a series of specific pollutant technical reports for the WDF, Annex VIII list of chemicals. These proposed EQS will only be used by Hydrock once they have been adopted formally by DEFRA and the Environment Agency.

The basis for the DWS and EQS used in this report is the Environment Agency Chemical Standards Database (http://evidence.environment-agency.gov.uk/ChemicalStandards/home.aspx).

The WFD imposes a duty on the Agency to classify surface water and groundwater bodies and to ensure long-term improvement (where necessary) to achieve acceptable standards. This includes the chemical status of the water. A new set of criteria for groundwater quality classification has been published, in addition to DWS and EQS. These are Threshold Values (TV) for individual groundwater bodies (GWB). Each GWB has been identified by the Agency and specific TVs calculated based on the perceived risks to that GWB. Failure of a TV is an indicator of potential adverse impact in specific circumstances. These TVs are not intended to be applied to meet the ‘prevent or limit’ objective of the Agency (UKTAG September 2008) and they are not used by Hydrock in this report.

Generic criteria for contaminated soils which might result in groundwater contamination can be derived from generic assumptions using the Environment Agency (2006) Remedial Targets Methodology. A tiered approach is detailed in this document. In accordance with CLR 11, EQS and DWS can be used as generic water quality targets with respect to contamination of controlled waters.

It is clearly not cost-effective to analyse every water sample for all determinands. Hydrock has produced a default *de minimus* suite which includes a number of common water quality indicators plus a selection of the more common chemicals of potential concern, drawn from the lists of Specific Pollutants and Priority Substances / Priority Hazardous Substances in Parts 4 and 5, respectively, of the 2009 Directions, plus additional common contaminants listed in the EPA-H1 Part 2 document, as being indicators of Good water quality under the terms of the Directive.

In addition to this, Hydrock will add to this list any chemicals identified as potential risks by reference to the conceptual site model.

Using the WQTs discussed above, the risks to groundwater and surface water from contaminants on site have been assessed according to the remedial targets methodology (RTM) prescribed by the Environment Agency (2006).

The Level 1 soil zone assessment considers whether the contaminant concentrations in the soil moisture are sufficient to impact the water receptor(s). It is a conservative model and compares soil pore water concentrations with the above criteria, taking no account of dilution, dispersion or attenuation. Pore water concentrations can be estimated by analysis of perched water samples, analysis of eluates produced in the laboratory by standard leaching of soil samples, or by calculation from physico-chemical properties of the substances. Calculation may be more appropriate for poorly soluble substances where retention times may not be long enough during the standard leaching tests to reach equilibrium. However, the Environment Agency (2009d) cautions that the use of published k_d values to calculate pore water concentrations “can lead to a conservative estimate of risk” and suggest that leaching tests may be designed for non-volatile organics using BS18772:2008.

The Level 2 groundwater assessment is applicable where groundwater quality data are available and compares these with the above criteria, again taking no account of dilution, dispersion or attenuation.

The remedial targets methodology also allows for more detailed assessment (soil Level 2, 3 or 4, or groundwater Level 3 or 4) for substances which fail the above-mentioned assessments. These are progressively more complex assessments and do take into account attenuation and/or dilution, as applicable to the conceptual exposure model. Such assessment is beyond the scope of this report.

Where more than one water quality target is available it is important to apply the one relevant to the critical receptor. The DWS apply to groundwater or to surface water used for abstraction and the EQS apply to surface water where the aquatic ecosystem is the receptor. EQS are available for *inland* surface waters (freshwater) and *other* surface waters (transitional and marine). Where the most appropriate water quality target cannot be determined with certainty, the lowest one is adopted in line with the precautionary principle.

For the purposes of this report, the site data are compared with the various targets as set out in Table 3.9

Table 3.9: Summary of Water Quality Risk Assessment Protocol

Scenario	Water Body Receptors	Secondary Receptors	Example Contaminant linkages	RTM Level and Samples Used (if Available)	Water Quality Targets
A	Groundwater.	Human health (abstraction).	Contaminants from site leach or seep into groundwater body and this is a (potential/actual) source of human consumption or a strategic resource.	RTM Level 2 - Groundwater. RTM Level 1 - Soil leachate (including any calculated pore water concentrations) or pore water.	DWS
A	Groundwater. Surface water.	Human health (abstraction).	Contaminants from site leach or seep into groundwater body and this feeds surface water by base flow. The surface water may be used for human consumption.		DWS
B	Groundwater. Surface water.	Aquatic ecosystem.	Contaminants from site leach or seep into groundwater body and this feeds surface water by base flow. The surface water may be an aquatic ecosystem.		EQS (inland)
C	Groundwater. Surface water.	Aquatic ecosystem.	Contaminants from site leach or seep into groundwater body and this feeds surface water by base flow. The surface water may be an aquatic ecosystem.		EQS (other)
D	Groundwater. Surface water.	Human health (abstraction). Aquatic ecosystem.	Contaminants from site leach or seep into groundwater body and this feeds surface water by base flow. The surface water may be used for human consumption and is an aquatic ecosystem.		DWS EQS (inland)
E	Surface water.	Human health (abstraction).	Contaminants from site leach or seep into surface water which may be used for human consumption.	RTM Level 1 - Soil leachate (including any calculated pore water concentrations) or pore water. Although not part of the RTM, these scenarios are used to compare surface water data to the water quality targets.	DWS
F	Surface water.	Aquatic ecosystem.	Contaminants from site leach or seep into surface water which may be an aquatic ecosystem.		EQS (inland)
G	Surface water.	Aquatic ecosystem.	Contaminants from site leach or seep into surface water which may be an aquatic ecosystem.		EQS (other)
H	Surface water.	Human health (abstraction). Aquatic ecosystem.	Contaminants from site leach or seep into surface water which may be used for human consumption and is an aquatic ecosystem.		DWS EQS (inland)

Notes:
Some EQS are water hardness dependent. This is measured either in the receiving water or in groundwater (if it is part of the pathway), or is estimated from national maps.
Inland waters EQS applicable to freshwater, other waters EQS applicable to marine or transitional waters.
Where both DWS and EQS are applicable, it is assumed that the EQS is for inland waters.
This table and the results of the assessment are considered as a first screening for potential risks of pollution of Controlled Waters. More specific requirements may be stipulated by the Environment Agency.

Note that in some instances the reporting limit (or detection limit) quoted by the laboratory may be greater than the water quality target that it is being assessed against. Where this is the case it is noted in the table. The current exercise is an initial screening assessment.

There are three main possible reasons for this. Firstly, it may be that the ‘standard’ method gives a relatively higher reporting limit, but that a lower one could be obtained using a more specialised technique. However, it would be disproportionately expensive to adopt the more costly specialist technique for this initial screening exercise. Secondly, it may be that the sample in question was not ‘clean’ because the matrix was contaminated by other substances which interfere with the analysis and so a less sensitive method has been used to protect the laboratory equipment. Thirdly, it may be that no method exists that can reach the required limit. Hydrock has contacted the Environment Agency’s own National Laboratory Service and even they cannot reach low enough limits for several of the substances in the Hydrock default suite (Cr(VI), total cyanide, phenols and certain PAHs). Consequently, and depending on the particular chemicals, it may be possible with additional effort to refine the assessment, or it may be the case that it is not possible to say for certainty because suitable techniques are not available. Methods are being continually updated and new ones may become available.

In some cases all samples are below the detection limit but above the water quality target. It is not possible to make any judgement about these. However, in other cases, even though the detection limit is greater than the water quality target, some sample results do exceed the target.

3.12.1 Petroleum Hydrocarbons in Water

With respect to hydrocarbons in water, the Water Supply (Water Quality) Regulations 1989 (as amended 1999) contained a prescribed concentration of 10 µg/l for “dissolved or emulsified hydrocarbons (after extraction with petroleum ether); mineral oils”. This was removed from the 2000 (consolidated 2007) Regulations. It was confirmed by email from the Drinking Water Inspectorate to Hydrock (1 November 2005) that dissolved hydrocarbons are no longer a prescribed substance under the Regulations. However, the 10 µg/l limit did remain in the Private Drinking Water Regulations 1991 until their revision at the end of 2009.

In the absence of a prescribed concentration for drinking water, many Environment Agency officers continue to use the superseded value. This is perhaps because petroleum hydrocarbons are a hazardous substance (former List 1) under the WFD. There is, however, no clear UK policy on hydrocarbon contamination of controlled waters. This is partly because analyses for ‘petroleum hydrocarbons’ are fraught with complications concerning false positives, the results being method dependent and not restricted to petroleum products.

Guidance written by the Environment Agency on risk assessment of hydrocarbons in groundwater is dated 2009 but has never been officially released through the Agency’s website, although the dissemination status of the document is given as publicly available. This gives a table of water quality targets for hydrocarbons and lists “TPH (dissolved or emulsified hydrocarbons)”. No minimum reporting value (MRV) is quoted, the value that would equate to a *de minimus* concentration under the prevention objective. The target of 10 µg/l is given and this is described as coming from the “Private Water Supply Regulations S! 1991 No. 2790 (due to be updated in 2009)”. As mentioned above, the 2009 Regulations no longer list dissolved hydrocarbons.

Furthermore, the guidance also states that in cases where petroleum hydrocarbons have already entered the water, the Agency will regulate under its limit objective, rather than the prevention objective. This means that EQS or DWS will be appropriate. However, none exist.

In the absence of definitive guidance on petroleum hydrocarbons in water Hydrock recognises that it is not possible to provide EQS and so regulation with respect to aquatic ecosystems is impossible. However, it is possible to extend the use of DWS by calculating screening criteria for the speciated TPH fractions. This provides a rational, transparent and risk-based approach using established scientific principles, rather than simply adopting a withdrawn standard.

Whilst not strictly applicable to aquatic ecosystems, at least this approach can help inform the judgement as to the degree of degradation of a water body.

Accordingly Hydrock has calculated guidelines for drinking water quality based on the methodology proposed by the World Health Organisation (WHO, 2005). This is based on an adult consuming 2 litres of water per day. Whereas the WHO document assumes a body weight of 60kg, Hydrock has assumed 70kg in keeping with the UK Contaminated Land CLEA methodology.

A conservative allocation of 10% of the oral Tolerable Daily Intake (TDI) has been attributed to intake from drinking water. It is noted by the WHO (2005) that exposure from other sources would be expected to be very small and that it would be possible to allocate a greater percentage to drinking water if required. In other words, this approach is very conservative and is appropriate as an initial screening value and allows for potential additive toxicity and simultaneous exposure from other sources.

The TDIs used are the same as those used in the derivation of soil GACs and are listed in Table 3.10 along with the calculated health-based water quality targets for drinking water. Note, however, that the Environment Agency (2009d) states that when considering carbon bands, one does not know the range of toxicities and health effects of the individual chemicals, and it is precautionary to assume that the toxicological effects are additive when setting water quality targets even though the toxic endpoints and modes of action might in reality be quite different. The recommendation is to adopt a precautionary approach whereby the water quality target for each band is divided by the number of bands with detected concentrations.

Table 3.10: Calculated Water Quality Targets for Petroleum Hydrocarbons in Drinking Water

Determinand	TDI (µg/kg/day)	Solubility (µg/l)	Water Quality Target (see note 1) (µg/l)	Notes
Ali EC5-EC6	5000	35900	**17500**[1]	
Ali >EC6-EC8	5000	5370	**17500**[1]	This concentration would be significantly above the solubility in water.
Ali >EC8-EC10	100	427	**350**[1]	

Determinand	TDI (µg/kg/day)	Solubility (µg/l)	Water Quality Target (see note 1) (µg/l)	Notes
Ali >EC10-EC12	100	33.9	**350[1]**	This concentration would be significantly above the solubility in water.
Ali >EC12-EC16	100	0.759	**350[1]**	This concentration would be significantly above the solubility in water.
Ali >EC16-EC44	2000	0.00254	**7000[1]**	This concentration would be significantly above the solubility in water.
Aro EC5-EC7	223	1780000	**1[1]**	Based on the TDI for toluene as recommended by Environment Agency (2005) P5-080/TR3 gives 780. In reality the UK DWS for benzene = **1** takes precedence.
Aro >EC7-EC8	223	590000	**700[1]**	Calculated as 780, WHO DWS = **700** takes precedence.
Aro >EC8-EC10	40	64600	**140[1]**	
Aro >EC10-EC12	40	24500	**140[1]**	
Aro > EC12-EC16	40	5750	**140[1]**	
Aro >EC16-EC21	30	653	**105[1]**	
Aro >EC21-EC44	30	6.61	**105[1]**	This concentration would be significantly above the solubility in water.
Benzene	n/a	1780000	**1**	Calculation not possible as non-threshold substance, UK DWS = **1** takes precedence.
Toluene	223	590000	**700**	Calculated as 780, WHO DWS = **700** takes precedence.
Ethylbenzene	100	180000	**300**	Calculated as 350, WHO DWS = **300** takes precedence.
Xylene	180	200000	**500**	Calculated as 630, WHO DWS = **500** takes precedence.
MTBE	300	48000000	**15**	Calculated as 1050 so the odour threshold = **15** is adopted.
Note 1: The value to be used in a risk assessment (for carbon bands) is the value in the table divided by the number of bands with detected concentrations. Last updated 29/06/10				

In instances where a simple 'total' TPH is reported for water samples this should be considered indicative only. This is particularly the case if groundwater or surface water samples were not available and an indication of pore water quality has been derived by subjecting soil samples to a standard leaching procedure or calculation.

Where petroleum hydrocarbon contamination of Controlled Waters is suspected, Hydrock recommends that discussion with the Environment Agency is entered into at the earliest opportunity.

3.13 Statistical Tests of Soil Contamination Results

As discussed above, the sample analyses are divided into representative data sets for the assessment, based on the conceptual site model, and are referred to as 'averaging areas'. In this case it has been chosen to characterize materials that are likely to form the ground cover in critical receptor areas (e.g. gardens), on a material by material basis. The critical part of the soil column is the upper metre in terms of contact with end users of a development site.

Under the **land use planning system** where the aim is to demonstrate ‘suitability for use’ the key question will usually be “can we say confidently that the level of contamination of this land is low relative to some appropriate measure of risk, sometimes referred to as the critical concentration?” The critical concentration can be, for example, the relevant GAC.

It is necessary to demonstrate that (for each contaminant) the mean concentration on the site is **below** the critical concentration. The true mean concentration of a contaminant is not known because all the site soil has not been tested. An estimation of the true mean can be obtained from the samples tested during the investigation. The greater the number of samples tested, the closer the mean of these values is to the true mean.

In practice, this involves calculation of a quantity known as the 95th Upper Confidence Limit (UCL) of the true population mean, also known as the US_{95}. This is the estimate of the true mean at a 95% level of confidence (i.e. there is a 95% probability that the true mean will not be greater than this, given the values obtained from the investigation sample testing).

The statistical test that is carried out, therefore, is used to demonstrate that there is a 95% probability that the true mean falls below critical concentration (typically the GAC in a screening exercise).

In statistical language, *a **null hypothesis** is stated; that the level of contamination is the same as, or higher than, the critical concentration.* The ***alternative hypothesis** is that the level of contamination is lower than the critical concentration*. The statistical test is used to decide whether or not the null hypothesis is rejected.

If it is rejected, the assessor can conclude that the alternative hypothesis is more likely to be true, i.e. that contaminant concentrations are low relative to the critical concentration and that, potentially, the land is suitable for use. Conversely, if the null hypothesis is not rejected, the assessor should conclude that contaminant concentrations may be the same as, or higher than, the critical concentration and further measures may be needed.

It should be noted that a similar, but opposite, set of propositions applies in the case of a potential Part 2A determination where the level of contamination must be higher than some appropriate level of risk (critical concentration) (e.g. that indicative of SPOSH). In this case, however, a lower standard of proof may be accepted and the guidance suggests that if the statistical test of significance at the 95% confidence level does not indicate rejection of the null hypothesis, then the test should be repeated at the 51% level to see if there is evidence to suggest the null hypothesis be rejected on the balance of probabilities.

A useful summary of the methodology is provided by CIEH & CL:AIRE (May 2008), which forms the basis for the approach adopted by Hydrock, and is described below.

Firstly, the data set is assessed for outliers and normality. This is mainly a visual exercise rather than following a particular statistical method. The reason for this approach was that the former guidance provided in CLR7 had the potential for misuse and that is why it was withdrawn. It is considered that a reasoned option is preferable to blindly following a particular test when it comes to outliers and normality.

Two graphs are considered, the data frequency histogram with a normal ‘bell curve’ for comparison and a quantlie-quantile (q-q) plot. The closer the data points lie to the 45° line, the closer they are to a normal distribution. Kinks in the q-q plot are indicative of more than one data set. Individual points away from the 45° line are indicative of outliers.

Additional evidence of outliers is obtained through a simple method of robust statistics advocated by the Royal Society of Chemistry (2001) and others. The measure of the mean is taken to be the median value because this is less susceptible to outliers and non-normal data sets. A value known as the mean absolute deviation (MAD) is calculated and from this can be calculated a robust standard deviation estimate by multiplying by 1.483.

A z-score can then be calculated, which is the absolute value of the data value minus the median, divided by the robust standard deviation. This is then compared with a critical value which, if exceeded, suggests a possible outlier. The critical value represents the number of standard deviations from the mean (or in this case the median). A critical value of 3 to 3.5 is generally considered appropriate. The attraction of this approach is that it is a robust, non-parametric method suitable for all data sets. It is not considered as definitive, but merely a tool to aid decision making.

If a potential outlier is identified it could be a laboratory or typographic error. If this is not the case it could be representative of a different contaminative incident and, therefore, be a hot-spot. However, it could also be simply the result of heterogeneous ground conditions and a relatively low number of sampling points. The initial review of the data is then coupled to a knowledge of the conceptual site model before an outlier is removed from the data set. A good reason is required to justify the removal of outliers and this will be reported in the text.

The second stage of the assessment is to carry out the statistical test as described previously. Two alternative methods are highlighted in the CIEH/CL:AIRE document. The one-sample t-test is appropriate for normally distributed data (it is a parametric test) but is not sensitive to moderate departures from normality. The Chebychev Theorem is a non-parametric test which is suitable for all data distributions. It is a less powerful test (statistically) and gives a more cautious result than the t-test because there is less certainty about the shape of the distribution.

If there is significant departure from normality, perhaps because outliers are still included, the t-test will be chosen. Otherwise, the Chebychev Theorem will be used. The chosen method is applied and the outcome recorded with respect to whether or not the null hypothesis is rejected and the site is potentially suitable for use.

When considering potential Part 2A sites, updated guidance published by Barnes *et al* (2010) recommends the t-test for all data sets (unless the data are negatively skewed, something these authors have never seen in contaminated land data sets).

Please note that under certain circumstances a ‘divided by 0’ error can occur in the spreadsheets used in the statistical analyses. This happens when all the data points are the same integer value, for example where all results are <3 mg/kg and they have been assumed to be 3 mg/kg. To prevent this error, one of the results can be altered by a small amount (e.g. 3 becomes 2.99999). This allows the statistical tests to be carried out but makes no difference to the outcome. However, it does mean that the q-q and histogram plots show a spurious point, which should be ignored.

3.13.1 Note on Clustered Data Sets

The assumption behind the statistical tests is that each sample represents an equal fraction of the averaging area (Nathanail, 2004). If the data are clustered, i.e. the sampling points are not equally spaced, the calculated US_{95} would be too high if targeted sampling has taken place around suspected high concentration areas to determine the extent of the high contamination. Conversely, the calculated US_{95} would be too low if there is a high density of sampling in an area of low contaminant concentration.

The sampling pattern used in this report has been reviewed to determine if clustering of data points is likely to affect the statistical tests significantly. In cases where the area represented by each sample is judged to be similar, the tests have been carried out without modification. The error in this approach is likely to be conservative to human health because the Hydrock approach to targeted sampling is more likely to produce more closely spaced higher concentrations than more closely spaced lower concentrations.

Erring on the conservative side is, however, counter productive when it would indicate unnecessary remediation, i.e. remediation triggered by a US_{95} which is skewed by clustered data. This is taken into consideration in the risk evaluation part of the risk assessment exercise and can take the form of professional judgement, the modification of the averaging area datasets to decluster them, or the weighting of sample results to decluster the data set. The latter method involves weighting the measured concentrations according the proportion of the area they represent, giving greater weight to samples representative of a larger area.

3.13.2 Statistical Tests and Risk to Controlled Waters

Where only a few water quality tests are available, the maximum concentrations are compared with the standards because the 95 percentile will be close to the maximum value. However, where a larger population is available, the 95 percentile is compared with the standards, as recommended by the Environment Agency.

3.14 Ground Gas Risk Assessment

The risks associated with the ground gases methane (CH_4) and carbon dioxide (CO_2) are assessed using BS 8485:2007 and guidelines from CIRIA (Wilson *et al* 2007) and the NHBC (Boyle and Witherington 2007).

In the above guidance, 'Situation B' is defined as the specific development of low-rise (1 or 2 storey) housing with beam and block floors, vented sub-floor void and gardens. Initial risk classification can be made according to NHBC Table 8.1. This determines the appropriate risk strategy for protection, including the need to progress to generic quantitative risk assessment (GQRA). Even where no risk assessment is recommended by this table, one may be carried out if so desired. The GQRA is known as the 'NHBC traffic light classification' as it uses red, amber and green designations to portray levels of risk.

'Situation A' covers all other forms of development. This uses a modified version of the Wilson and Card (1999) methodology.

The idealised frequency of monitoring is suggested in CIRIA Tables 5.5a and 5.5b. These tables are adapted from Wilson and Haines (2005) Table 3 which gives examples of ground conditions with the various gas generation potentials, ranging from inert Made Ground (very low potential) to post 1960s domestic landfill (very high potential).

The report does not constitute a design for gas protection measures, but lists the recommendations given by the above-mentioned guidance for the particular "Situation" considered relevant. For information, BS 8485:2007, Table 3 is reproduced herein as Table 3.11.

Table 3.11: BS 8485:2007, Table 3 Recommended Measures Based on Sum of Scores from Table 2

Protection Element/System		**Score**	**Comments**
a) Venting/dilution (see BS 8485, Annex A)			
Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.). [A)]	Very good performance.	2.5	Ventilation performance in accordance with Annex A.
	Good performance.	1	If passive ventilation is poor this is generally unacceptable and some form of active system will be required.
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.). [A)]		2.5	There have to be robust management systems in place to ensure the continued maintenance of any ventilation system. Active ventilation can always be designed to meet good performance. Mechanically assisted systems come in two main forms: extraction and positive pressurization.

<table>
<tr><th colspan="2">Protection Element/System</th><th>Score</th><th>Comments</th></tr>
<tr><td colspan="2">Ventilated car park (basement or undercroft).</td><td>4</td><td>Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F and IStructE guidance (design recommendations for multistorey and underground car parks, 3rd ed, 2002) .</td></tr>
<tr><td colspan="4">b) Barriers</td></tr>
<tr><td colspan="2">Block and beam floor slab.</td><td>0</td><td rowspan="5">It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum.

Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.</td></tr>
<tr><td colspan="2">Reinforced concrete ground bearing floor slab.</td><td>0.5</td></tr>
<tr><td colspan="2">Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab.</td><td>1.5</td></tr>
<tr><td colspan="2">Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints.</td><td>1.5</td></tr>
<tr><td colspan="2">Fully tanked basement.</td><td>2</td></tr>
<tr><td colspan="4">c) Membranes</td></tr>
<tr><td colspan="2">Taped and sealed membrane to reasonable levels of workmanship/in line with current good practice with verification. [B), C)]</td><td>0.5</td><td rowspan="3">The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and the integrity of joints.</td></tr>
<tr><td colspan="2">Proprietary gas resistant membrane to reasonable levels of workmanship/in line with current good practice under independent inspection (CQA). [B), C)]</td><td>1</td></tr>
<tr><td colspan="2">Proprietary gas resistant membrane installed to reasonable levels of workmanship/in line with current good practice under CQA with integrity testing and independent verification.</td><td>2</td></tr>
<tr><td colspan="4">d) Monitoring and detection (not applicable to non-managed property, or in isolation)</td></tr>
<tr><td colspan="2">Intermittent monitoring using hand held equipment</td><td>0.5</td><td rowspan="3">Where fitted, permanent monitoring systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe.</td></tr>
<tr><td rowspan="2">Permanent monitoring and alarm system. [A)]</td><td>Installed in the underfloor venting/dilution system.</td><td>2</td></tr>
<tr><td>Installed in the building.</td><td>1</td></tr>
<tr><td colspan="4">e) Pathway intervention</td></tr>
<tr><td colspan="2">Pathway intervention.</td><td>-</td><td>This can consist of site protection measures for off-site or on-site sources (see Annex A).</td></tr>
<tr><td colspan="4">NOTE: In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection.</td></tr>
<tr><td colspan="4">A) It is possible to test ventilation systems by installing monitoring probes for post installation verification.
B) If a 1200 g DPM material is to function as a gas barrier it should be installed according to BRE 212 (Hartless 1991)]/BRE 414 (Johnson 2001), being taped and sealed to all penetrations.
C) Polymeric Materials >1200 g can be used to improve confidence in the barrier. Remember that their gas resistance is little more than the standard 1200 g (proportional to thickness) but their physical properties mean that they are more robust and resistant to site damage.</td></tr>
</table>

4.0 WATER SUPPLY PIPES

The current guidance on selection of materials for water supply pipes to be laid in contaminated land is contained in UKWIR Report 10/WM/03/02 (re-issued 2010) which sets out in Table 3.1 of that document threshold values for a selection of organic contaminants that may have a detrimental effect on pipes and fittings. The contaminants are divided into a number of ‘parameter groups’. Also included are threshold values for certain parameters that could cause corrosion of metal pipes. This guidance supersedes the former WRAS guidance (October 2002).

Some water suppliers (e.g. Anglian, United Utilities, Wessex and Yorkshire) specify their own soil threshold values and material design requirements, however these are currently not nationally recognised.

The UKWIR guidance recommends a *mandatory* analytical suite in its Table G1 comprising five groups of substances as follows: extended VOC suite, BTEX & MTBE, extended SVOC suite, phenols, cresols and chlorinated phenols, mineral oil C11-C20, mineral oil C21-C40 and corrosive suite. Other groups and sub-groups are recommended on a site-specific basis: ethers, nitrobenzene, ketones, aldehydes and amines.

The Association of Geotechnical and Geoenvironmental Specialists (AGS, 9 July 2009) stated that the former WRAS guidance was out of date and should be withdrawn and that the internal guidance adopted by water companies is inconsistent in some respects. Unfortunately, the replacement UKWIR document also contains a number of technical errors and inconsistencies and to date has not been universally accepted. For example, it requires a desk study, but then gives a mandatory list of determinands that would negate the need for a desk study. Also, a number of substances are listed under the wrong groups in Table G1. The AGS continues to have concern.

The UKWIR suggested methodology includes a soil vapour survey in cored boreholes along the pipeline routes, the construction of sampling boreholes where water is detected within 1 m of the base of a proposed pipe trench and analysis of soil samples over a 30 m wide corridor along each pipe run. The sampling plan is to be agreed with the water company beforehand. There are significant cost and time implications associated with this approach and so it has **not** been followed as part of this report.

Note that the use of barrier pipe (PE-Al-PE) is applicable for all brownfield sites according to the UKWIR guidelines. Further work may be required if other types are contemplated.

As a minimum, the findings of this investigation can been compared to the threshold values in UKWIR Table 3.1 as far as is practicable and with the modifications shown in Table 4.1 (and ignoring obvious errors in Table G1) to give an indication of the possible restrictions to the use of plastic water pipes.

Table 4.1: UKWIR Threshold Values for Plastic Water Pipes (Modified by Hydrock Comments)

Parameter Group from UKWIR Table 3.1	Hydrock Comments	Trigger Value (mg/kg)	
		PE	**PVC**
1 – Extended VOC suite by purge & trap or head-space and GC-MS with TIC (total VOC concentration excluding BTEX and MTBE).	Sum of VOC excluding BTEX & MTBE from this report (if available).	0.5	0.125
1a – BTEX & MTBE (total concentration).	Sum of BTEX and MTBE from this report (if available).	0.1	0.03
2 – Extended SVOC suite by purge & trap or head-space and GS-MS with TIC (aliphatic and aromatic C5-C10) (total SVOC concentration excluding 2a to 2f listed below).	Sum of SVOC from this report excluding substances in 2a to 2f. Also excluding petroleum hydrocarbons aliphatic and aromatic C5-C10 listed by UKWIR because these are VOCs not SVOCs and it is presumed to be an error. These will be included in the VOC total automatically.	2	1.4
2e – Phenols (total concentration).	Sum of phenols from this report (if available).	2	0.4
2f – Cresols and chlorinated phenols (total concentration).	Sum of cresols and chlorinated phenols from this report (if available).	2	0.04
3 – Mineral oil C11-C20 (total concentration).	Sum of TPH fractions >EC10-EC21 from this report (if available).	10	No limit
4 – Mineral oil C21-C40 (total concentration).	Sum of TPH fractions >EC21-EC35 from this report (if available).	500	No limit
2a – Ethers (if site history suggests as a potential hazard) (total concentration).	Sum of ethers from this report (if available).	0.5	1
2b – Nitrobenzene.	Nitrobenzene (if available).	0.5	0.4
2c – Ketones (total concentration).	Sum of ketones from this report (if available).	0.5	0.02
2d – Aldehydes (total concentration).	Sum of aldehydes from this report (if available).	0.5	0.02
6 – Amines (total concentration).	The UKWIR report says the presence of amines precludes the use of PE. Since a less than detection limit value is not necessarily zero, logically PE cannot be used on site where the desk study leads to a suspicion of there being amines in the ground.	Fail	No limit

In view of the lack of clear and unambiguous guidance it is **strongly recommended** that site-specific approval of the materials for underground pipes to be used for water supply be obtained from the water company that will be supplying this site and/or adopting the pipework.

5.0 FLOOD RISK

The following additional information concerns the background to flood risk mentioned in the report. Guidance is given in the document *Technical Guidance to the National Planning Policy Framework* (DCLG March 2012) which retains key elements from the withdrawn Planning Policy Statement 25.

The Environment Agency flood maps are divided into Flood Zones, as follows.

- Flood Zone 1 is land outside the extent of extreme flooding and the annual risk is less than 1:1000, low probability (depicted as white on the web-based map).

- Flood Zone 2 is land unlikely to flood except in extreme conditions if no defences are present and the annual risk is between 1:100 and 1:1000 (for rivers) or 1:200 and 1:1000 (for the sea), medium probability (depicted as light blue on the web-based map).

- Flood Zone 3 is land within the floodplain at risk of flooding if no defences are present and the annual risk is greater than or equal to 1:100 (for rivers) or 1:200 (for the sea), high probability (depicted as dark blue on the web-based map).

The Agency flood maps also define the risk of flooding: as ‘low’ (≤1:200), ‘moderate’ (>1:200 to ≤1:75) or ‘significant’ (>1:75), which are not the same divisions as those in the guidance mentioned above. Note that the published flood map only relates to flooding from rivers, estuaries and the sea and does not include other potential sources such as surface water, groundwater, sewers, canals and reservoirs. Note also that the presence on the map of flood defences, or areas benefiting from flood defences, should not be taken to imply that a proposed development in these areas is acceptable.

The **Environment Agency in England** has issued Flood Risk Standing Advice. However, this is to be reviewed following the publication of the NPPF (see http://www.environment-agency.gov.uk/research/planning/33098.aspx for updates and details).

The flood map mentioned above can be accessed at the Agency’s website.

The Technical Guidance states:

- Within Flood Zone 1 all uses of land are appropriate. For development proposals on sites comprising one hectare or above, the vulnerability to flooding from other sources as well as from river and sea flooding; and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment (FRA) to accompany the planning application. This need only be brief unless the factors above or other local considerations require particular attention.

For development proposals less than one hectare no flood risk assessment (FRA) is required.

- Within Flood Zone 2, water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure (as defined in Technical Guidance, Table 2) are appropriate in this zone. The Sequential Test of PPS25 is required and must be passed and for highly vulnerable uses in Table 2 the Exception Test must be applied and passed also. All development proposals in this zone should be accompanied by a flood risk assessment (FRA).

- Flood Zone 3 is sub-divided into 3a and 3b, but these are not distinguished on the published maps. Flood Zone 3a is land having an annual probability of flooding of >1:100 (from rivers) or >1:200 (from the sea). The water-compatible and less vulnerable uses of land (as defined in Technical Guidance, Table 2) are appropriate in this zone. The highly vulnerable uses in Table 2 should not be permitted in this zone. The Sequential Test is required and must be passed and for the more vulnerable and essential infrastructure uses in Table 2 the Exception Test must be applied and passed also. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood. All development proposals in this zone should be accompanied by a flood risk assessment (FRA).

  Flood Zone 3b is known as the ‘functional floodplain’ and comprises land where water has to flow or be stored in times of flood and should be identified on Strategic Flood Risk Assessments (SFRA) undertaken by the Local Planning Authority. Such land is defined as land which would flood with an annual probability of 1:20 or greater, or is *designed* to flood in an extreme (1:1000) flood, or at another probability to be agreed between the Local Planning Authority and the Environment Agency, including water conveyance routes). Only the water-compatible uses and the essential infrastructure (as defined in Technical Guidance, Table 2) that has to be there should be permitted in this zone. It should be designed and constructed to: remain operational and safe for users in times of flood; result in no net loss of floodplain storage; not impede water flows; and not increase flood risk elsewhere. The Sequential Test is required and must be passed and for essential infrastructure the Exception Test must be applied and passed also. All development proposals in this zone should be accompanied by a FRA.

The **Environment Agency Wales** flood map is not used for planning purposes (only to provide information on flood risk and to raise awareness). Development advice with respect to flooding is provided by the Welsh Assembly Government (July 2004) Technical Advice Note 15 (TAN15) and the accompanying development advice maps. An interactive map is available from the WAG web site.

The development advice map containing three zones (A, B and C with subdivision into C1 and C2) should be used to trigger the appropriate planning tests.

- Zone A is considered to be at little or no risk of fluvial or tidal/coastal flooding. The justification test (TAN15, Section 6) is not applicable and there is no need to consider flood risk further. This equates to Flood Zone 1 on the Agency maps.

- Zone B is land known to have been flooded in the past evidenced by sedimentary deposits. As part of a precautionary approach site levels should be checked against the extreme (1:1000) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further. This land within Flood Zone 1 of the Agency maps but close to Flood Zone 2 or 3.

Zone C is based on the Environment Agency Wales extreme flood outline, equal to or greater than 1:1000 (river, tidal or coastal) and equates to Flood Zones 2 and 3 on the Agency map. Flooding issues should be considered as an integral part of decision making by the application of the justification test (TAN15, Section 6) including assessment of consequences (TAN15, Section 7) is required. Sub-division C1 is land in the floodplain which are developed and served by significant infrastructure, including flood defences. Development can take place subject to application of the justification test, including acceptability of consequences. Sub-division C2 is land in the floodplain without significant flood defence infrastructure. Only less vulnerable development should be considered subject to application of the justification test, including acceptability of consequences. Emergency services and highly vulnerable development should not be considered. The categories of land use are defined in TAN15, Figure 2.

6.0 REFERENCES

AGS. 9 July 2009. AGS Position on guidance on water supply pipe materials for contaminated land. Association of Geotechnical and Geoenvironmental Specialists. <<ags.og.uk>>.

ALBERTA ENVIRONMENT. 1990. Alberta Tier 1 Criteria for Contaminated Soil Assessment and Remediation. Waste Management and Chemicals Division, Soil Protection Branch. Draft.

ALCONTROL LABORATORIES. 2006. Land Division – Information Sheet: *Where have my PAHs come from??*

BARNES, B., GLENNIE, E., DAVEY, A,. and THOMAS, J. 2010. Cheby or not Cheby? Is that the question? L*and Contamination and Reclamation,* **18(2)**, 121-33.

BOYLE, R. and WITHERINGTON, P. JANUARY 2007. Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present. Report No. 10627-R01(04). NHBC, Milton Keynes. 93pp + apps.

BRITISH STANDARDS INSTITUTION. 1999. Code of practice for Site Investigations. *BS 5930 Incorporating Amendment No.2:2010.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2004. Eurocode 7 – Geotechnical design - Part 1: General rules. *BS EN 1997-1. Incorporating Corrigendum No.1.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2007. Eurocode 7 – Geotechnical design - Part 2: Geotechnical investigation and testing. *BS EN 1997-2.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2007. Specification of topsoil and requirements for use. *BS 3882.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2007. Code of practice for the characterization and remediation from ground gas in affected developments. *BS 8485.* BSI, London.

BRITISH STANDARDS INSTITUTION. 2011. Code of Practice for Investigation of Potentially Contaminated sites. *BS 10175.* BSI, London.

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME). 1991. Review and recommendations for Canadian Interim Environmental Quality Criteria for contaminated sites. Environment Canada.

CIEH and CL:AIRE. May 2008. Guidance on comparing soil contamination data with a critical concentration. The Chartered Institute of Environmental Health and Contaminated Land: Applications in Real Environments. 66pp.

COSTA, H. J. and SAUER, T. C. 2005. Forensic approaches and considerations in identifying PAH background. *Environmental Forensics,* **6,** 9-16.

COSTA, H. J., WHITE, K. A. and RUSPANTINI, J. J. 2004. Distinguishing PAH background and MGP residues in sediments of a freshwater creek. *Environmental Forensics,* **5,** 171-182.

DCLG. March 2012. *National Planning Policy Framework*. DCLG, London.

DCLG. March 2012. *Technical Guidance top the National Planning Policy Framework.* DCLG, London.

DEFRA. 1 September 2005. Soil Guideline Values and the Determination of Land as Contaminated Land under Part 2A. *Guidance Note CLAN 2/05*. DEFRA/LEQ, London.

DEFRA. September 2006. Environmental Protection Act 1990: Part 2A. Contaminated Land. *Circular 01/2006*. DEFRA, London.

DEFRA. July 2008. *Guidance on the legal definition of contaminated land.* DEFRA, London.

DEFRA. 2009. *The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2009* (Part 5 Priority Substances).

DEFRA. April 2012. *Contaminated Land Statutory Guidance*. DEFRA, London.

DEFRA and the ENVIRONMENT AGENCY. 2002. Soil Guideline Values for Lead Contamination. SGV10. Environment Agency, Bristol, 20pp.

EIC, AGS and CL:AIRE. 2009. The EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment. Environmental Industries Commission, Association of Geotechnical and Geoenvironmental Specialists and Contaminated Land: Applications in Real Environments. Available from <www.claire.co.uk>.

ENVIRONMENT AGENCY. 2000. Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination. *R&D Technical Report P5-066/TR1*. The Environment Agency.

ENVIRONMENT AGENCY. 2002a. Contaminants in soils: collation of toxicological data and intake values for humans. *Contaminated Land Report 9.* The Environment Agency.

ENVIRONMENT AGENCY. 2002b. Possible contaminants for the assessment of land. *Contaminated Land Report 8.* The Environment Agency.

ENVIRONMENT AGENCY. 2003. Principles for Evaluation the Human Health Risks from Petroleum Hydrocarbons in Soils: A Consultation paper*. R&D Technical Report P5-080/TR1*. The Environment Agency.

ENVIRONMENT AGENCY. 2004a. Model procedures for the management of land contamination. *Contaminated Land Report 11.* The Environment Agency.

ENVIRONMENT AGENCY. 2004b. Soil screening values for use in UK ecological risk assessment. *R&D Technical Report P5-091/TR1*. The Environment Agency.

ENVIRONMENT AGENCY. 2005. The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils*. Science Report P5-080/TR3*. The Environment Agency.

ENVIRONMENT AGENCY. 2006. *Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.* The Environment Agency, Bristol, 123pp.

ENVIRONMENT AGENCY. July 2008a. *Groundwater protection: policy and practice (GP3), Part 2 – technical framework.* The Environment Agency, Bristol, 54pp.

ENVIRONMENT AGENCY. July 2008b. *Groundwater protection: Policy and practice (GP3). Part 4 - legislation and policies*. Edition 1. The Environment Agency, Bristol, 95pp.

ENVIRONMENT AGENCY. 2009a. Updated technical background to the CLEA model. *Science Report – SC050021/SR3.* The Environment Agency, Bristol, 164pp.

ENVIRONMENT AGENCY. 2009b. CLEA Software (Version 1.04) Handbook. *Science Report – SC050021/SR4.* The Environment Agency, Bristol, 121pp.

ENVIRONMENT AGENCY. 2009c. CLEA Software (Version 1.05) Handbook. *Science Report – SC050021/SR4.* The Environment Agency, Bristol, 129pp.

ENVIRONMENT AGENCY. 2009d. *Petroleum Hydrocarbons in Groundwater: Supplementary Guidance for Hydrogeological Risk Assessment.* The Environment Agency, Bristol, 48pp.

ENVIRONMENT AGENCY. March 2009. S*cience Report – SC050021/benzene SGV.* The Environment Agency, Bristol, 10pp.

ENVIRONMENT AGENCY. June 2009. S*cience Report – SC050021/Cd SGV.* The Environment Agency, Bristol, 11pp.

ENVIRONMENT AGENCY. September 2009. S*cience Report – SC050021/Dioxins SGV.* The Environment Agency, Bristol,

FRANKEN, R.O.G., BAARS, A.J., CROMMENTUIJN, G.H. & OTTE, P. 1999. A proposal for revised Intervention Values for petroleum hydrocarbons (‘minerale olie’) on base of fractions of petroleum hydrocarbons. *RIVM Report 711701015*. (Dutch) National Institute of Public Health and the Environment. P.O. Box 1, 3720 BA Bilthoven.

HARTLESS, R. 1991. Construction of new buildings on gas-contaminated land. Building Research Establishment Report BR 212. BRE, Garston.

HEALTH PROTECTION AGENCY. 2009. An introduction to land contamination for public health professionals, Ver 1.2. HPA, Cardiff.

INTERDEPARTMENTAL COMMITTEE ON THE REDEVELOPMENT OF CONTAMINATED LAND. 1983. Notes on the Redevelopment of Scrap Yards and Similar Sites. *ICRCL 42/80 (2nd Ed).* DETR, Rotherham.

INTERDEPARTMENTAL COMMITTEE ON THE REDEVELOPMENT OF CONTAMINATED LAND. 1987. Guidance on the assessment of contaminated land. *ICRCL 59/83 (2nd Ed).* DETR, Rotherham.

INTERDEPARTMENTAL COMMITTEE ON THE REDEVELOPMENT OF CONTAMINATED LAND. 1990. Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing. *ICRCL 70/90.* DETR, Rotherham.

JONES, J. 2008. Personal Communication.

LITTON, P. J. 2006. Personal Communication. *Determining the source of hydrocarbon sheen using chromatogram fingerprinting and dual-ratio scatter plot analysis*. Poster produced by BBL Inc, Tampa, Florida.

LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY. 2003. Risk Evaluation / Corrective Action Program. Appendix D. Louisiana Department of Environmental Quality Corrective Action Group, 20 October 2003.

MINISTRY OF AGRICULTURE FISHERIES AND FOOD. October 1998. *Code of Good Agricultural Practice for the Protection of Soil.*

MINISTRY OF HOUSING, SPATIAL PLANNING AND ENVIRONMENT. February 2000. Circular on Target Values and Intervention Values for Soil Remediation. DBO/1999226863. VROM, The Hague.

NATHANAIL, C. P. 2004. The use and misuse of CLR 7 acceptance tests for assessment of risks to human health from contaminated land. *Quarterly Journal of Engineering Geology and Hydrogeology*, **37**, 361-367.

NATHANAIL, P., McCAFFREY, C., ASHMORE, M., CHENG, Y., GILLETT, A., OGDNE, R. and SCOTT, D. 2009. The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd ed.). Land Quality Press, Nottingham.

NATIONAL ENVIRONMENTAL PROTECTION COUNCIL. 1999. *National Environmental Protection (Assessment of Site Contamination) Measure 1999. Schedule B(1) – Guideline on Investigation Levels for Soil and Groundwater.* National Environmental Protection Council Service Corporation, Adelaide, Australia.

NAVFAC. April 2003. Guidance for Environmental Background Analysis, Vol. II: Sediment. *NFESC User's Guide UG-2054-ENV.* Naval Facilities Engineering Command, Washington DC, USA.

NEW ZEALAND MINISTRY FOR THE ENVIRONMENT. June 1997. Health and Environmental Guidelines for Selected Timber Treatment Chemicals. NZ Ministry for the Environment, Wellington.

NHBC and ENVIRONMENT AGENCY. 2008. Guidance for the safe development of housing on land affected by contamination. R&D Publication 66, 2 Volumes.

ONTARIO MINISTRY OF THE ENVIRONMENT. 1990. Guidelines for the decommissioning and clean-up of contaminated sites in Ontario.

PONNAMPERUMA, F. N., LANTIN, R. S. and CLAYTON, M. T. C. 1979. Boron toxicity in rice soils. *Int. Rice Res. Newsletter,* **4, 8.**

ROYAL SOCIETY OF CHEMISTRY. 2001. Robust statistics: a method of coping with outliers. AMC Technical Brief No. 6.. Analytical Methods Committee, Royal Society of Chemistry.

RUDLAND, D. J., LANCEFIELD, R. M. and MAYELL, P. N. 2001. Contaminated land risk assessment. A guide to good practice. *CIRIA Report C552*. CIRIA, London. 158 pp.

STONE, K., MURRAY, A., COOKE, S., FORAN, J. and GOODERHAM, L. 2009. Unexploded ordnance (UXO), a guide to the construction industry. *CIRIA Report C681*. CIRIA, London. 141 pp.

SWARTJES, F. and van den Berg, R. 1993. Remediation of contaminated soil and groundwater: proposals for criteria and priority setting. *Proc. Workshop on Contaminated Soils*, *October 1993*, Stockholm.

UKTAG. September 2008. Application of Groundwater Standards to regulation. Paper 11b(iii) v14 final. UK Technical Advisory Group on the Water Framework Directive.

UK WATER INDUSTRY RESEARCH (UKWIR). 2010 re-issued. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites. *Report 10/WM/03/21*.

WATER REGULATIONS ADVISORY SCHEME (WRAS). October 2002. The selection of materials for water supply pipes to be laid in contaminated land. *Information and Guidance Note No. 9-04-03, Issue 1.*

WELSH ASSEMBLY GOVERNMENT. July 2004. Development and flood risk. Planning Policy Wales, Technical Advice Note 15.

WILSON, S.A. and CARD, G.B. 1999. Reliability and risk in gas protection design. *Ground Engineering,* February 1999, 33-36, plus letters in March 1999.

WILSON, S. and HAINES, S. 2005. Site investigation and monitoring for ground gas assessment – back to basics. *Land Contamination and Reclamation* **13(3),** 211-222.

WILSON, S., OLIVER, S., MALLETT, H., HUTCHINGS, H. and CARD, G. 2007. Assessing risks posed by hazardous ground gases to buildings. *CIRIA Report C665*. CIRIA, London. 182pp.

WORLD HEALTH ORGANIZATION. 2011. Guidelines for drinking-water quality (4th Edition). WHO, Geneva.

WORLD HEALTH ORGANIZATION. 2005. Petroleum products in drinking-water. Background documentation for development of WHO guidelines for Drinking-water Quality. *Report WHO/SDE/WSH/05.08/123*. WHO, Geneva.

YUNKER, M.B., MACDONALD, R.W., VINGARZAN, R., MITCHELL, R.H., GOYETTE, D AND SYLVESTRE, S. 2002. PAHs in the Fraser River basin: a critical appraisal of PAH ratios as indicators of PAH source and composition. *Organic Geochemistry*, **33,** 489-515.

Appendix E

CONTAMINATION TEST RESULTS & STATISTICAL ANALYSIS

This appendix may not be included in the printed report to reduce the document size.

It is presented in the PDF version of the report on the CD enclosed with the printed report.

Chemtest
The right chemistry to deliver results

Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Rob Hooker
14 December 2012

Dear Rob Hooker

Test Report Number	**217776**
Your Project Reference	**Banbury**

Please find enclosed the results of analysis for the samples received 10 December 2012.

All soil samples will be retained for a period of one month and all water samples will be retained for 7 days following the date of the test report. Should you require an extended retention period then please detail your requirements in an email to customerservices@chemtest.co.uk. Please be aware that charges may be applicable for extended sample storage.

If you require any further assistance, please do not hesitate to contact the Customer Services team.

Yours sincerely

Darrell Hall, Director

2183

Notes to accompany report:

- *The sign < means 'less than'*
- *Tests marked 'U' hold UKAS accreditation*
- *Tests marked 'M' hold MCertS (and UKAS) accreditation*
- *Tests marked 'N' do not currently hold UKAS accreditation*
- *Tests marked 'S' were subcontracted to an approved laboratory*
- *n/e means 'not evaluated'*
- *i/s means 'insufficient sample'*
- *u/s means 'unsuitable sample'*
- *Comments or interpretations are beyond the scope of UKAS accreditation*
- *The results relate only to the items tested*
- *All results are expressed on a dry weight basis*
- *The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, phenols*
- *For all other tests the samples were dried at < 37°C prior to analysis*
- *Uncertainties of measurement for the determinands tested are available upon request*
- *None of the test results included in this report have been recovery corrected*

Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Rob Hooker
14 December 2012

Dear Rob Hooker

Test Report Number	**217776**
Your Project Reference	**Banbury**

Please find enclosed the results of analysis for the samples received 10 December 2012.

If you require any further assistance, please do not hesitate to contact the Customer Services team.

Yours sincerely

Darrell Hall, Director

2183

Notes to accompany report:

- *The in-house procedure is employed to identify materials and fibres in soils*
- *The sample is examined by stereo-binocular and polarised light microscopy*
- *Sample size is reduced by coning and quartering to obtain a representative sub-sample if necessary*
- *The bulk identification is in accordance with the requirements of the analyst guide (HSG 248)*
- *Samples associated with asbestos are retained for six months*
- *The results relate only to the items tested as supplied by the client*
- *Comments or interpretations are beyond the scope of UKAS accreditation*

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FAO Rob Hooker

LABORATORY TEST REPORT
Asbestos in Soils

Chemtest

Results of analysis of 20 samples
received 10 December 2012
Banbury

Report Date
14 December 2012

Login Batch No: 217776

Qualitative Results

				SOP 2190	
				ACM Type	Asbestos Identification
Chemtest ID	Sample ID	Sample Desc	Depth (m)		
AI05105	7	HTP02	0.20	-	No Asbestos Detected
AI05108	12	HTP03	0.50	-	No Asbestos Detected
AI05109	16	HTP04	0.10	-	No Asbestos Detected
AI05112	23	HTP05	0.50	-	No Asbestos Detected
AI05113	28	HTP06	0.10	-	No Asbestos Detected
AI05115	33	HTP07	0.50	-	No Asbestos Detected
AI05117	41	HTP09	0.20	-	No Asbestos Detected
AI05118	47	HTP10	0.50	-	No Asbestos Detected
AI05121	116	HTP13	0.20	-	No Asbestos Detected
AI05123	101	HTP15	0.25	-	No Asbestos Detected
AI05125	109	HTP17	0.15	-	No Asbestos Detected
AI05127	129	HTP20	0.15	-	No Asbestos Detected
AI05129	137	HTP22	0.20	-	No Asbestos Detected
AI05131	76	HTP24	0.20	-	No Asbestos Detected
AI05132	72	HTP25	0.15	-	No Asbestos Detected
AI05133	68	HTP26	0.10	-	No Asbestos Detected
AI05135	87	HTP29	0.15	-	No Asbestos Detected
AI05137	64	HTP33	0.25	-	No Asbestos Detected
AI05140	90	HTP39	0.20	-	No Asbestos Detected
AI05141	97	HTP40	0.20	-	No Asbestos Detected

The detection limit for this method is 0.001%

Signed

Signed

Pauline Hellier
Asbestos Analyst

All tests undertaken between 13-Dec-2012 and 14-Dec-2012

LIMS sample ID range AI05105 to AI05141

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Rob Hooker

LABORATORY TEST REPORT

Results of analysis of 4 samples
received 10 December 2012

Banbury

Report Date
14 December 2012

Login Batch No					217776			
Chemtest LIMS ID					AI05256	AI05257	AI05258	AI05259
Sample ID					HTP02	HTP05	HTP11	HTP35
Sample No					8	22	51	57
Sampling Date					Not Provided	Not Provided	Not Provided	Not Provided
Depth					0.50m	0.20m	0.50m	0.60m
Matrix					*LEACHATE*	*LEACHATE*	*LEACHATE*	*LEACHATE*
SOP↓	Determinand↓	CAS No↓	Units↓	*				
1010	pH	PH		U	8.2	8.0	8.0	7.9
1020	Electrical Conductivity	EC	µS cm-¹	U	220	240	36	80
1215	Bromate	15541454	mg l-¹	N	<0.01	<0.01	<0.01	<0.01
1220	Chloride	16887006	mg l-¹	U	2.5	2.7	2.9	1.4
	Fluoride	16984488	mg l-¹	U	0.16	0.25	0.34	0.62
	Ammonium	14798039	mg l-¹	U	0.20	0.20	0.37	0.27
	Nitrite	14797650	mg l-¹	U	0.12	0.44	0.16	0.19
	Nitrate	14797558	mg l-¹	U	0.64	5.7	1.4	2.3
1300	Cyanide (free) Low-Level	57125	mg l-¹	N	<0.005	<0.005	<0.005	<0.005
	Cyanide (total) Low-Level	57125	mg l-¹	N	<0.005	<0.005	<0.005	<0.005
1470	Iron (dissolved)	7439896	µg l-¹	N	590	100	1200	220
1270	Hardness	HARD_TOT	mg CaCO3 l-¹	U	61	73	28	280
1415	Sodium	7440235	mg l-¹	U	2.3	1.6	2.3	5.3
1220	Sulfate	14808798	mg l-¹	U	6.8	3.6	6.7	1.6
1430	Aluminium	7429905	µg l-¹	N	1200	30	770	170
1450	Silver	7440224	µg l-¹	N	<0.5	<0.5	<0.5	<0.5
	Arsenic	7440382	µg l-¹	U	1.6	<1.0	<1.0	<1.0
	Boron	7440428	µg l-¹	U	<20	<20	<20	<20
	Barium	7440393	µg l-¹	U	6.2	33	<5.0	<5.0
	Cadmium	7440439	µg l-¹	U	<0.080	<0.080	<0.080	<0.080
	Cobalt	7440484	µg l-¹	U	<1.0	<1.0	<1.0	<1.0
	Chromium	7440473	µg l-¹	U	<1.0	<1.0	<1.0	<1.0
	Copper	7440508	µg l-¹	U	<1.0	6.3	1.7	<1.0

¹No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

All tests undertaken between 10/12/2012 and 14/12/2012
* Accreditation status
This report should be interpreted in conjuction with the notes on the accompanying cover page.

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Rob Hooker

LABORATORY TEST REPORT

Results of analysis of 4 samples
received 10 December 2012

Banbury

Report Date
14 December 2012

					217776			
					AI05256	AI05257	AI05258	AI05259
					HTP02	HTP05	HTP11	HTP35
					8	22	51	57
					Not Provided	Not Provided	Not Provided	Not Provided
					0.50m	0.20m	0.50m	0.60m
					LEACHATE	*LEACHATE*	*LEACHATE*	*LEACHATE*
1450	Manganese	7439965	µg l-¹	U	29	<1.0	5.8	1.2
	Molybdenum	7439987	µg l-¹	U	<1.0	19	<1.0	<1.0
	Nickel	7440020	µg l-¹	U	<1.0	<1.0	<1.0	<1.0
	Lead	7439921	µg l-¹	U	<1.0	2.0	<1.0	<1.0
	Antimony	7440364	µg l-¹	U	<1.0	<1.0	<1.0	<1.0
	Selenium	7782492	µg l-¹	U	1.8	<1.0	<1.0	<1.0
	Tin	7440315	µg l-¹	U	2.2	<1.0	<1.0	<1.0
	Vanadium	7440622	µg l-¹	U	2.6	<1.0	1.8	<1.0
	Zinc (dissolved)	7440666	µg l-¹	U	3.4	3.8	4.2	<1.0
	Zinc	7440666	µg l-¹	U	3.5	3.8	4.2	<1.0
1460	Mercury Low Level	7439976	µg l-¹	U	0.022	<0.01	<0.01	<0.01
1490	Chromium (trivalent)	16065831	µg l-¹	N	<20	<20	<20	<20
	Chromium (hexavalent)	18540299	µg l-¹	U	<20 [1]	<20 [1]	<20 [1]	<20 [1]
1700	Naphthalene	91203	µg l-¹	N	2.6	3.3	2.2	<0.01
	Acenaphthylene	208968	µg l-¹	N	0.5	0.6	0.6	0.8
	Acenaphthene	83329	µg l-¹	N	1.8	1.9	0.7	1
	Fluorene	86737	µg l-¹	N	94	69	<0.01	<0.01
	Phenanthrene	85018	µg l-¹	N	2	1.6	<0.01	<0.01
	Anthracene	120127	µg l-¹	N	<0.01	<0.01	<0.01	<0.01
	Fluoranthene	206440	µg l-¹	N	<0.01	0.6	<0.01	1
	Pyrene	129000	µg l-¹	N	<0.01	1.3	<0.01	1.6
	Benzo[a]anthracene	56553	µg l-¹	N	<0.01	<0.01	<0.01	<0.01
	Chrysene	218019	µg l-¹	N	<0.01	<0.01	<0.01	<0.01
	Benzo[b]fluoranthene	205992	µg l-¹	N	<0.01	1.2	<0.01	<0.01

[1]No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

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Banbury

					217776			
					AI05256	AI05257	AI05258	AI05259
					HTP02	HTP05	HTP11	HTP35
					8	22	51	57
					Not Provided	Not Provided	Not Provided	Not Provided
					0.50m	0.20m	0.50m	0.60m
					LEACHATE	*LEACHATE*	*LEACHATE*	*LEACHATE*
1700	Benzo[k]fluoranthene	207089	µg l-¹	N	<0.01	<0.01	<0.01	<0.01
	Benzo[a]pyrene	50328	µg l-¹	N	8.9	6.7	5.2	7.1
	Dibenzo[a,h]anthracene	53703	µg l-¹	N	2.6	2.6	1.6	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l-¹	N	<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
	Total (of 16) PAHs		µg l-¹	N	110	89	10	11
1900	2-sec-Butyl-4,6-dinitrophenol	88857	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	4-Chloro-3-methylphenol	59507	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2-Chlorophenol	95578	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,4-Dichlorophenol	120832	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,6-Dichlorophenol	87650	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,4-Dimethylphenol	105679	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,4-Dinitrophenol	51285	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2-Methyl-4,6-dinitrophenol	534521	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2-Methylphenol	95487	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	3-Methylphenol	108394	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	4-Methylphenol	106445	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2-Nitrophenol	88755	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	4-Nitrophenol	100027	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	Pentachlorophenol	87865	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	Phenol	108952	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,3,4,5-Tetrachlorophenol	4901513	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,3,4,6-Tetrachlorophenol	58902	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,3,5,6-Tetrachlorophenol	935955	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002

[1]No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

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Almondsbury, Bristol
BS32 4DF

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LABORATORY TEST REPORT

Results of analysis of 4 samples received 10 December 2012

Banbury

Report Date 14 December 2012

					217776			
					AI05256	AI05257	AI05258	AI05259
					HTP02	HTP05	HTP11	HTP35
					8	22	51	57
					Not Provided	Not Provided	Not Provided	Not Provided
					0.50m	0.20m	0.50m	0.60m
					LEACHATE	*LEACHATE*	*LEACHATE*	*LEACHATE*
1900	2,3,4-Trichlorophenol	15950660	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,3,5-Trichlorophenol	933788	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,3,6-Trichlorophenol	933755	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,4,5-Trichlorophenol	95954	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	2,4,6-Trichlorophenol	88062	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002
	3,4,5-Trichlorophenol	609198	mg l-¹	N	<0.0002	<0.0002	<0.0002	<0.0002

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LABORATORY TEST REPORT

Results of analysis of 24 samples received 10 December 2012

Banbury

Report Date 14 December 2012

Login Batch No					217776					
Chemtest LIMS ID					AI05105	AI05108	AI05109	AI05112	AI05113	AI05115
Sample ID					HTP02	HTP03	HTP04	HTP05	HTP06	HTP07
Sample No					7	12	16	23	28	33
Sampling Date					Not Provided	Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
Depth					0.20m	0.50m	0.10m	0.50m	0.10m	0.50m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*						
2010	pH			M	6.7	8.3	7.7	8.2	8.0	7.1
2300	Cyanide (free)	57125	mg kg-¹	M	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
2625	Fraction of Organic Carbon			M	0.015	0.0065	0.030	0.0093	0.12	0.023
2120	Boron (hot water soluble)	7440428	mg kg-¹	M	0.8	1	1	0.6	1.2	0.5
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2450	Arsenic	7440382	mg kg-¹	M	28	84	56	33	48	18
	Beryllium	7440417	mg kg-¹	M	<1.00	2.1	1.6	1.1	1.8	<1.00
	Cadmium	7440439	mg kg-¹	M	<0.10	0.10	<0.10	<0.10	0.23	<0.10
	Chromium	7440473	mg kg-¹	M	47	150	100	75	80	49
	Copper	7440508	mg kg-¹	M	18	36	26	18	150	15
	Mercury	7439976	mg kg-¹	M	<0.10	<0.10	<0.10	<0.10	0.71	<0.10
	Nickel	7440020	mg kg-¹	M	25	64	67	45	53	33
	Lead	7439921	mg kg-¹	M	39	230	52	30	480	26
	Selenium	7782492	mg kg-¹	M	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Vanadium	7440622	mg kg-¹	M	67	230	150	95	120	61
	Zinc	7440666	mg kg-¹	M	79	170	190	110	410	85
2800	Naphthalene	91203	mg kg-¹	M	< 0.01	0.069	< 0.01	< 0.01	1.8	< 0.01
	Acenaphthylene	208968	mg kg-¹	N	< 0.01	0.2	< 0.01	< 0.01	2.8	< 0.01
	Acenaphthene	83329	mg kg-¹	M	< 0.01	0.088	< 0.01	< 0.01	0.73	< 0.01
	Fluorene	86737	mg kg-¹	M	< 0.01	0.16	< 0.01	< 0.01	2.3	< 0.01
	Phenanthrene	85018	mg kg-¹	M	0.088	2.7	0.014	0.049	27	0.018
	Anthracene	120127	mg kg-¹	M	< 0.01	0.47	< 0.01	0.013	6	< 0.01
	Fluoranthene	206440	mg kg-¹	M	0.17	3.6	0.075	0.2	36	0.047

¹No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

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Almondsbury, Bristol
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LABORATORY TEST REPORT

Results of analysis of 24 samples
received 10 December 2012

Banbury

Report Date
14 December 2012

Login Batch No				217776					
Chemtest LIMS ID				AI05117	AI05118	AI05121	AI05123	AI05125	AI05127
Sample ID				HTP09	HTP10	HTP13	HTP15	HTP17	HTP20
Sample No				41	47	116	101	109	129
Sampling Date				Not Provided	Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
Depth				0.20m	0.50m	0.20m	0.25m	0.15m	0.15m
Matrix				*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓ Determinand↓	CAS No↓	Units↓	*						
2010 pH			M	6.9	7.3	7.3	7.1	7.5	7.7
2300 Cyanide (free)	57125	mg kg-¹	M	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
2625 Fraction of Organic Carbon			M	0.0046	0.019	0.018	0.0099	0.017	0.023
2120 Boron (hot water soluble)	7440428	mg kg-¹	M	<0.4	0.5	0.7	0.8	0.9	1.4
2490 Chromium (hexavalent)	18540299	mg kg-¹	N	<0.5	<0.5	<0.5	<0.5	<0.5	< 0.5
2450 Arsenic	7440382	mg kg-¹	M	22	18	17	110	66	68
Beryllium	7440417	mg kg-¹	M	<1.00	<1.00	<1.00	4.1	1.6	2.3
Cadmium	7440439	mg kg-¹	M	<0.10	<0.10	<0.10	<0.10	<0.10	0.28
Chromium	7440473	mg kg-¹	M	41	42	39	270	78	88
Copper	7440508	mg kg-¹	M	12	10	12	21	23	31
Mercury	7439976	mg kg-¹	M	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nickel	7440020	mg kg-¹	M	22	22	21	110	62	99
Lead	7439921	mg kg-¹	M	16	24	29	39	46	62
Selenium	7782492	mg kg-¹	M	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Vanadium	7440622	mg kg-¹	M	58	58	53	410	120	150
Zinc	7440666	mg kg-¹	M	59	66	61	190	110	180
2800 Naphthalene	91203	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthylene	208968	mg kg-¹	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthene	83329	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluorene	86737	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenanthrene	85018	mg kg-¹	M	< 0.01	< 0.01	0.014	0.039	< 0.01	0.39
Anthracene	120127	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.11
Fluoranthene	206440	mg kg-¹	M	< 0.01	0.031	0.088	0.096	0.019	0.81

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LABORATORY TEST REPORT

Results of analysis of 24 samples
received 10 December 2012

Banbury

Chemtest
The right chemistry to deliver results

Report Date
14 December 2012

Login Batch No				217776					
Chemtest LIMS ID				AI05129	AI05131	AI05132	AI05133	AI05135	AI05137
Sample ID				HTP22	HTP24	HTP25	HTP26	HTP29	HTP33
Sample No				137	76	72	68	87	64
Sampling Date				Not Provided	Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
Depth				0.20m	0.20m	0.15m	0.10m	0.15m	0.25m
Matrix				*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓ Determinand↓	CAS No↓	Units↓	*						
2010 pH			M	8.3	7.7	7.7	7.9	7.9	7.6
2300 Cyanide (free)	57125	mg kg-¹	M	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
2625 Fraction of Organic Carbon			M	0.021	0.057	0.012	0.013	0.023	0.017
2120 Boron (hot water soluble)	7440428	mg kg-¹	M	0.7	0.9	0.5	1.1	1.3	1.2
2490 Chromium (hexavalent)	18540299	mg kg-¹	N	<0.5	< 0.5	<0.5	<0.5	<0.5	<0.5
2450 Arsenic	7440382	mg kg-¹	M	86	79	140	120	58	76
Beryllium	7440417	mg kg-¹	M	2.5	2.0	4.2	3.7	1.6	2.1
Cadmium	7440439	mg kg-¹	M	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	7440473	mg kg-¹	M	110	110	270	240	78	100
Copper	7440508	mg kg-¹	M	31	31	41	46	28	40
Mercury	7439976	mg kg-¹	M	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nickel	7440020	mg kg-¹	M	100	92	150	120	69	79
Lead	7439921	mg kg-¹	M	55	51	70	120	48	71
Selenium	7782492	mg kg-¹	M	<0.20	<0.20	0.22	<0.20	<0.20	<0.20
Vanadium	7440622	mg kg-¹	M	150	160	380	320	120	150
Zinc	7440666	mg kg-¹	M	140	160	300	260	110	150
2800 Naphthalene	91203	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthylene	208968	mg kg-¹	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthene	83329	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluorene	86737	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenanthrene	85018	mg kg-¹	M	< 0.01	< 0.01	< 0.01	0.043	0.059	0.029
Anthracene	120127	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	0.012	< 0.01
Fluoranthene	206440	mg kg-¹	M	0.043	< 0.01	0.028	0.13	0.26	0.076

[1]No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

* Accreditation status

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

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Rob Hooker

LABORATORY TEST REPORT

Results of analysis of 24 samples
received 10 December 2012

Banbury

Chemtest
The right chemistry to deliver results

Report Date
14 December 2012

Login Batch No					**217776**	
Chemtest LIMS ID					AI05140	AI05141
Sample ID					HTP39	HTP40
Sample No					90	97
Sampling Date					Not Provided	Not Provided
Depth					0.20m	0.20m
Matrix					*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*		
2010	pH			M	7.6	7.3
2300	Cyanide (free)	57125	mg kg-¹	M	<0.50	<0.50
2625	Fraction of Organic Carbon			M	0.011	0.013
2120	Boron (hot water soluble)	7440428	mg kg-¹	M	0.7	0.9
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	<0.5	<0.5
2450	Arsenic	7440382	mg kg-¹	M	52	58
	Beryllium	7440417	mg kg-¹	M	1.4	1.6
	Cadmium	7440439	mg kg-¹	M	<0.10	<0.10
	Chromium	7440473	mg kg-¹	M	78	82
	Copper	7440508	mg kg-¹	M	23	26
	Mercury	7439976	mg kg-¹	M	<0.10	<0.10
	Nickel	7440020	mg kg-¹	M	52	60
	Lead	7439921	mg kg-¹	M	44	49
	Selenium	7782492	mg kg-¹	M	<0.20	<0.20
	Vanadium	7440622	mg kg-¹	M	100	120
	Zinc	7440666	mg kg-¹	M	100	120
2800	Naphthalene	91203	mg kg-¹	M	< 0.01	< 0.01
	Acenaphthylene	208968	mg kg-¹	N	0.073	0.026
	Acenaphthene	83329	mg kg-¹	M	< 0.01	< 0.01
	Fluorene	86737	mg kg-¹	M	< 0.01	< 0.01
	Phenanthrene	85018	mg kg-¹	M	0.28	0.17
	Anthracene	120127	mg kg-¹	M	0.14	0.064
	Fluoranthene	206440	mg kg-¹	M	1.7	0.84

¹No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

* Accreditation status

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					217776					
					AI05105	AI05108	AI05109	AI05112	AI05113	AI05115
					HTP02	HTP03	HTP04	HTP05	HTP06	HTP07
					7	12	16	23	28	33
					Not Provided	Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
					0.20m	0.50m	0.10m	0.50m	0.10m	0.50m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2800	Pyrene	129000	mg kg-[1]	M	0.11	2.9	0.066	0.16	29	0.035
	Benzo[a]anthracene	56553	mg kg-[1]	M	0.04	1.6	0.031	0.11	17	0.023
	Chrysene	218019	mg kg-[1]	M	0.027	1.3	0.03	0.061	15	0.013
	Benzo[b]fluoranthene	205992	mg kg-[1]	M	0.074	1.8	0.047	0.2	20	< 0.01
	Benzo[k]fluoranthene	207089	mg kg-[1]	N	< 0.01	0.64	0.012	0.026	5.7	< 0.01
	Benzo[a]pyrene	50328	mg kg-[1]	M	0.021	1.3	0.017	0.087	14	< 0.01
	Dibenzo[a,h]anthracene	53703	mg kg-[1]	N	< 0.01	< 0.01	< 0.01	< 0.01	2	< 0.01
	Indeno[1,2,3-cd]pyrene	193395	mg kg-[1]	M	< 0.01	0.53	< 0.01	0.03	7.2	< 0.01
	Benzo[g,h,i]perylene	191242	mg kg-[1]	M	< 0.01	0.67	< 0.01	0.033	7.8	< 0.01
	Total (of 16) PAHs		mg kg-[1]	N	0.53	18	0.29	0.97	190	< 0.2
2920	Phenols (total)		mg kg-[1]	N	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

[1]No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Rob Hooker

LABORATORY TEST REPORT

Results of analysis of 24 samples received 10 December 2012

Banbury

Report Date
14 December 2012

					217776					
					AI05117	AI05118	AI05121	AI05123	AI05125	AI05127
					HTP09	HTP10	HTP13	HTP15	HTP17	HTP20
					41	47	116	101	109	129
					Not Provided	Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
					0.20m	0.50m	0.20m	0.25m	0.15m	0.15m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2800	Pyrene	129000	mg kg-¹	M	< 0.01	0.017	0.061	0.037	0.028	0.64
	Benzo[a]anthracene	56553	mg kg-¹	M	< 0.01	0.012	0.021	< 0.01	< 0.01	0.36
	Chrysene	218019	mg kg-¹	M	< 0.01	0.01	0.012	< 0.01	< 0.01	0.3
	Benzo[b]fluoranthene	205992	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.5
	Benzo[k]fluoranthene	207089	mg kg-¹	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.13
	Benzo[a]pyrene	50328	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.38
	Dibenzo[a,h]anthracene	53703	mg kg-¹	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Indeno[1,2,3-cd]pyrene	193395	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.083
	Benzo[g,h,i]perylene	191242	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.12
	Total (of 16) PAHs		mg kg-¹	N	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	3.8
2920	Phenols (total)		mg kg-¹	N	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

¹No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

* Accreditation status

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Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Rob Hooker

LABORATORY TEST REPORT

Results of analysis of 24 samples
received 10 December 2012

Report Date
14 December 2012

Banbury

					217776					
					AI05129	AI05131	AI05132	AI05133	AI05135	AI05137
					HTP22	HTP24	HTP25	HTP26	HTP29	HTP33
					137	76	72	68	87	64
					Not Provided	Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
					0.20m	0.20m	0.15m	0.10m	0.15m	0.25m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2800	Pyrene	129000	mg kg-¹	M	0.03	< 0.01	0.024	0.1	0.21	0.056
	Benzo[a]anthracene	56553	mg kg-¹	M	< 0.01	< 0.01	< 0.01	0.047	0.099	0.023
	Chrysene	218019	mg kg-¹	M	< 0.01	< 0.01	< 0.01	0.029	0.08	0.024
	Benzo[b]fluoranthene	205992	mg kg-¹	M	< 0.01	< 0.01	0.01	0.046	0.12	0.021
	Benzo[k]fluoranthene	207089	mg kg-¹	N	< 0.01	< 0.01	< 0.01	< 0.01	0.011	< 0.01
	Benzo[a]pyrene	50328	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	0.07	0.018
	Dibenzo[a,h]anthracene	53703	mg kg-¹	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Indeno[1,2,3-cd]pyrene	193395	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Benzo[g,h,i]perylene	191242	mg kg-¹	M	< 0.01	< 0.01	< 0.01	< 0.01	0.013	< 0.01
	Total (of 16) PAHs		mg kg-¹	N	< 0.2	< 0.2	< 0.2	0.4	0.93	0.25
2920	Phenols (total)		mg kg-¹	N	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

¹No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

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Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Rob Hooker

LABORATORY TEST REPORT

Results of analysis of 24 samples received 10 December 2012

Banbury

Report Date 14 December 2012

					217776	
					AI05140	AI05141
					HTP39	HTP40
					90	97
					Not Provided	Not Provided
					0.20m	0.20m
					SOIL	*SOIL*
2800	Pyrene	129000	mg kg-¹	M	1.4	0.65
	Benzo[a]anthracene	56553	mg kg-¹	M	0.95	0.48
	Chrysene	218019	mg kg-¹	M	0.78	0.32
	Benzo[b]fluoranthene	205992	mg kg-¹	M	1.2	0.62
	Benzo[k]fluoranthene	207089	mg kg-¹	N	0.35	0.099
	Benzo[a]pyrene	50328	mg kg-¹	M	0.69	0.33
	Dibenzo[a,h]anthracene	53703	mg kg-¹	N	< 0.01	< 0.01
	Indeno[1,2,3-cd]pyrene	193395	mg kg-¹	M	0.22	0.069
	Benzo[g,h,i]perylene	191242	mg kg-¹	M	0.21	0.076
	Total (of 16) PAHs		mg kg-¹	N	8	3.7
2920	Phenols (total)		mg kg-¹	N	<0.3	<0.3

¹No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

* Accreditation status

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

Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Richard Heath
15 March 2013

Dear Richard Heath

Test Report Number **225356**
Your Project Reference **C12702 - Bankside, Banbury**

Please find enclosed the results of analysis for the samples received 8 March 2013.

All soil samples will be retained for a period of one month and all water samples will be retained for 7 days following the date of the test report. Should you require an extended retention period then please detail your requirements in an email to customerservices@chemtest.co.uk. Please be aware that charges may be applicable for extended sample storage.

If you require any further assistance, please do not hesitate to contact the Customer Services team.

Yours sincerely

Darrell Hall, Director

2183

Notes to accompany report:
- *The sign < means 'less than'*
- *Tests marked 'U' hold UKAS accreditation*
- *Tests marked 'M' hold MCertS (and UKAS) accreditation*
- *Tests marked 'N' do not currently hold UKAS accreditation*
- *Tests marked 'S' were subcontracted to an approved laboratory*
- *n/e means 'not evaluated'*
- *i/s means 'insufficient sample'*
- *u/s means 'unsuitable sample'*
- *Comments or interpretations are beyond the scope of UKAS accreditation*
- *The results relate only to the items tested*
- *All results are expressed on a dry weight basis*
- *The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, phenols*
- *For all other tests the samples were dried at < 37°C prior to analysis*
- *Uncertainties of measurement for the determinands tested are available upon request*
- *None of the test results included in this report have been recovery corrected*

Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Richard Heath
02 April 2013

Dear Richard Heath

Test Report Number **225356**

Your Project Reference **C12702 - Bankside, Banbury**

Please find enclosed the results of analysis for the samples received 8 March 2013.

If you require any further assistance, please do not hesitate to contact the Customer Services team.

Yours sincerely

Keith Jones, Technical Manager

2183

Notes to accompany report:

- *The in-house procedure is employed to identify materials and fibres in soils*
- *The sample is examined by stereo-binocular and polarised light microscopy*
- *Sample size is reduced by coning and quartering to obtain a representative sub-sample if necessary*
- *The bulk identification is in accordance with the requirements of the analyst guide (HSG 248)*
- *Samples associated with asbestos are retained for six months*
- *The results relate only to the items tested as supplied by the client*
- *Comments or interpretations are beyond the scope of UKAS accreditation*

ISO 14001 sira UKAS

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Richard Heath

LABORATORY TEST REPORT
Asbestos in Soils

Results of analysis of 5 samples
received 8 March 2013
C12702 - Bankside, Banbury

Chemtest

Report Date
02 April 2013

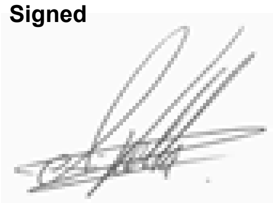
Login Batch No: 225356

Qualitative Results

Chemtest ID	Sample ID	Sample Desc	Depth (m)	SOP 2190 ACM Type	SOP 2190 Asbestos Identification
AI39854	HTP41		0.1	-	No Asbestos Detected
AI39856	HTP43		0.2	-	No Asbestos Detected
AI39857	HTP44		0.7	-	No Asbestos Detected
AI39858	HTP45		0.4	-	No Asbestos Detected
AI39860	HTP46		0.7	-	No Asbestos Detected

The detection limit for this method is 0.001%

Signed



Albert Vella
Senior Environmental Surveyor

All tests undertaken between 12-Mar-2013 and 12-Mar-2013

LIMS sample ID range AI39854 to AI39860

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Richard Heath

LABORATORY TEST REPORT

Results of analysis of 5 samples received 8 March 2013

C12702 - Bankside, Banbury

Report Date
14 March 2013

Login Batch No					**225356**				
Chemtest LIMS ID					AI39854	AI39856	AI39857	AI39858	AI39860
Sample ID					HTP41	HTP43	HTP44	HTP45	HTP46
Sample No									
Sampling Date					Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
Depth					0.1m	0.2m	0.7m	0.4m	0.7m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*					
2010	pH			M	7.7	7.5	7.6	6.9	7.9
2300	Cyanide (free)	57125	mg kg-¹	M	<0.5	<0.5	<0.5	<0.5	<0.5
2625	Fraction of Organic Carbon			M	0.023	0.018	0.012	0.022	0.0053
2120	Boron (hot water soluble)	7440428	mg kg-¹	M	1.0	1.0	0.7	1.0	1.2
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	<0.5	<0.5	<0.5	<0.5	<0.5
2450	Arsenic	7440382	mg kg-¹	M	190	130	230	120	170
	Beryllium	7440417	mg kg-¹	M	5.4	3.6	5.6	3.3	4.8
	Cadmium	7440439	mg kg-¹	M	0.36	0.37	0.27	0.40	0.23
	Chromium	7440473	mg kg-¹	M	480	210	540	190	590
	Copper	7440508	mg kg-¹	M	40	49	35	43	25
	Mercury	7439976	mg kg-¹	M	0.19	0.19	0.13	0.17	<0.10
	Nickel	7440020	mg kg-¹	M	170	160	210	130	180
	Lead	7439921	mg kg-¹	M	81	90	84	81	33
	Selenium	7782492	mg kg-¹	M	<0.20	<0.20	<0.20	<0.20	<0.20
	Vanadium	7440622	mg kg-¹	M	670	330	710	290	740
	Zinc	7440666	mg kg-¹	M	340	290	380	220	970
2800	Naphthalene	91203	mg kg-¹	M	0.8	1.5	0.95	1.2	2
	Acenaphthylene	208968	mg kg-¹	N	< 0.01	0.063	0.03	0.028	< 0.01
	Acenaphthene	83329	mg kg-¹	M	< 0.01	0.1	0.044	0.054	0.091
	Fluorene	86737	mg kg-¹	M	< 0.01	0.08	0.038	0.053	0.11
	Phenanthrene	85018	mg kg-¹	M	0.22	0.17	0.1	0.08	0.24
	Anthracene	120127	mg kg-¹	M	0.03	0.02	< 0.01	< 0.01	0.031
	Fluoranthene	206440	mg kg-¹	M	0.24	0.17	0.091	0.071	0.096
	Pyrene	129000	mg kg-¹	M	0.17	0.12	0.072	0.045	0.063

All tests undertaken between 08/03/2013 and 14/03/2013

* Accreditation status

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

Hydrock Consultants
Over Court Barns
Over Lane
Almondsbury, Bristol
BS32 4DF

FAO Richard Heath

LABORATORY TEST REPORT

Results of analysis of 5 samples
received 8 March 2013

C12702 - Bankside, Banbury

Report Date
14 March 2013

					225356				
					AI39854	AI39856	AI39857	AI39858	AI39860
					HTP41	HTP43	HTP44	HTP45	HTP46
					Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
					0.1m	0.2m	0.7m	0.4m	0.7m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2800	Benzo[a]anthracene	56553	mg kg-¹	M	0.11	0.04	< 0.01	< 0.01	< 0.01
	Chrysene	218019	mg kg-¹	M	0.11	0.054	< 0.01	< 0.01	< 0.01
	Benzo[b]fluoranthene	205992	mg kg-¹	M	0.18	0.056	< 0.01	< 0.01	< 0.01
	Benzo[k]fluoranthene	207089	mg kg-¹	N	0.014	0.023	< 0.01	< 0.01	< 0.01
	Benzo[a]pyrene	50328	mg kg-¹	M	0.055	0.023	< 0.01	< 0.01	< 0.01
	Dibenzo[a,h]anthracene	53703	mg kg-¹	N	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Indeno[1,2,3-cd]pyrene	193395	mg kg-¹	M	0.025	< 0.01	< 0.01	< 0.01	< 0.01
	Benzo[g,h,i]perylene	191242	mg kg-¹	M	0.032	< 0.01	< 0.01	< 0.01	< 0.01
	Total (of 16) PAHs		mg kg-¹	N	2	2.4	1.3	1.5	2.6
2920	Phenols (total)		mg kg-¹	N	<0.3	<0.3	<0.3	<0.3	<0.3

All tests undertaken between 08/03/2013 and 14/03/2013

* Accreditation status

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

LIMS sample ID range AI39854 to AI39860

Assessment of Chemicals of Potential Concern to Human Health

Hydrock

All values in mg/kg unless otherwise stated

Chemical of Potential Concern	Lab. RL	No. Samples	Min. Value	Max. Value	No. Samples > or = GAC	GAC	US_{95}	Result of Significance Test
Arsenic	2	28	12	150	19	32	79.77682	FURTHER ASSESSMENT REQUIRED
Beryllium	1	7	0.5	2.1	0	51	2.260837	POTENTIALLY SUITABLE FOR USE
Boron	0.4	28	0.6	3.8	0	290	2.162511	POTENTIALLY SUITABLE FOR USE
Cadmium	0.1	28	0.1	0.71	0	11	0.576684	POTENTIALLY SUITABLE FOR USE
Chromium (III)	5	28	31.9	410	0	630	159.8763	POTENTIALLY SUITABLE FOR USE
Chromium (VI)	0.5	19	0.1	0.5	0	4.3	0.41444	POTENTIALLY SUITABLE FOR USE
Copper	5	28	7.3	230	0	2300	87.18576	POTENTIALLY SUITABLE FOR USE
Lead	5	28	17	1500	2	450	381.0785	POTENTIALLY SUITABLE FOR USE
Mercury, inorganic	0.1	28	0.1	2.6	0	170	1.029042	POTENTIALLY SUITABLE FOR USE
Nickel	5	28	23	150	1	130	86.43294	POTENTIALLY SUITABLE FOR USE
Selenium	0.2	28	0.2	0.76	0	350	0.431448	POTENTIALLY SUITABLE FOR USE
Vanadium	5	7	0.5	230	4	74	230.1368	FURTHER ASSESSMENT REQUIRED
Zinc	10	28	56	410	0	3700	229.6131	POTENTIALLY SUITABLE FOR USE
Cyanide (free)	0.5	28	0.5	5	0	750	4.775601	POTENTIALLY SUITABLE FOR USE
Phenol (total)	0.3	28	0.3	4.8	0	290	1.948196	POTENTIALLY SUITABLE FOR USE
Acenaphthene	0.01	19	0.01	11	0	480	3.549764	POTENTIALLY SUITABLE FOR USE
Acenaphthylene	0.01	19	0.01	5.4	0	400	2.106977	POTENTIALLY SUITABLE FOR USE
Anthracene	0.01	19	0.01	19	0	4900	8.456297	POTENTIALLY SUITABLE FOR USE
Benz(a)anthracene	0.01	19	0.031	36	4	4.7	16.01503	FURTHER ASSESSMENT REQUIRED
Benzo(a)pyrene	0.01	19	0.017	56	9	0.94	20.05253	FURTHER ASSESSMENT REQUIRED
Benzo(b)fluoranthene	0.01	19	0.047	40	4	6.5	16.18368	FURTHER ASSESSMENT REQUIRED
Benzo(ghi)perylene	0.01	19	0.01	45	0	46	15.13916	POTENTIALLY SUITABLE FOR USE
Benzo(k)fluoranthene	0.01	19	0.01	26	2	9.6	9.280907	POTENTIALLY SUITABLE FOR USE
Chrysene	0.01	19	0.027	40	4	8	18.44244	FURTHER ASSESSMENT REQUIRED
Dibenz(a,h)anthracene	0.01	19	0.01	4.5	4	0.86	1.832813	FURTHER ASSESSMENT REQUIRED
Fluoranthene	0.01	19	0.075	99	0	460	44.88063	POTENTIALLY SUITABLE FOR USE
Fluorene	0.01	19	0.01	18	0	380	6.306193	POTENTIALLY SUITABLE FOR USE
Indeno(1,2,3,cd)pyrene	0.01	19	0.01	43	4	3.9	14.60898	FURTHER ASSESSMENT REQUIRED
Naphthalene	0.01	19	0.01	42	3	3.7	13.63966	FURTHER ASSESSMENT REQUIRED
Phenanthrene	0.01	19	0.014	84	0	200	34.56433	POTENTIALLY SUITABLE FOR USE
Pyrene	0.01	19	0.066	95	0	1000	38.88174	POTENTIALLY SUITABLE FOR USE
	Mean							
FOC (dimensionless)	0.018							
SOM (calculated)	3.17%							
pH (su)	7.9							

Location & Depth	HTP02 0.20	HTP03 0.50	HTP04 0.10	HTP05 0.50	HTP06 0.10	TP1 0.4	TP1 0.90m	TP2 0.2	TP2 0.5	TP2 1.5	TP3 0.1	TP3 0.5	TP3 1.8	TP4 0.6	TP4 1.5	TP7 0.2	TP7 0.7	TP10 0.3	TP10 0.9	TP11 0.3	TP12 0.2	TP12 0.4
Soil Type	MG	NAT	MG	MG	MG																	
Arsenic	28	84	56	33	48	150	76		26	22	42	40	78	27	22	72	72		45	49	69	66
Beryllium	1	2.1	1.6	1.1	1.8	0.5	0.5															
Boron	0.8	1	1	0.6	1.2	1.6	1.6		2.3	0.86	2.8	1.4	2.2	1.7	0.68	2.4	3.8		1	2.8	1.2	1.2
Cadmium	0.1	0.1	0.1	0.1	0.23	0.61	0.5		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.52		0.5	0.71	0.5	0.5
Chromium (III)	46.5	149.5	99.5	74.5	79.5	410	159.9		38.89	31.9	74.9	63	129.9	62.88	37.67	80	109.85		39	72.85	66	129.9
Chromium (VI)	0.5	0.5	0.5	0.5	0.5		0.1		0.11	0.1	0.1		0.1	0.12	0.33		0.15			0.15		0.1
Copper	18	36	26	18	150	7.3	33		23	13	180	23	16	21	19	25	110		24	230	25	17
Lead	39	230	52	30	480	40	75		62	17	410	24	33	51	20	64	360		29	1500	40	40
Mercury, inorganic	0.1	0.1	0.1	0.1	0.71	0.27	0.92		0.65	0.24	2.1	0.2	0.39	0.21	0.2	0.27	2.6		0.2	2	0.2	0.25
Nickel	25	64	67	45	53	150	80		23	28	52	80	59	31	33	81	64		70	77	110	65
Selenium	0.2	0.2	0.2	0.2	0.2	0.3	0.38		0.3	0.3	0.49	0.3	0.33	0.32	0.3	0.3	0.76		0.3	0.59	0.43	0.3
Vanadium	67	230	150	95	120	0.5	0.5															
Zinc	79	170	190	110	410	260	180		130	64	300	59	160	98	64	130	260		64	320	120	150
Cyanide (free)	0.5	0.5	0.5	0.5	0.5	2	5		5	5	5	2	5	5	5	2	5		2	5	2	5
Phenol (total)	0.3	0.3	0.3	0.3	0.3	0.5	4.3		0.5	0.5	3.7	0.5	0.5	0.5	0.5	0.5	4.8		0.5	2.1	0.5	0.5
Acenaphthene	0.01	0.088	0.01	0.01	0.73		0.5		0.5	0.5	0.5		0.5	0.5	0.5		11			2.7		0.5
Acenaphthylene	0.01	0.2	0.01	0.01	2.8		0.5		0.5	0.5	5.4		0.5	0.5	0.5		1.5			0.51		0.5
Anthracene	0.01	0.47	0.01	0.013	6		0.92		0.85	0.5	17		0.5	0.5	0.5		19			5.4		0.5
Benz(a)anthracene	0.04	1.6	0.031	0.11	17		2		2.3	0.5	29		0.5	0.74	0.5		36			11		0.5
Benzo(a)pyrene	0.021	1.3	0.017	0.087	14		2.3		2.8	0.5	25		0.5	1.1	0.5		56			13		0.5
Benzo(b)fluoranthene	0.074	1.8	0.047	0.2	20		1.8		2.1	0.5	23		0.5	0.66	0.5		40			9.6		0.5
Benzo(ghi)perylene	0.01	0.67	0.01	0.033	7.8		1.7		2.2	0.5	15		0.5	1	0.5		45			9.1		0.5
Benzo(k)fluoranthene	0.01	0.64	0.012	0.026	5.7		0.93		1.1	0.5	11		0.5	0.5	0.5		26			6.8		0.5
Chrysene	0.027	1.3	0.03	0.061	15		2.4		2.7	0.5	38		0.5	0.88	0.5		40			12		0.5
Dibenz(a,h)anthracene	0.01	0.01	0.01	0.01	2		0.5		0.5	0.5	1.8		0.5	0.5	0.5		4.5			1.1		0.5
Fluoranthene	0.17	3.6	0.075	0.2	36		4.9		6.2	0.5	91		0.5	2.2	0.5		99			31		0.5
Fluorene	0.01	0.16	0.01	0.01	2.3		0.5		0.5	0.5	18		0.5	0.5	0.5		9.1			1.3		0.5
Indeno(1,2,3,cd)pyrene	0.01	0.53	0.01	0.03	7.2		1.4		1.8	0.5	15		0.5	0.91	0.5		43			10		0.5
Naphthalene	0.01	0.069	0.01	0.01	1.8		1.3		0.91	0.5	42		0.5	0.5	0.5		15			5.2		0.5
Phenanthrene	0.088	2.7	0.014	0.049	27		3		2.6	0.5	84		0.5	1.3	0.5		64			19		0.5
Pyrene	0.11	2.9	0.066	0.16	29		4.1		4.7	0.5	69		0.5	1.8	0.5		95			27		0.5
FOC (dimensionless)	0.015	0.0065	0.03	0.0093	0.12	0.004244		0.02093				0.004244				0.022674		0.023256	0.004244		0.006395	
SOM (calculated)	2.59%	1.12%	5.17%	1.60%	20.69%	0.73%		3.61%				0.73%				3.91%		4.01%	0.73%		1.10%	
pH (su)	6.7	8.3	7.7	8.2	8	7.9	8.2	7.7	8.6	7.7	8.2	8.4	7.7	8	7.6	7.7	8.1	7.1	8.3	8.1	8.1	8.1

Risk parameter: **Human health - residential with plant uptake (2.5%SOM)**
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Legend: Values in blue are at or below the laboratory reporting limit (where a single value is indicated) and are considered as being at the detection limit for the purposes of statistical analysis, as a conservative estimate.
Values in red are equal to, or greater than, the generic assessment criterion (GAC).
MG denotes Made Ground
NAT denotes natural ground

Assessment of Chemicals of Potential Concern to Human Health

Hydrock

								Soil Type									
All values in mg/kg unless otherwise stated								Location & Depth	TP13	TP13	TP13	TP14	TP15	TP16	TP16	TP23	TP24
Chemical of Potential Concern	**Lab. RL**	**No. Samples**	**Min. Value**	**Max. Value**	**No. Samples > or = GAC**	**GAC**	**US_{95}**	**Result of Significance Test**	**0.3**	**0.8**	**1**	**0.4**	**2.7**	**0.4**	**0.7**	**0.4**	**0.4**
Arsenic	2	28	12	150	19	32	79.77682	FURTHER ASSESSMENT REQUIRED	82	95		12	16	19	80	21	79
Beryllium	1	7	0.5	2.1	0	51	2.260837	POTENTIALLY SUITABLE FOR USE									
Boron	0.4	28	0.6	3.8	0	290	2.162511	POTENTIALLY SUITABLE FOR USE	2.2	2.1		0.94	1.3	0.89	1.2	0.88	0.81
Cadmium	0.1	28	0.1	0.71	0	11	0.576684	POTENTIALLY SUITABLE FOR USE	0.5	0.5		0.5	0.5	0.5	0.5	0.5	0.5
Chromium (III)	5	28	31.9	410	0	630	159.8763	POTENTIALLY SUITABLE FOR USE	94	159.9		53.76	41.7	53	219.9	40	89
Chromium (VI)	0.5	19	0.1	0.5	0	4.3	0.41444	POTENTIALLY SUITABLE FOR USE		0.1		0.24	0.3		0.1		
Copper	5	28	7.3	230	0	2300	87.18576	POTENTIALLY SUITABLE FOR USE	30	30		21	15	18	14	9.5	10
Lead	5	28	17	1500	2	450	381.0785	POTENTIALLY SUITABLE FOR USE	74	81		23	22	21	22	19	25
Mercury, inorganic	0.1	28	0.1	2.6	0	170	1.029042	POTENTIALLY SUITABLE FOR USE	0.35	0.45		0.2	0.2	0.2	0.26	0.2	0.2
Nickel	5	28	23	150	1	130	86.43294	POTENTIALLY SUITABLE FOR USE	91	73		40	29	29	96	24	86
Selenium	0.2	28	0.2	0.76	0	350	0.431448	POTENTIALLY SUITABLE FOR USE	0.42	0.33		0.3	0.34	0.3	0.3	0.3	0.3
Vanadium	5	7	0.5	230	4	74	230.1368	FURTHER ASSESSMENT REQUIRED									
Zinc	10	28	56	410	0	3700	229.6131	POTENTIALLY SUITABLE FOR USE	170	180		120	56	110	150	62	220
Cyanide (free)	0.5	28	0.5	5	0	750	4.775601	POTENTIALLY SUITABLE FOR USE	2	5		5	5	2	5	2	2
Phenol (total)	0.3	28	0.3	4.8	0	290	1.948196	POTENTIALLY SUITABLE FOR USE	0.5	0.58		0.5	0.76	0.5	0.5	0.5	0.5
Acenaphthene	0.01	19	0.01	11	0	480	3.549764	POTENTIALLY SUITABLE FOR USE		0.5		0.5	0.5		0.5		
Acenaphthylene	0.01	19	0.01	5.4	0	400	2.106977	POTENTIALLY SUITABLE FOR USE		0.5		0.5	0.5		0.5		
Anthracene	0.01	19	0.01	19	0	4900	8.456297	POTENTIALLY SUITABLE FOR USE		0.58		0.5	0.5		0.5		
Benz(a)anthracene	0.01	19	0.031	36	4	4.7	16.01503	FURTHER ASSESSMENT REQUIRED		1.3		0.5	0.5		0.5		
Benzo(a)pyrene	0.01	19	0.017	56	9	0.94	20.05253	FURTHER ASSESSMENT REQUIRED		1.4		0.5	0.5		0.5		
Benzo(b)fluoranthene	0.01	19	0.047	40	4	6.5	16.18368	FURTHER ASSESSMENT REQUIRED		0.97		0.5	0.5		0.5		
Benzo(ghi)perylene	0.01	19	0.01	45	0	46	15.13916	POTENTIALLY SUITABLE FOR USE		0.91		0.5	0.5		0.5		
Benzo(k)fluoranthene	0.01	19	0.01	26	2	9.6	9.280907	POTENTIALLY SUITABLE FOR USE		0.77		0.5	0.5		0.5		
Chrysene	0.01	19	0.027	40	4	8	18.44244	FURTHER ASSESSMENT REQUIRED		1.4		0.5	0.5		0.5		
Dibenz(a,h)anthracene	0.01	19	0.01	4.5	4	0.86	1.832813	FURTHER ASSESSMENT REQUIRED		0.5		0.5	0.5		0.5		
Fluoranthene	0.01	19	0.075	99	0	460	44.88063	POTENTIALLY SUITABLE FOR USE		3.6		0.5	0.5		0.5		
Fluorene	0.01	19	0.01	18	0	380	6.306193	POTENTIALLY SUITABLE FOR USE		0.5		0.5	0.5		0.5		
Indeno(1,2,3,cd)pyrene	0.01	19	0.01	43	4	3.9	14.60898	FURTHER ASSESSMENT REQUIRED		0.98		0.5	0.5		0.5		
Naphthalene	0.01	19	0.01	42	3	3.7	13.63966	FURTHER ASSESSMENT REQUIRED		1.1		0.5	0.5		0.5		
Phenanthrene	0.01	19	0.014	84	0	200	34.56433	POTENTIALLY SUITABLE FOR USE		2.4		0.5	0.5		0.5		
Pyrene	0.01	19	0.066	95	0	1000	38.88174	POTENTIALLY SUITABLE FOR USE		3.1		0.5	0.5		0.5		
	Mean																
FOC (dimensionless)	0.018								0.027907		0.003895			0.003488		0.00814	0.001919
SOM (calculated)	3.17%								4.81%		0.67%			0.60%		1.40%	0.33%
pH (su)	7.9								8	8.3	8.3	7.3	7.9	7.9	8.2	7.8	8

Risk parameter: **Human health - residential with plant uptake (2.5%SOM)**
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Assessment of Chemicals of Potential Concern to Plant Life

								Soil Type	MG	NAT	MG	MG	MG										
	All values in mg/kg unless otherwise stated							Location & Depth	HTP02	HTP03	HTP04	HTP05	HTP06	TP1	TP1	TP2	TP2	TP2	TP3	TP3	TP3	TP4	TP4
Chemical of Potential Concern	**Lab. RL**	**No. Samples**	**Min. Value**	**Max. Value**	**No. Samples > or = GAC**	**GAC**	**US_{95}**	**Result of Significance Test**	**0.20**	**0.50**	**0.10**	**0.50**	**0.10**	**0.4**	**0.90m**	**0.2**	**0.5**	**1.5**	**0.1**	**0.5**	**1.8**	**0.6**	**1.5**
Arsenic	2	28	12	150	0	250	79.77682	POTENTIALLY SUITABLE FOR USE	28	84	56	33	48	150	76		26	22	42	40	78	27	22
Boron	0.4	28	0.6	3.8	1	3	2.162511	POTENTIALLY SUITABLE FOR USE	0.8	1	1	0.6	1.2	1.6	1.6		2.3	0.86	2.8	1.4	2.2	1.7	0.68
Chromium (III)	5	28	31.9	410	1	400	159.8763	POTENTIALLY SUITABLE FOR USE	46.5	149.5	99.5	74.5	79.5	410	159.9		38.89	31.9	74.9	63	129.9	62.88	37.67
Chromium (VI)	0.5	19	0.1	0.5	0	25	0.41444	POTENTIALLY SUITABLE FOR USE	0.5	0.5	0.5	0.5	0.5		0.1		0.11	0.1	0.1		0.1	0.12	0.33
Copper	5	28	7.3	230	1	200	87.18576	POTENTIALLY SUITABLE FOR USE	18	36	26	18	150	7.3	33		23	13	180	23	16	21	19
Nickel	5	28	23	150	2	110	86.43294	POTENTIALLY SUITABLE FOR USE	25	64	67	45	53	150	80		23	28	52	80	59	31	33
Zinc	10	28	56	410	3	300	229.6131	POTENTIALLY SUITABLE FOR USE	79	170	190	110	410	260	180		130	64	300	59	160	98	64
	Mean																						
pH (su)	7.9								6.7	8.3	7.7	8.2	8	7.9	8.2	7.7	8.6	7.7	8.2	8.4	7.7	8	7.6

Risk parameter: **Plant life pH >7**
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Legend: Values in blue are at or below the laboratory reporting limit (where a single value is indicated) and are considered as being at the detection limit for the purposes of statistical analysis, as a conservative estimate.
Values in red are equal to, or greater than, the generic assessment criterion (GAC).
MG denotes Made Ground
NAT denotes natural ground

Assessment of Chemicals of Potential Concern to Plant Life

Hydrock

All values in mg/kg unless otherwise stated								Soil Type																
								Location & Depth	TP7	TP7	TP10	TP10	TP11	TP12	TP12	TP13	TP13	TP13	TP14	TP15	TP16	TP16	TP23	TP24
Chemical of Potential Concern	Lab. RL	No. Samples	Min. Value	Max. Value	No. Samples > or = GAC	GAC	US_{95}	Result of Significance Test	0.2	0.7	0.3	0.9	0.3	0.2	0.4	0.3	0.8	1	0.4	2.7	0.4	0.7	0.4	0.4
Arsenic	2	28	12	150	0	250	79.77682	POTENTIALLY SUITABLE FOR USE	72	72		45	49	69	66	82	95		12	16	19	80	21	79
Boron	0.4	28	0.6	3.8	1	3	2.162511	POTENTIALLY SUITABLE FOR USE	2.4	3.8		1	2.8	1.2	1.2	2.2	2.1		0.94	1.3	0.89	1.2	0.88	0.81
Chromium (III)	5	28	31.9	410	1	400	159.8763	POTENTIALLY SUITABLE FOR USE	80	109.85		39	72.85	66	129.9	94	159.9		53.76	41.7	53	219.9	40	89
Chromium (VI)	0.5	19	0.1	0.5	0	25	0.41444	POTENTIALLY SUITABLE FOR USE		0.15			0.15		0.1		0.1		0.24	0.3		0.1		
Copper	5	28	7.3	230	1	200	87.18576	POTENTIALLY SUITABLE FOR USE	25	110		24	230	25	17	30	30		21	15	18	14	9.5	10
Nickel	5	28	23	150	2	110	86.43294	POTENTIALLY SUITABLE FOR USE	81	64		70	77	110	65	91	73		40	29	29	96	24	86
Zinc	10	28	56	410	3	300	229.6131	POTENTIALLY SUITABLE FOR USE	130	260		64	320	120	150	170	180		120	56	110	150	62	220
	Mean																							
pH (su)	7.9								7.7	8.1	7.1	8.3	8.1	8.1	8.1	8	8.3	8.3	7.3	7.9	7.9	8.2	7.8	8

Risk parameter: **Plant life pH >7**
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

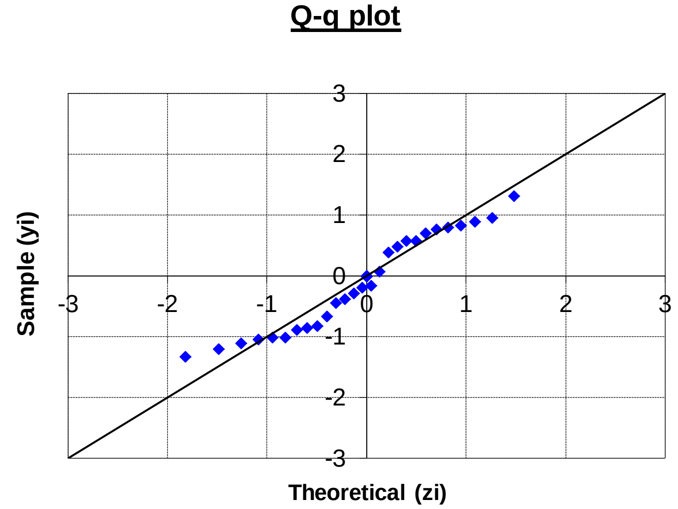
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

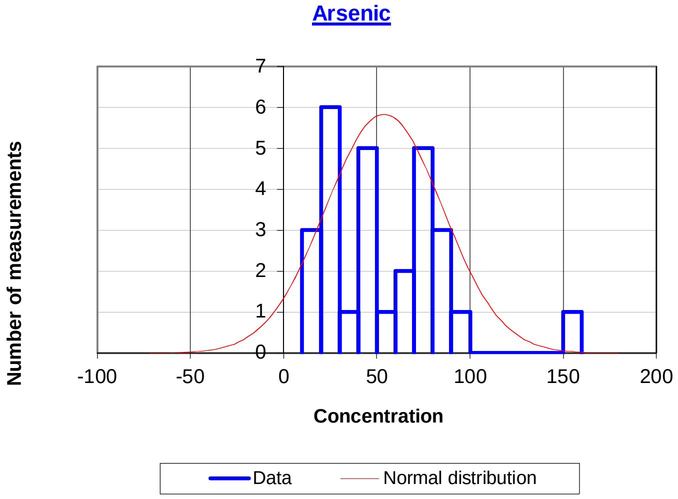
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Arsenic	Potential Outlier?	Sample
28		HTP02 @ 0.20
84		HTP03 @ 0.50
56		HTP04 @ 0.10
33		HTP05 @ 0.50
48		HTP06 @ 0.10
150		TP1 @ 0.4
76		TP1 @ 0.90m
26		TP2 @ 0.5
22		TP2 @ 1.5
42		TP3 @ 0.1
40		TP3 @ 0.5
78		TP3 @ 1.8
27		TP4 @ 0.6
22		TP4 @ 1.5
72		TP7 @ 0.2
72		TP7 @ 0.7
45		TP10 @ 0.9
49		TP11 @ 0.3
69		TP12 @ 0.2
66		TP12 @ 0.4
82		TP13 @ 0.3
95		TP13 @ 0.8
12		TP14 @ 0.4
16		TP15 @ 2.7
19		TP16 @ 0.4
80		TP16 @ 0.7
21		TP23 @ 0.4
79		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter
Human health - residential with plant uptake (2.5%SOM)

32 = GAC (critical conc.) (mg/kg)
28 = no. samples
19 = no. samples > or = GAC
12 = min. value
150 = max. value
2 = laboratory reporting limit (RL)
53.89286 = mean (mean>GAC)
0 = no. samples at RL
31.41401 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
3.687721 = t_0
1.703 = $t_{(n-1,0.95)}$
64.00304 = 95% UCL (US_{95})

One-sided Chebychev Theorem
3.687721 = k_0
4.36 = $k_{0.05}$
79.77682 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho accepted, true mean >GAC
US_{95} = 79.776824 GAC = 32 (US95 = 2.493 x GAC)

FURTHER ASSESSMENT REQUIRED

Site reference
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

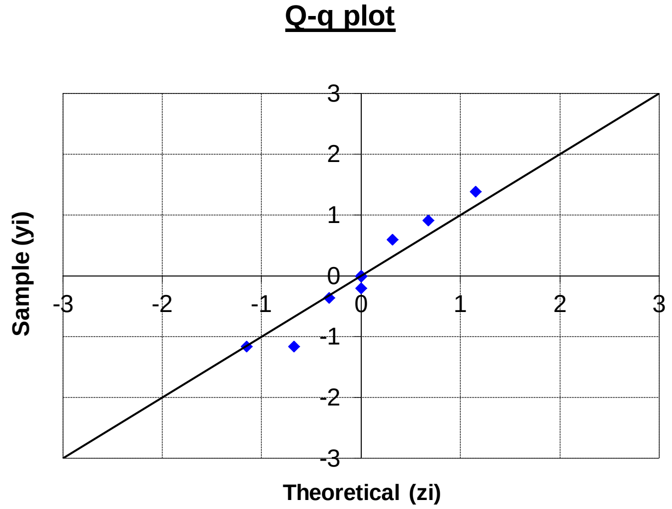
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Beryllium		
1		HTP02 @ 0.20
2.1		HTP03 @ 0.50
1.6		HTP04 @ 0.10
1.1		HTP05 @ 0.50
1.8		HTP06 @ 0.10
0.5		TP1 @ 0.4
0.5		TP1 @ 0.90m

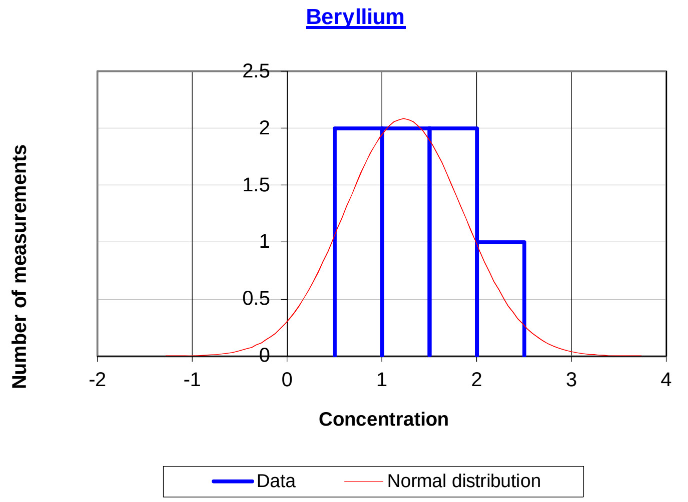
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

51 = GAC (critical conc.) (mg/kg)

7 = no. samples
0.5 = min. value
2.1 = max. value
1.228571 = mean
0.626403 = standard deviation

0 = no. samples > or = GAC
1 = laboratory reporting limit (RL)
3 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-210.2205 = t_0
1.943 = $t_{(n-1,0.95)}$
1.688593 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-210.221 = k_0
4.36 = $k_{0.05}$
2.260837 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 2.260837 GAC = 51 (US95 = 0.044 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Boron		
0.8		HTP02 @ 0.20
1		HTP03 @ 0.50
1		HTP04 @ 0.10
0.6		HTP05 @ 0.50
1.2		HTP06 @ 0.10
1.6		TP1 @ 0.4
1.6		TP1 @ 0.90m
2.3		TP2 @ 0.5
0.86		TP2 @ 1.5
2.8		TP3 @ 0.1
1.4		TP3 @ 0.5
2.2		TP3 @ 1.8
1.7		TP4 @ 0.6
0.68		TP4 @ 1.5
2.4		TP7 @ 0.2
3.8	Yes	TP7 @ 0.7
1		TP10 @ 0.9
2.8		TP11 @ 0.3
1.2		TP12 @ 0.2
1.2		TP12 @ 0.4
2.2		TP13 @ 0.3
2.1		TP13 @ 0.8
0.94		TP14 @ 0.4
1.3		TP15 @ 2.7
0.89		TP16 @ 0.4
1.2		TP16 @ 0.7
0.88		TP23 @ 0.4
0.81		TP24 @ 0.4

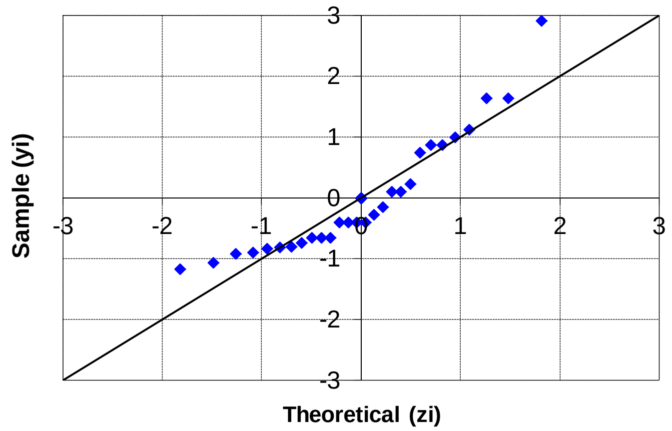
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

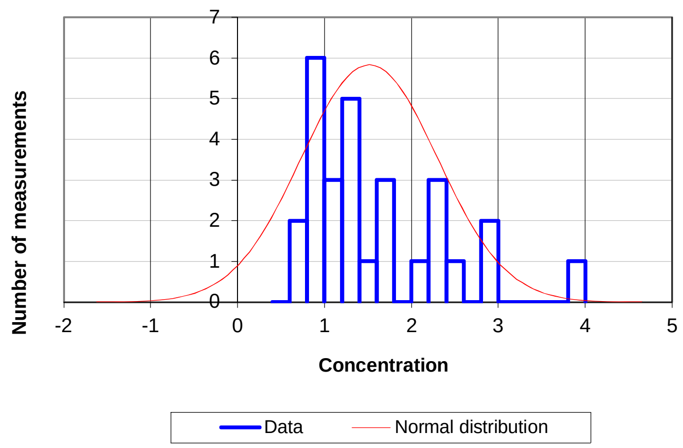
3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots

Q-q plot



Boron



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

290 = GAC (critical conc.) (mg/kg)

28 = no. samples
0 = no. samples > or = GAC
0.6 = min. value
3.8 = max. value
0.4 = laboratory reporting limit (RL)
1.516429 = mean
0 = no. samples at RL
0.784116 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-1946.792 = t_0
1.703 = $t_{(n-1,0.95)}$
1.768786 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-1946.79 = k_0
4.36 = $k_{0.05}$
2.162511 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 2.1625112 GAC = 290 (US95 = 0.007 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

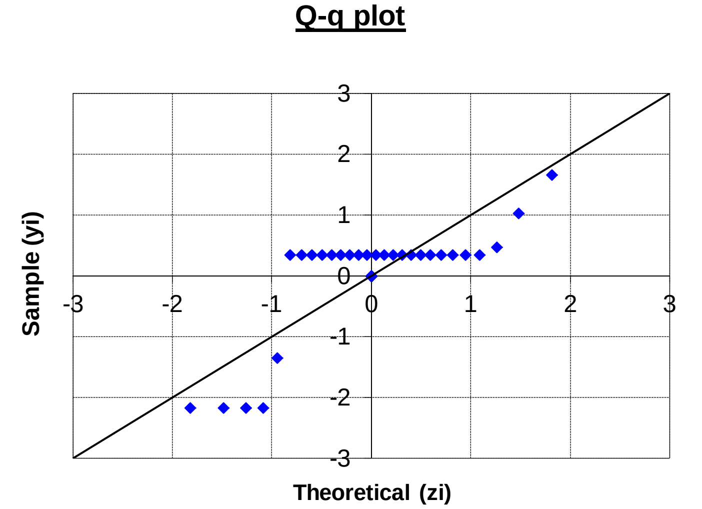
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

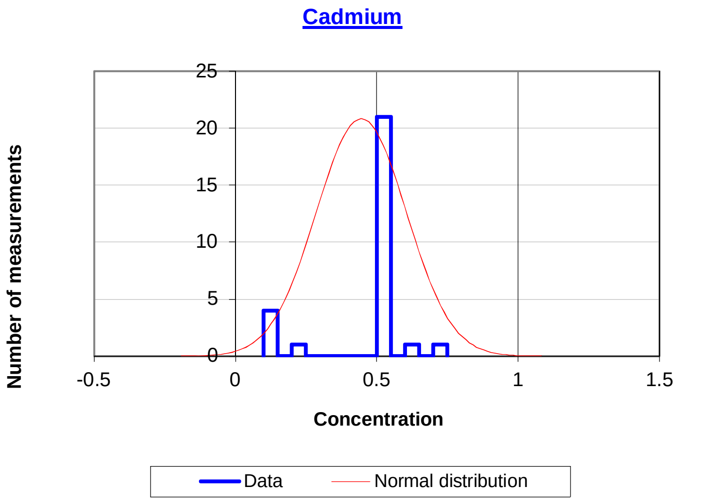
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA	
	Mean Absolute Deviation for potential outliers	
	3.5 = critical value of test statistic	Note - MAD not applicable as 50% or more of values are the same.

Cadmium	Potential Outlier?	Sample
0.1	n/a	HTP02 @ 0.20
0.1	n/a	HTP03 @ 0.50
0.1	n/a	HTP04 @ 0.10
0.1	n/a	HTP05 @ 0.50
0.23	n/a	HTP06 @ 0.10
0.61	n/a	TP1 @ 0.4
0.5	n/a	TP1 @ 0.90m
0.5	n/a	TP2 @ 0.5
0.5	n/a	TP2 @ 1.5
0.5	n/a	TP3 @ 0.1
0.5	n/a	TP3 @ 0.5
0.5	n/a	TP3 @ 1.8
0.5	n/a	TP4 @ 0.6
0.5	n/a	TP4 @ 1.5
0.5	n/a	TP7 @ 0.2
0.52	n/a	TP7 @ 0.7
0.5	n/a	TP10 @ 0.9
0.71	n/a	TP11 @ 0.3
0.5	n/a	TP12 @ 0.2
0.5	n/a	TP12 @ 0.4
0.5	n/a	TP13 @ 0.3
0.5	n/a	TP13 @ 0.8
0.5	n/a	TP14 @ 0.4
0.5	n/a	TP15 @ 2.7
0.5	n/a	TP16 @ 0.4
0.5	n/a	TP16 @ 0.7
0.5	n/a	TP23 @ 0.4
0.5	n/a	TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

11 = GAC (critical conc.) (mg/kg)

28 = no. samples	0 = no. samples > or = GAC
0.1 = min. value	
0.71 = max. value	0.1 = laboratory reporting limit (RL)
0.445357 = mean	4 = no. samples at RL
0.159385 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-350.4089 = t_0	-350.409 = k_0
1.703 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.496653 = 95% UCL (US_{95})	0.576684 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.5766844 GAC = 11 (US95 = 0.052 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)

Client: Bovis Barratt and Taylor Wimpey

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

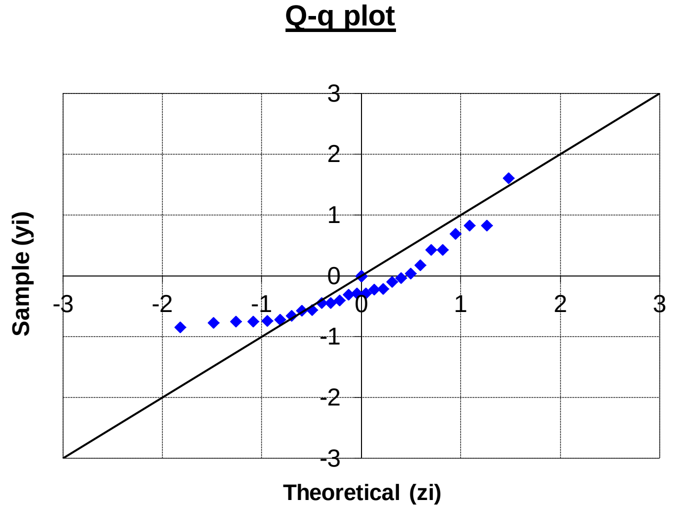
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

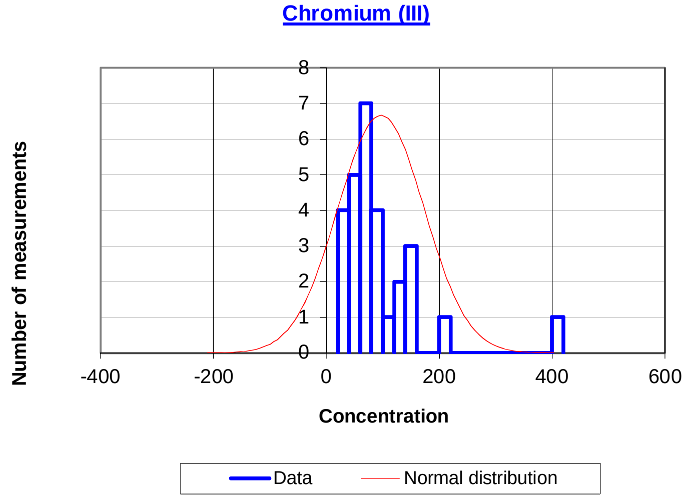
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Chromium (III)	Potential Outlier?	Sample
46.5		HTP02 @ 0.20
149.5		HTP03 @ 0.50
99.5		HTP04 @ 0.10
74.5		HTP05 @ 0.50
79.5		HTP06 @ 0.10
410	Yes	TP1 @ 0.4
159.9		TP1 @ 0.90m
38.89		TP2 @ 0.5
31.9		TP2 @ 1.5
74.9		TP3 @ 0.1
63		TP3 @ 0.5
129.9		TP3 @ 1.8
62.88		TP4 @ 0.6
37.67		TP4 @ 1.5
80		TP7 @ 0.2
109.85		TP7 @ 0.7
39		TP10 @ 0.9
72.85		TP11 @ 0.3
66		TP12 @ 0.2
129.9		TP12 @ 0.4
94		TP13 @ 0.3
159.9		TP13 @ 0.8
53.76		TP14 @ 0.4
41.7		TP15 @ 2.7
53		TP16 @ 0.4
219.9		TP16 @ 0.7
40		TP23 @ 0.4
89		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
630 = GAC (critical conc.) (mg/kg)
28 = no. samples
31.9 = min. value
410 = max. value
96.69286 = mean
76.68242 = standard deviation
0 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-36.80109 = t_0
1.703 = $t_{(n-1,0.95)}$
121.3721 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-36.8011 = k_0
4.36 = $k_{0.05}$
159.8763 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 159.8763 GAC = 630 (US95 = 0.254 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

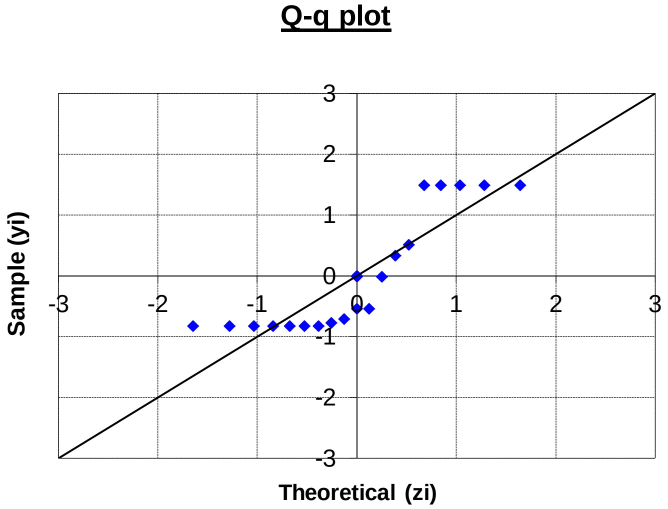
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

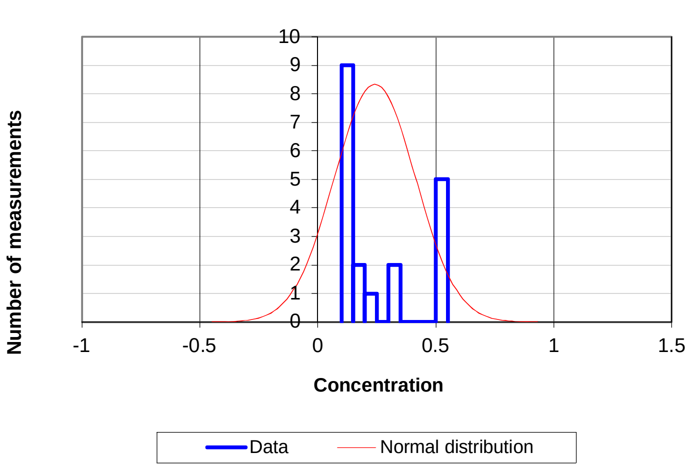
Chromium (VI)	Potential Outlier?	Sample
0.5	Yes	HTP02 @ 0.20
0.5	Yes	HTP03 @ 0.50
0.5	Yes	HTP04 @ 0.10
0.5	Yes	HTP05 @ 0.50
0.5	Yes	HTP06 @ 0.10
0.1		TP1 @ 0.90m
0.11		TP2 @ 0.5
0.1		TP2 @ 1.5
0.1		TP3 @ 0.1
0.1		TP3 @ 1.8
0.12		TP4 @ 0.6
0.33		TP4 @ 1.5
0.15		TP7 @ 0.7
0.15		TP11 @ 0.3
0.1		TP12 @ 0.4
0.1		TP13 @ 0.8
0.24		TP14 @ 0.4
0.3		TP15 @ 2.7
0.1		TP16 @ 0.7

Visual assessment - Q-q & histogram plots

Q-q plot



Chromium (VI)



Basic data — Risk parameter

Human health - residential with plant uptake (2.5%SOM)

4.3 = GAC (critical conc.) (mg/kg)

19 = no. samples
0.1 = min. value
0.5 = max. value
0.242105 = mean
0.172291 = standard deviation

0 = no. samples > or = GAC
0.5 = laboratory reporting limit (RL)
19 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-102.6632 = t_0
1.734 = $t_{(n-1,0.95)}$
0.310644 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-102.663 = k_0
4.36 = $k_{0.05}$
0.41444 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.4144398 GAC = 4.3 (US95 = 0.096 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

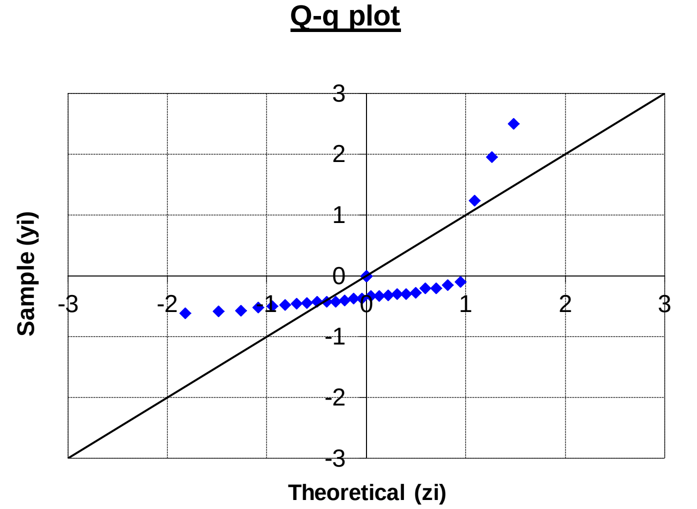
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

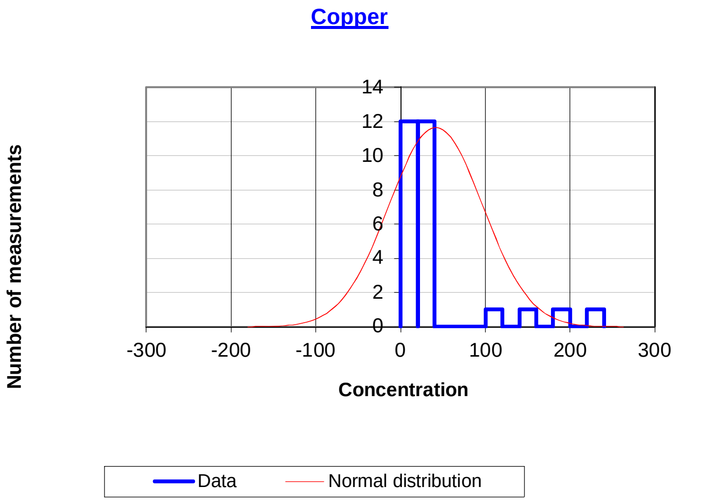
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Copper	Potential Outlier?	Sample
18		HTP02 @ 0.20
36		HTP03 @ 0.50
26		HTP04 @ 0.10
18		HTP05 @ 0.50
150	Yes	HTP06 @ 0.10
7.3		TP1 @ 0.4
33		TP1 @ 0.90m
23		TP2 @ 0.5
13		TP2 @ 1.5
180	Yes	TP3 @ 0.1
23		TP3 @ 0.5
16		TP3 @ 1.8
21		TP4 @ 0.6
19		TP4 @ 1.5
25		TP7 @ 0.2
110	Yes	TP7 @ 0.7
24		TP10 @ 0.9
230	Yes	TP11 @ 0.3
25		TP12 @ 0.2
17		TP12 @ 0.4
30		TP13 @ 0.3
30		TP13 @ 0.8
21		TP14 @ 0.4
15		TP15 @ 2.7
18		TP16 @ 0.4
14		TP16 @ 0.7
9.5		TP23 @ 0.4
10		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
2300 = GAC (critical conc.) (mg/kg)
28 = no. samples
7.3 = min. value
230 = max. value
41.49286 = mean
55.45507 = standard deviation
0 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-215.5059 = t_0
1.703 = $t_{(n-1,0.95)}$
59.34034 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-215.506 = k_0
4.36 = $k_{0.05}$
87.18576 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 87.185755 GAC = 2300 (US95 = 0.038 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

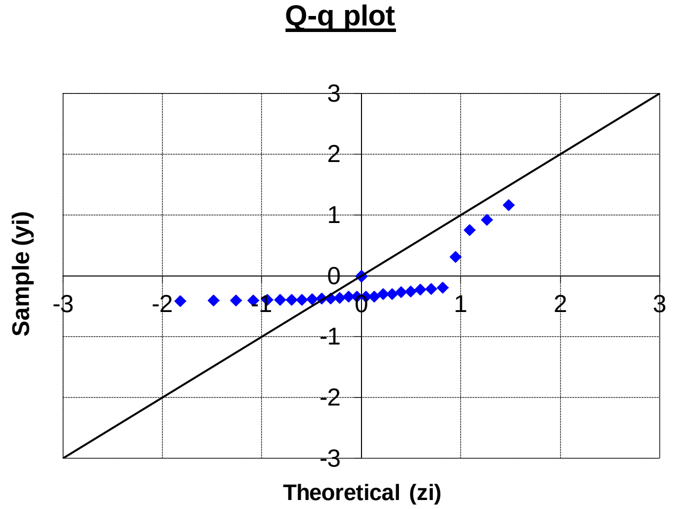
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

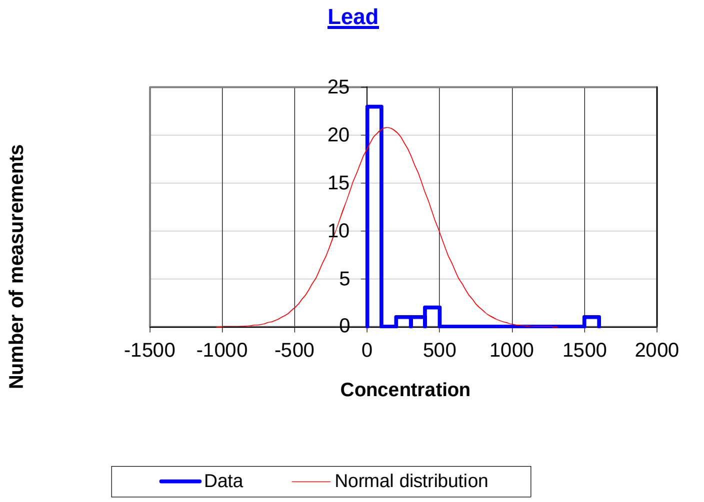
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Lead	Potential Outlier?	Sample
39		HTP02 @ 0.20
230	Yes	HTP03 @ 0.50
52		HTP04 @ 0.10
30		HTP05 @ 0.50
480	Yes	HTP06 @ 0.10
40		TP1 @ 0.4
75		TP1 @ 0.90m
62		TP2 @ 0.5
17		TP2 @ 1.5
410	Yes	TP3 @ 0.1
24		TP3 @ 0.5
33		TP3 @ 1.8
51		TP4 @ 0.6
20		TP4 @ 1.5
64		TP7 @ 0.2
360	Yes	TP7 @ 0.7
29		TP10 @ 0.9
1500	Yes	TP11 @ 0.3
40		TP12 @ 0.2
40		TP12 @ 0.4
74		TP13 @ 0.3
81		TP13 @ 0.8
23		TP14 @ 0.4
22		TP15 @ 2.7
21		TP16 @ 0.4
22		TP16 @ 0.7
19		TP23 @ 0.4
25		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

450 = GAC (critical conc.) (mg/kg)

28 = no. samples
17 = min. value
1500 = max. value
138.6786 = mean
294.188 = standard deviation

2 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-5.599678 = t_0
1.703 = $t_{(n-1,0.95)}$
233.3591 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-5.59968 = k_0
4.36 = $k_{0.05}$
381.0785 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 381.07849 GAC = 450 (US95 = 0.847 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

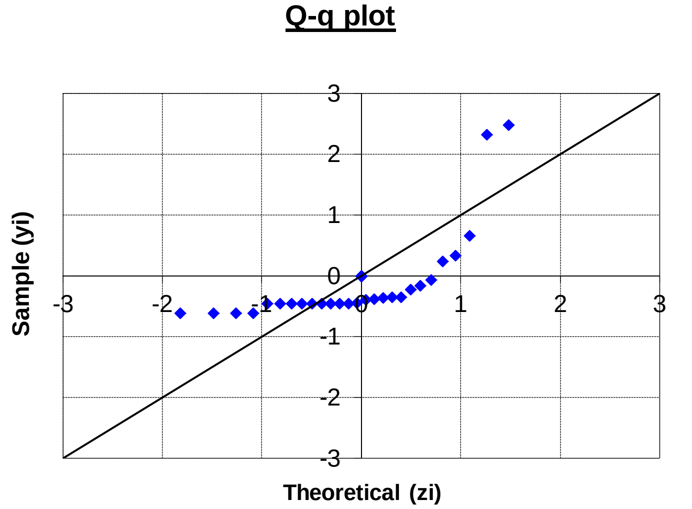
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

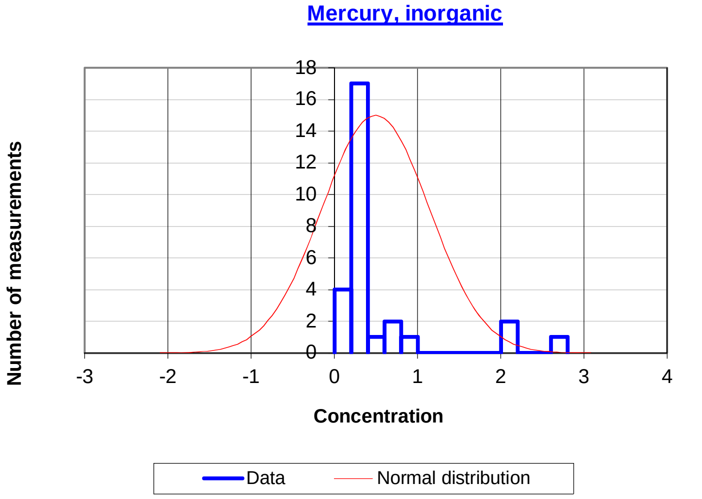
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Mercury, inorganic	Potential Outlier?	Sample
0.1		HTP02 @ 0.20
0.1		HTP03 @ 0.50
0.1		HTP04 @ 0.10
0.1		HTP05 @ 0.50
0.71	Yes	HTP06 @ 0.10
0.27		TP1 @ 0.4
0.92	Yes	TP1 @ 0.90m
0.65	Yes	TP2 @ 0.5
0.24		TP2 @ 1.5
2.1	Yes	TP3 @ 0.1
0.2		TP3 @ 0.5
0.39		TP3 @ 1.8
0.21		TP4 @ 0.6
0.2		TP4 @ 1.5
0.27		TP7 @ 0.2
2.6	Yes	TP7 @ 0.7
0.2		TP10 @ 0.9
2	Yes	TP11 @ 0.3
0.2		TP12 @ 0.2
0.25		TP12 @ 0.4
0.35		TP13 @ 0.3
0.45		TP13 @ 0.8
0.2		TP14 @ 0.4
0.2		TP15 @ 2.7
0.2		TP16 @ 0.4
0.26		TP16 @ 0.7
0.2		TP23 @ 0.4
0.2		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter

Human health - residential with plant uptake (2.5%SOM)

170 = GAC (critical conc.) (mg/kg)

28 = no. samples
0.1 = min. value
2.6 = max. value
0.495357 = mean
0.647705 = standard deviation

0 = no. samples > or = GAC
0.1 = laboratory reporting limit (RL)
4 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-1384.788 = t_0
1.703 = $t_{(n-1,0.95)}$
0.703812 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-1384.79 = k_0
4.36 = $k_{0.05}$
1.029042 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 1.029042 GAC = 170 (US95 = 0.006 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

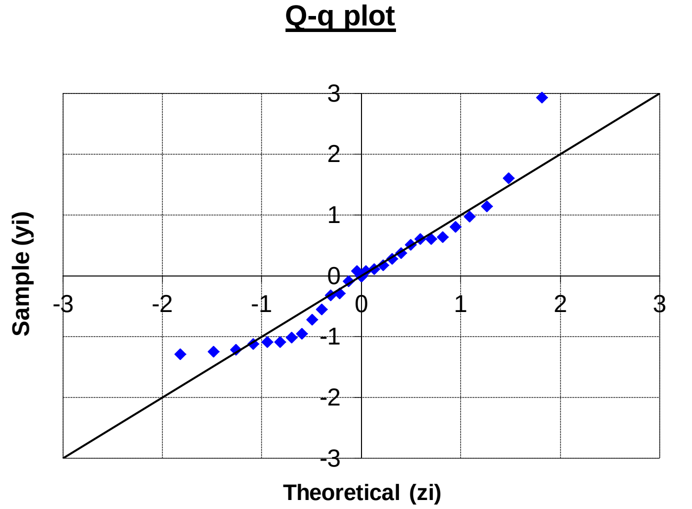
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

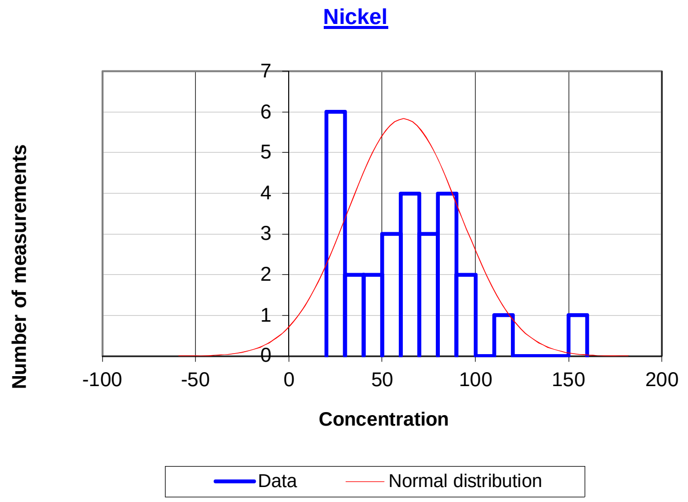
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Nickel	Potential Outlier?	Sample
25		HTP02 @ 0.20
64		HTP03 @ 0.50
67		HTP04 @ 0.10
45		HTP05 @ 0.50
53		HTP06 @ 0.10
150		TP1 @ 0.4
80		TP1 @ 0.90m
23		TP2 @ 0.5
28		TP2 @ 1.5
52		TP3 @ 0.1
80		TP3 @ 0.5
59		TP3 @ 1.8
31		TP4 @ 0.6
33		TP4 @ 1.5
81		TP7 @ 0.2
64		TP7 @ 0.7
70		TP10 @ 0.9
77		TP11 @ 0.3
110		TP12 @ 0.2
65		TP12 @ 0.4
91		TP13 @ 0.3
73		TP13 @ 0.8
40		TP14 @ 0.4
29		TP15 @ 2.7
29		TP16 @ 0.4
96		TP16 @ 0.7
24		TP23 @ 0.4
86		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

130 = GAC (critical conc.) (mg/kg)

28 = no. samples	1 = no. samples > or = GAC
23 = min. value	
150 = max. value	5 = laboratory reporting limit (RL)
61.60714 = mean	0 = no. samples at RL
30.12977 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-12.01141 = t_0	-12.0114 = k_0
1.703 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
71.30401 = 95% UCL (US_{95})	86.43294 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 86.432943 GAC = 130 (US95 = 0.665 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

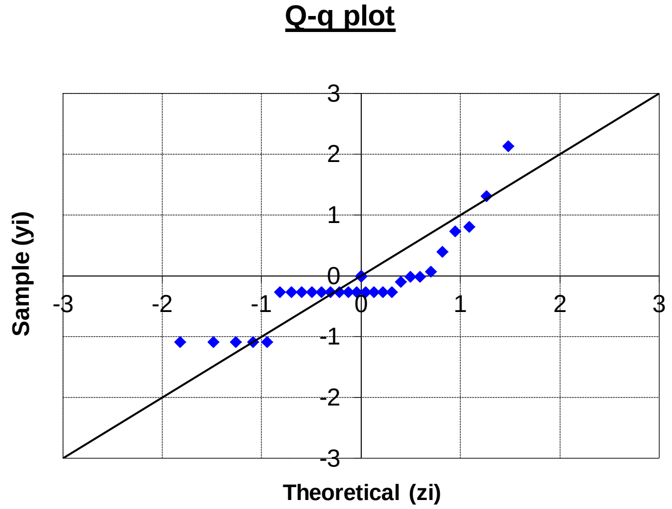
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

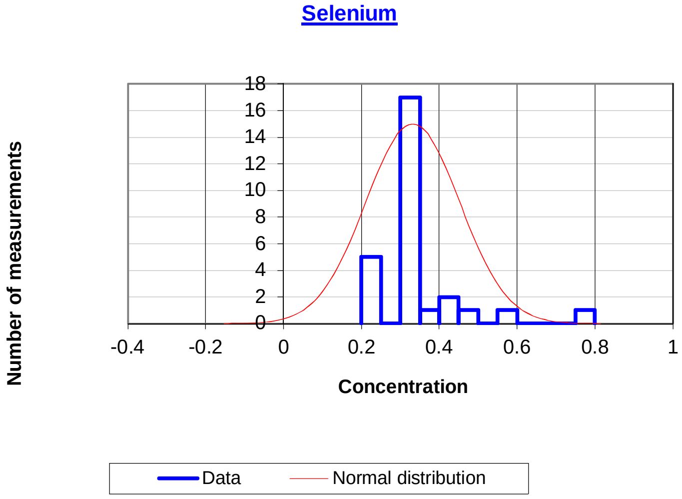
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Selenium	Potential Outlier?	Sample
0.2		HTP02 @ 0.20
0.2		HTP03 @ 0.50
0.2		HTP04 @ 0.10
0.2		HTP05 @ 0.50
0.2		HTP06 @ 0.10
0.3		TP1 @ 0.4
0.38		TP1 @ 0.90m
0.3		TP2 @ 0.5
0.3		TP2 @ 1.5
0.49	Yes	TP3 @ 0.1
0.3		TP3 @ 0.5
0.33		TP3 @ 1.8
0.32		TP4 @ 0.6
0.3		TP4 @ 1.5
0.3		TP7 @ 0.2
0.76	Yes	TP7 @ 0.7
0.3		TP10 @ 0.9
0.59	Yes	TP11 @ 0.3
0.43	Yes	TP12 @ 0.2
0.3		TP12 @ 0.4
0.42		TP13 @ 0.3
0.33		TP13 @ 0.8
0.3		TP14 @ 0.4
0.34		TP15 @ 2.7
0.3		TP16 @ 0.4
0.3		TP16 @ 0.7
0.3		TP23 @ 0.4
0.3		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

350 = GAC (critical conc.) (mg/kg)

28 = no. samples
0.2 = min. value
0.76 = max. value
0.331786 = mean
0.120955 = standard deviation

0 = no. samples > or = GAC
0.2 = laboratory reporting limit (RL)
5 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-15297.22 = t_0
1.703 = $t_{(n-1,0.95)}$
0.370713 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-15297.2 = k_0
4.36 = $k_{0.05}$
0.431448 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.4314478 GAC = 350 (US95 = 0.001 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

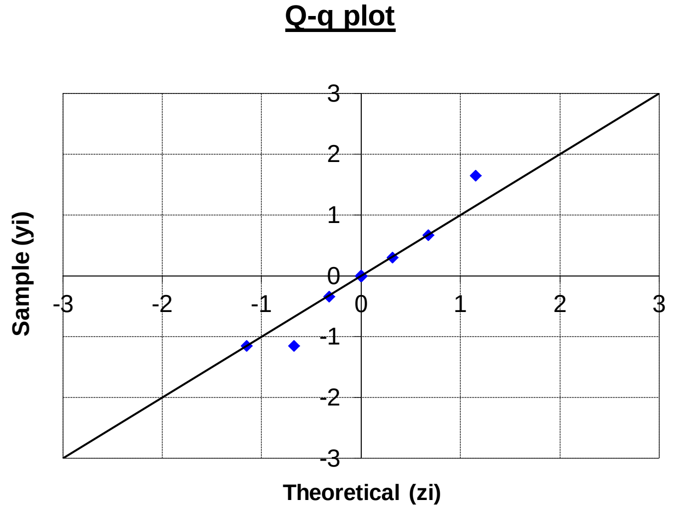
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Vanadium		
67		HTP02 @ 0.20
230		HTP03 @ 0.50
150		HTP04 @ 0.10
95		HTP05 @ 0.50
120		HTP06 @ 0.10
0.5		TP1 @ 0.4
0.5		TP1 @ 0.90m

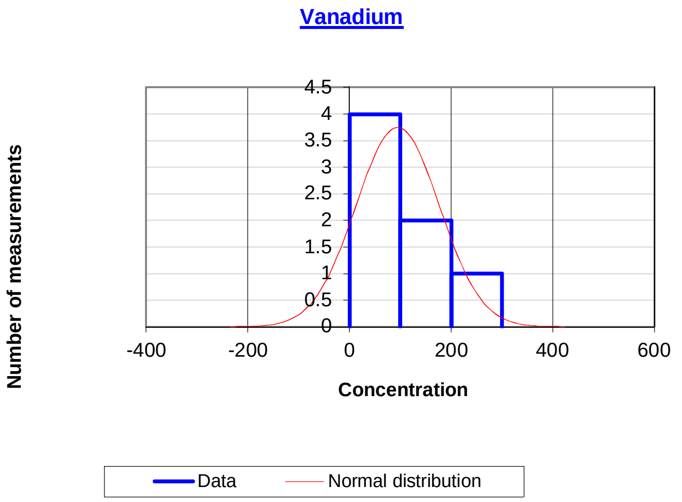
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

74 = GAC (critical conc.) (mg/kg)

7 = no. samples	4 = no. samples > or = GAC
0.5 = min. value	
230 = max. value	5 = laboratory reporting limit (RL)
94.71429 = mean (mean>GAC)	2 = no. samples at RL
82.17758 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
0.666908 = t_0	0.666908 = k_0
1.943 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
155.0643 = 95% UCL (US_{95})	230.1368 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho accepted, true mean >GAC

US_{95} = 230.13678 GAC = 74 (US95 = 3.11 x GAC)

Site reference **FURTHER ASSESSMENT REQUIRED**

Data set: Tip Area (COMBINED)

Client: Bovis Barratt and Taylor Wimpey

Site: Land at Bankside, Banbury

Job no: C12702

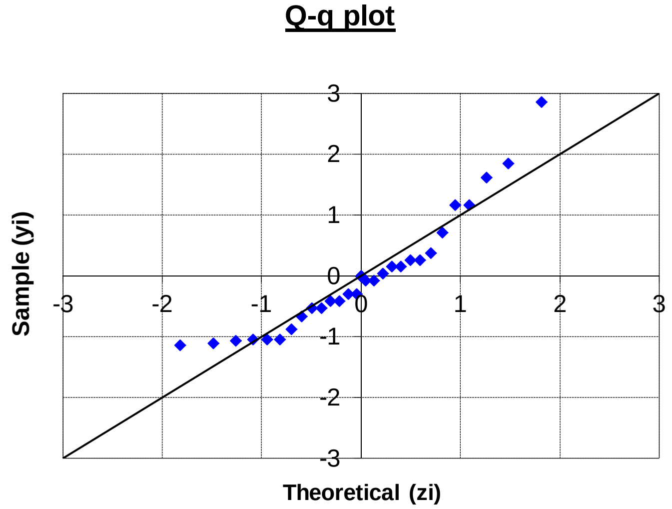
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

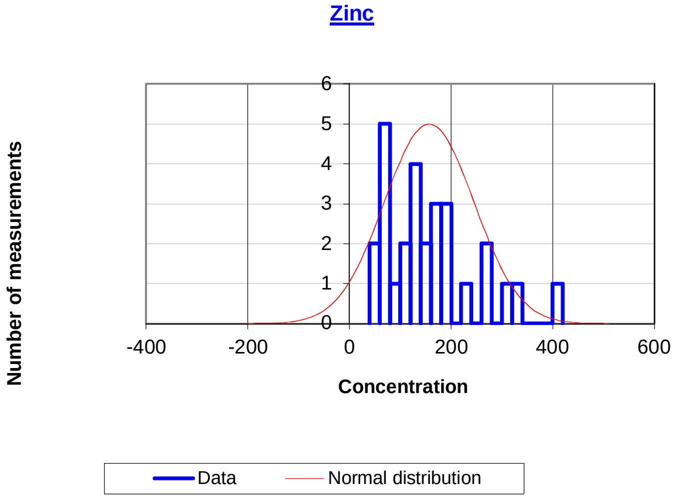
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Zinc	**Potential Outlier?**	**Sample**
79		HTP02 @ 0.20
170		HTP03 @ 0.50
190		HTP04 @ 0.10
110		HTP05 @ 0.50
410	Yes	HTP06 @ 0.10
260		TP1 @ 0.4
180		TP1 @ 0.90m
130		TP2 @ 0.5
64		TP2 @ 1.5
300		TP3 @ 0.1
59		TP3 @ 0.5
160		TP3 @ 1.8
98		TP4 @ 0.6
64		TP4 @ 1.5
130		TP7 @ 0.2
260		TP7 @ 0.7
64		TP10 @ 0.9
320		TP11 @ 0.3
120		TP12 @ 0.2
150		TP12 @ 0.4
170		TP13 @ 0.3
180		TP13 @ 0.8
120		TP14 @ 0.4
56		TP15 @ 2.7
110		TP16 @ 0.4
150		TP16 @ 0.7
62		TP23 @ 0.4
220		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter
Human health - residential with plant uptake (2.5%SOM)
3700 = GAC (critical conc.) (mg/kg)

28 = no. samples	0 = no. samples > or = GAC
56 = min. value	
410 = max. value	10 = laboratory reporting limit (RL)
156.6429 = mean	0 = no. samples at RL
88.56018 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-211.7169 = t_0	-211.717 = k_0
1.703 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
185.1448 = 95% UCL (US_{95})	229.6131 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 229.61313 GAC = 3700 (US95 = 0.062 x GAC)

Site reference — **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

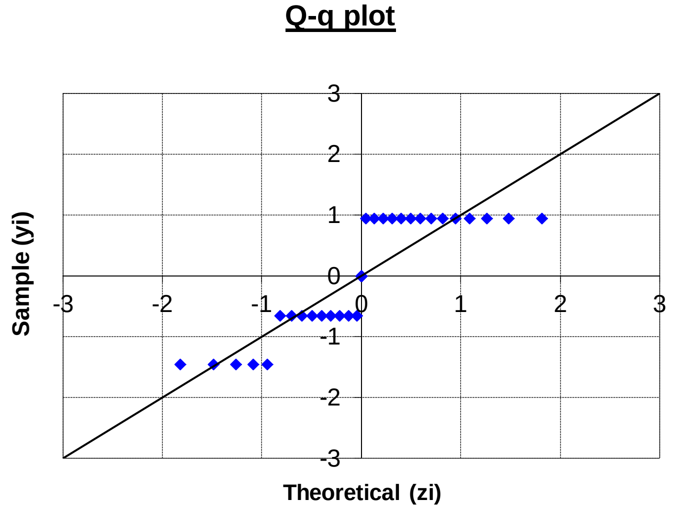
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

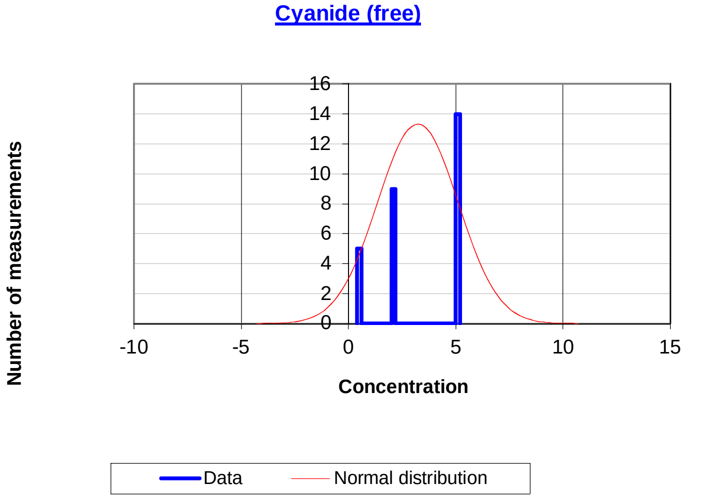
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Cyanide (free)	Potential Outlier?	Sample
0.5		HTP02 @ 0.20
0.5		HTP03 @ 0.50
0.5		HTP04 @ 0.10
0.5		HTP05 @ 0.50
0.5		HTP06 @ 0.10
2		TP1 @ 0.4
5		TP1 @ 0.90m
5		TP2 @ 0.5
5		TP2 @ 1.5
5		TP3 @ 0.1
2		TP3 @ 0.5
5		TP3 @ 1.8
5		TP4 @ 0.6
5		TP4 @ 1.5
2		TP7 @ 0.2
5		TP7 @ 0.7
2		TP10 @ 0.9
5		TP11 @ 0.3
2		TP12 @ 0.2
5		TP12 @ 0.4
2		TP13 @ 0.3
5		TP13 @ 0.8
5		TP14 @ 0.4
5		TP15 @ 2.7
2		TP16 @ 0.4
5		TP16 @ 0.7
2		TP23 @ 0.4
2		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

750 = GAC (critical conc.) (mg/kg)

28 = no. samples	0 = no. samples > or = GAC
0.5 = min. value	
5 = max. value	0.5 = laboratory reporting limit (RL)
3.232143 = mean	5 = no. samples at RL
1.873213 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-2109.49 = t_0	-2109.49 = k_0
1.703 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
3.835012 = 95% UCL (US_{95})	4.775601 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 4.7756006 GAC = 750 (US95 = 0.006 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

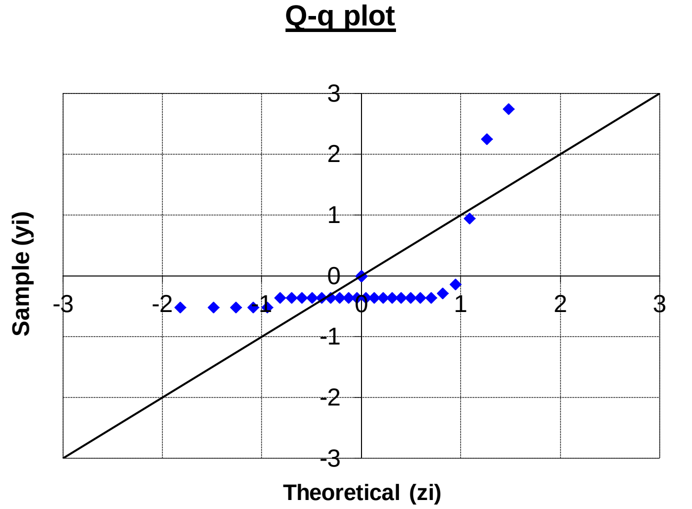
3.5 = critical value of test statistic

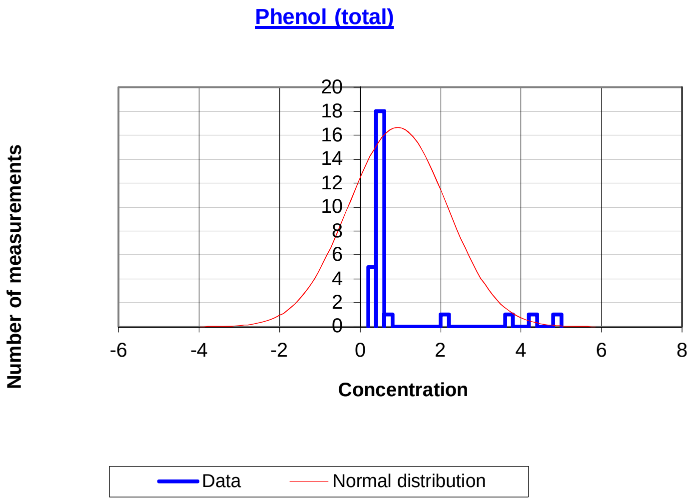
Note - MAD not applicable as 50% or more of values are the same.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

Phenol (total)	Potential Outlier?	Sample
0.3	n/a	HTP02 @ 0.20
0.3	n/a	HTP03 @ 0.50
0.3	n/a	HTP04 @ 0.10
0.3	n/a	HTP05 @ 0.50
0.3	n/a	HTP06 @ 0.10
0.5	n/a	TP1 @ 0.4
4.3	n/a	TP1 @ 0.90m
0.5	n/a	TP2 @ 0.5
0.5	n/a	TP2 @ 1.5
3.7	n/a	TP3 @ 0.1
0.5	n/a	TP3 @ 0.5
0.5	n/a	TP3 @ 1.8
0.5	n/a	TP4 @ 0.6
0.5	n/a	TP4 @ 1.5
0.5	n/a	TP7 @ 0.2
4.8	n/a	TP7 @ 0.7
0.5	n/a	TP10 @ 0.9
2.1	n/a	TP11 @ 0.3
0.5	n/a	TP12 @ 0.2
0.5	n/a	TP12 @ 0.4
0.5	n/a	TP13 @ 0.3
0.58	n/a	TP13 @ 0.8
0.5	n/a	TP14 @ 0.4
0.76	n/a	TP15 @ 2.7
0.5	n/a	TP16 @ 0.4
0.5	n/a	TP16 @ 0.7
0.5	n/a	TP23 @ 0.4
0.5	n/a	TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

290 = GAC (critical conc.) (mg/kg)

28 = no. samples | 0 = no. samples > or = GAC

0.3 = min. value

4.8 = max. value | 0.3 = laboratory reporting limit (RL)

0.937143 = mean | 5 = no. samples at RL

1.227062 = standard deviation | RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-1246.536 = t_0	-1246.54 = k_0
1.703 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
1.332056 = 95% UCL (US_{95})	1.948196 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 1.9481957 GAC = 290 (US95 = 0.007 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)

Client: Bovis Barratt and Taylor Wimpey

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

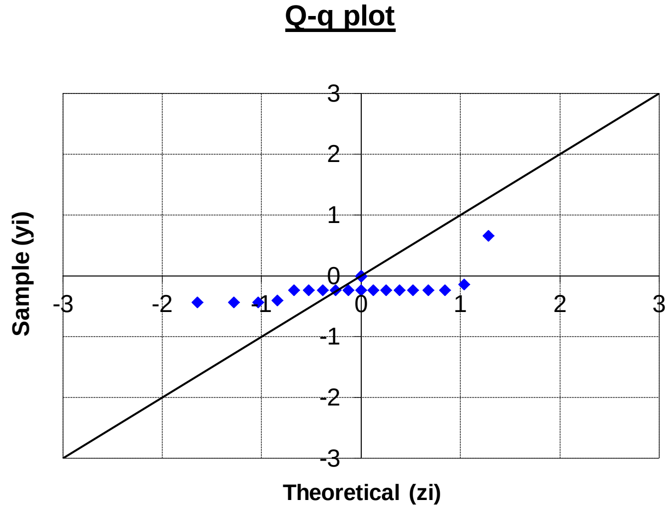
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

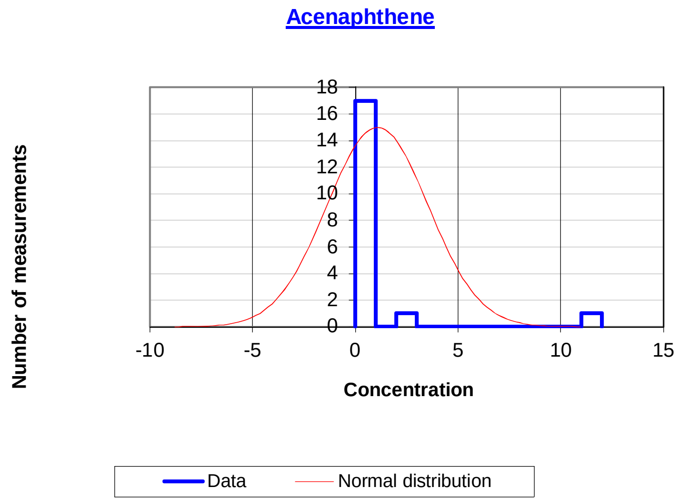
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Acenaphthene	Potential Outlier?	Sample
0.01	n/a	HTP02 @ 0.20
0.088	n/a	HTP03 @ 0.50
0.01	n/a	HTP04 @ 0.10
0.01	n/a	HTP05 @ 0.50
0.73	n/a	HTP06 @ 0.10
0.5	n/a	TP1 @ 0.90m
0.5	n/a	TP2 @ 0.5
0.5	n/a	TP2 @ 1.5
0.5	n/a	TP3 @ 0.1
0.5	n/a	TP3 @ 1.8
0.5	n/a	TP4 @ 0.6
0.5	n/a	TP4 @ 1.5
11	n/a	TP7 @ 0.7
2.7	n/a	TP11 @ 0.3
0.5	n/a	TP12 @ 0.4
0.5	n/a	TP13 @ 0.8
0.5	n/a	TP14 @ 0.4
0.5	n/a	TP15 @ 2.7
0.5	n/a	TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
480 = GAC (critical conc.) (mg/kg)
19 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
11 = max. value
0.01 = laboratory reporting limit (RL)
1.081474 = mean
3 = no. samples at RL
2.467667 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-845.9641 = t_0
1.734 = $t_{(n-1,0.95)}$
2.063128 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-845.964 = k_0
4.36 = $k_{0.05}$
3.549764 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 3.5497637 GAC = 480 (US95 = 0.007 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

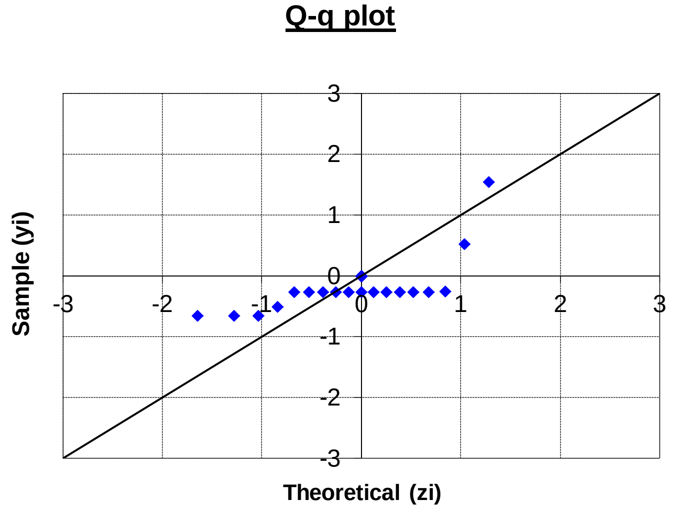
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

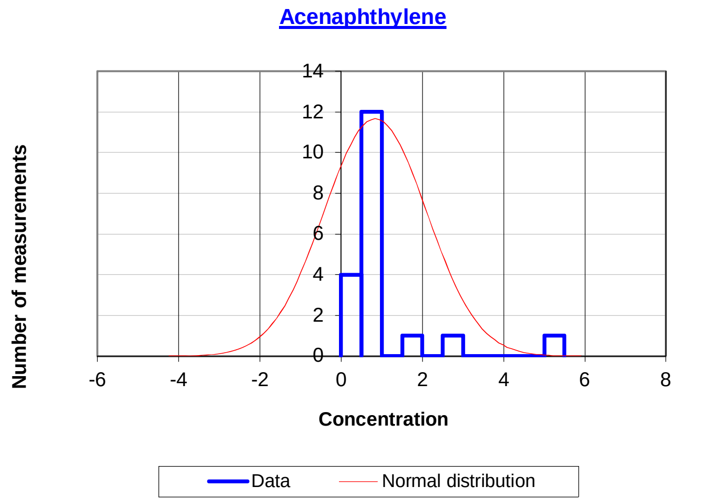
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Acenaphthylene	Potential Outlier?	Sample
0.01	n/a	HTP02 @ 0.20
0.2	n/a	HTP03 @ 0.50
0.01	n/a	HTP04 @ 0.10
0.01	n/a	HTP05 @ 0.50
2.8	n/a	HTP06 @ 0.10
0.5	n/a	TP1 @ 0.90m
0.5	n/a	TP2 @ 0.5
0.5	n/a	TP2 @ 1.5
5.4	n/a	TP3 @ 0.1
0.5	n/a	TP3 @ 1.8
0.5	n/a	TP4 @ 0.6
0.5	n/a	TP4 @ 1.5
1.5	n/a	TP7 @ 0.7
0.51	n/a	TP11 @ 0.3
0.5	n/a	TP12 @ 0.4
0.5	n/a	TP13 @ 0.8
0.5	n/a	TP14 @ 0.4
0.5	n/a	TP15 @ 2.7
0.5	n/a	TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
400 = GAC (critical conc.) (mg/kg)

19 = no. samples	0 = no. samples > or = GAC
0.01 = min. value	
5.4 = max. value	0.01 = laboratory reporting limit (RL)
0.838947 = mean	3 = no. samples at RL
1.26771 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-1372.477 = t_0	-1372.48 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
1.343251 = 95% UCL (US_{95})	2.106977 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 2.1069772 GAC = 400 (US95 = 0.005 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

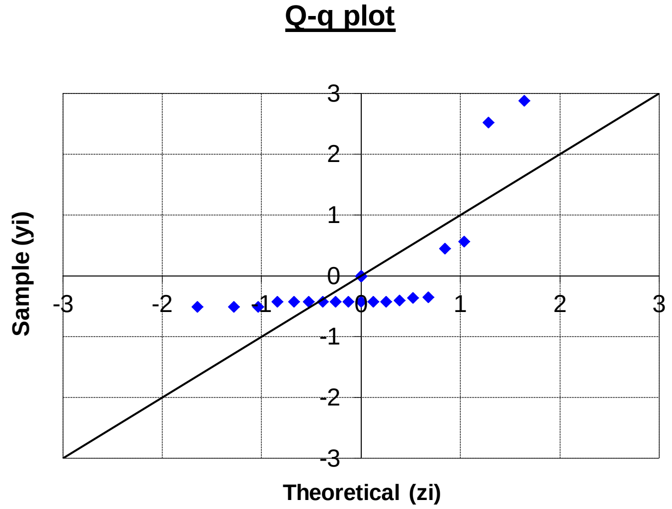
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

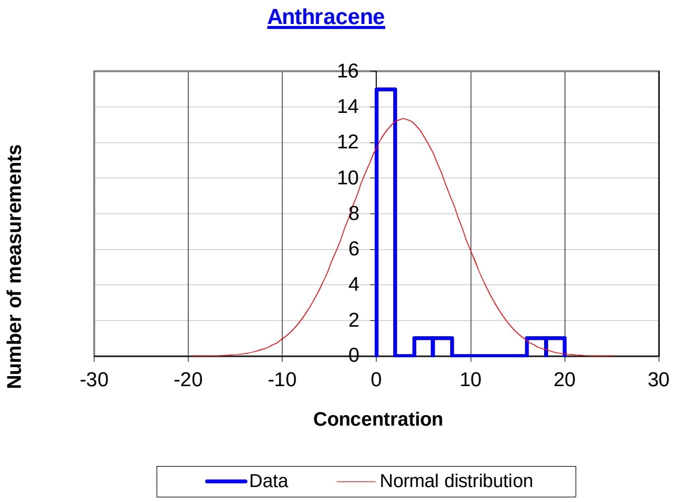
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Mean Absolute Deviation for potential outliers 3.5 = critical value of test statistic	
Anthracene	Potential Outlier?	Sample
0.01	Yes	HTP02 @ 0.20
0.47		HTP03 @ 0.50
0.01	Yes	HTP04 @ 0.10
0.013	Yes	HTP05 @ 0.50
6	Yes	HTP06 @ 0.10
0.92	Yes	TP1 @ 0.90m
0.85		TP2 @ 0.5
0.5		TP2 @ 1.5
17	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
0.5		TP4 @ 0.6
0.5		TP4 @ 1.5
19	Yes	TP7 @ 0.7
5.4	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
0.58		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)

4900 = GAC (critical conc.) (mg/kg)

19 = no. samples
0.01 = min. value
19 = max. value
2.855421 = mean
5.599461 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
2 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-3812.181 = t_0
1.734 = $t_{(n-1,0.95)}$
5.082925 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-3812.18 = k_0
4.36 = $k_{0.05}$
8.456297 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 8.4562968 GAC = 4900 (US_{95} = 0.002 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

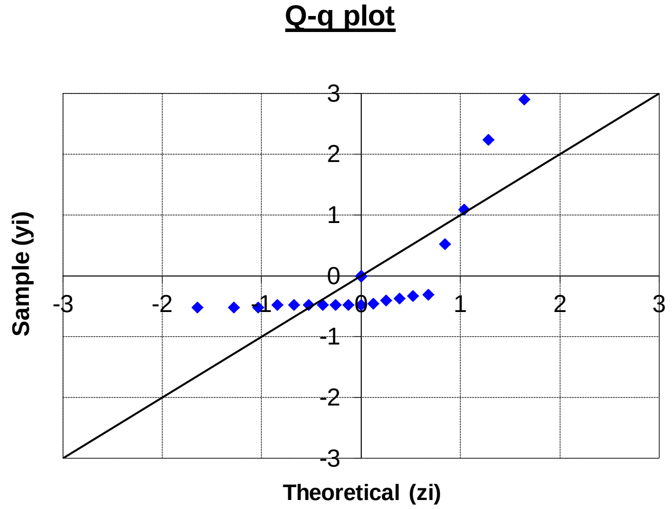
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

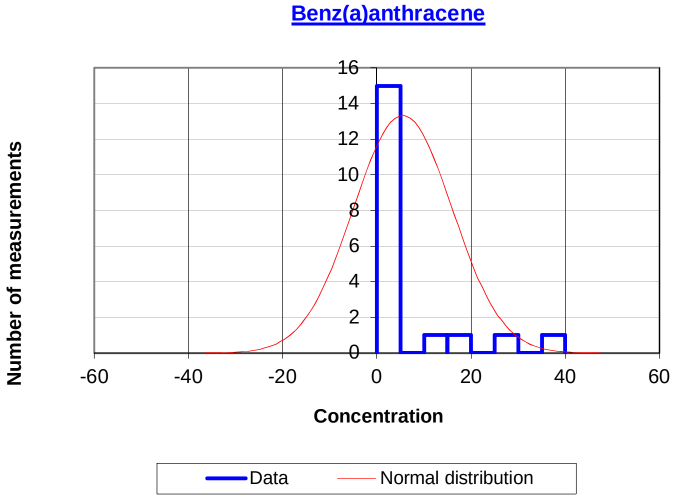
Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

Benz(a)anthracene	Potential Outlier?	Sample
0.04		HTP02 @ 0.20
1.6		HTP03 @ 0.50
0.031		HTP04 @ 0.10
0.11		HTP05 @ 0.50
17	Yes	HTP06 @ 0.10
2		TP1 @ 0.90m
2.3		TP2 @ 0.5
0.5		TP2 @ 1.5
29	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
0.74		TP4 @ 0.6
0.5		TP4 @ 1.5
36	Yes	TP7 @ 0.7
11	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
1.3		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

4.7 = GAC (critical conc.) (mg/kg)

19 = no. samples	4 = no. samples > or = GAC
0.031 = min. value	
36 = max. value	0.01 = laboratory reporting limit (RL)
5.506368 = mean (mean>GAC)	0 = no. samples at RL
10.506 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
0.334559 = t_0	0.334559 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
9.685729 = 95% UCL (US_{95})	16.01503 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho accepted, true mean >GAC
US_{95} = 16.015027 GAC = 4.7 (US95 = 3.407 x GAC)

Site reference **FURTHER ASSESSMENT REQUIRED**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

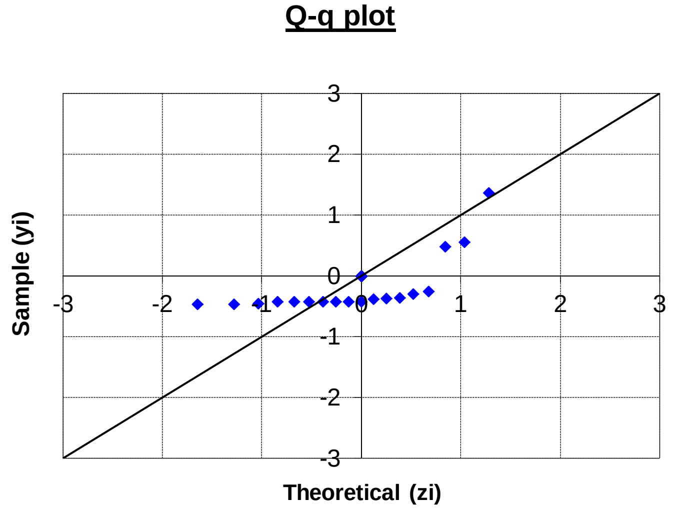
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

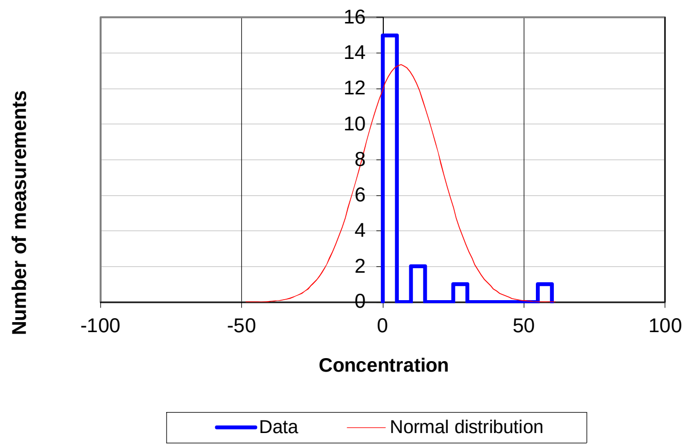
Benzo(a)pyrene	Potential Outlier?	Sample
0.021		HTP02 @ 0.20
1.3		HTP03 @ 0.50
0.017		HTP04 @ 0.10
0.087		HTP05 @ 0.50
14	Yes	HTP06 @ 0.10
2.3		TP1 @ 0.90m
2.8		TP2 @ 0.5
0.5		TP2 @ 1.5
25	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
1.1		TP4 @ 0.6
0.5		TP4 @ 1.5
56	Yes	TP7 @ 0.7
13	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
1.4		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots

Q-q plot



Benzo(a)pyrene



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

0.94 = GAC (critical conc.) (mg/kg)

19 = no. samples
0.017 = min. value
56 = max. value
6.343421 = mean (mean>GAC)
13.70565 = standard deviation

9 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
1.718486 = t_0
1.734 = $t_{(n-1,0.95)}$
11.79562 = 95% UCL (US_{95})

One-sided Chebychev Theorem
1.718486 = k_0
4.36 = $k_{0.05}$
20.05253 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho accepted, true mean >GAC
US_{95} = 20.052534 GAC = 0.94 (US95 = 21.332 x GAC)

FURTHER ASSESSMENT REQUIRED

Site reference
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

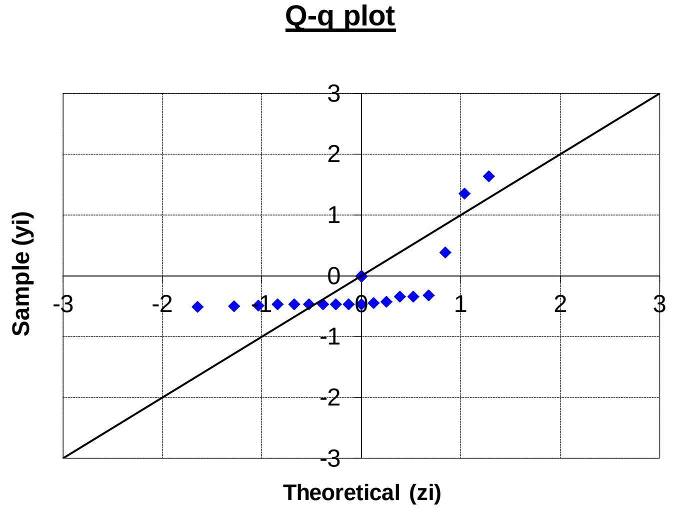
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

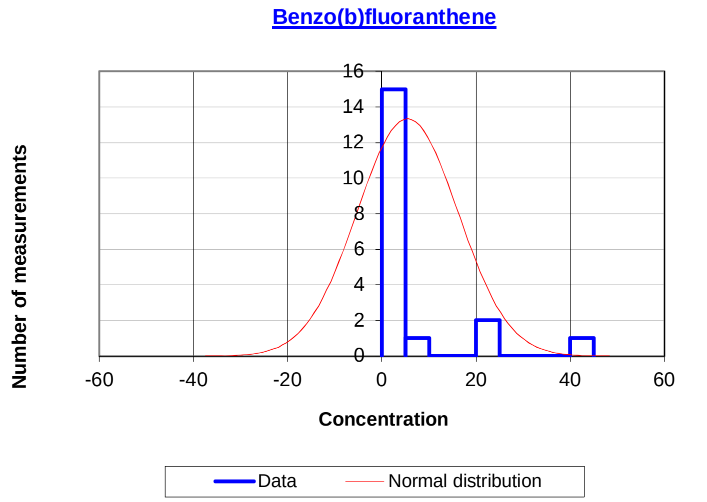
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Benzo(b)fluoranthene	**Potential Outlier?**	**Sample**
0.074		HTP02 @ 0.20
1.8		HTP03 @ 0.50
0.047		HTP04 @ 0.10
0.2		HTP05 @ 0.50
20	**Yes**	HTP06 @ 0.10
1.8		TP1 @ 0.90m
2.1		TP2 @ 0.5
0.5		TP2 @ 1.5
23	**Yes**	TP3 @ 0.1
0.5		TP3 @ 1.8
0.66		TP4 @ 0.6
0.5		TP4 @ 1.5
40	**Yes**	TP7 @ 0.7
9.6	**Yes**	TP11 @ 0.3
0.5		TP12 @ 0.4
0.97		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

6.5 = GAC (critical conc.) (mg/kg)

19 = no. samples	4 = no. samples > or = GAC
0.047 = min. value	
40 = max. value	0.01 = laboratory reporting limit (RL)
5.460579 = mean	0 = no. samples at RL
10.7204 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-0.422627 = t_0	-0.42263 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
9.725226 = 95% UCL (US_{95})	16.18368 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho accepted, true mean >GAC

US_{95} = 16.183682 GAC = 6.5 (US95 = 2.49 x GAC)

FURTHER ASSESSMENT REQUIRED

Site reference

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

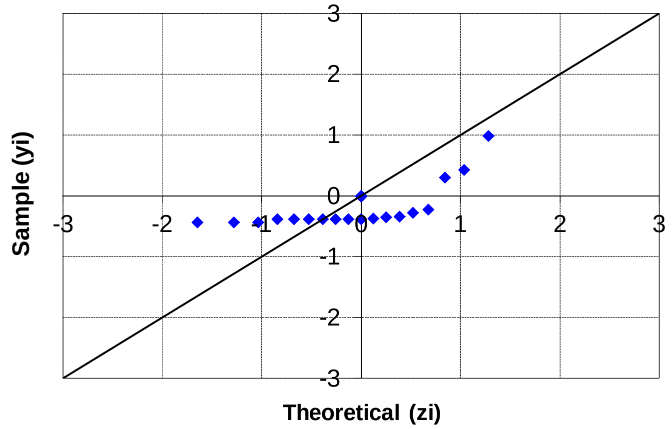
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

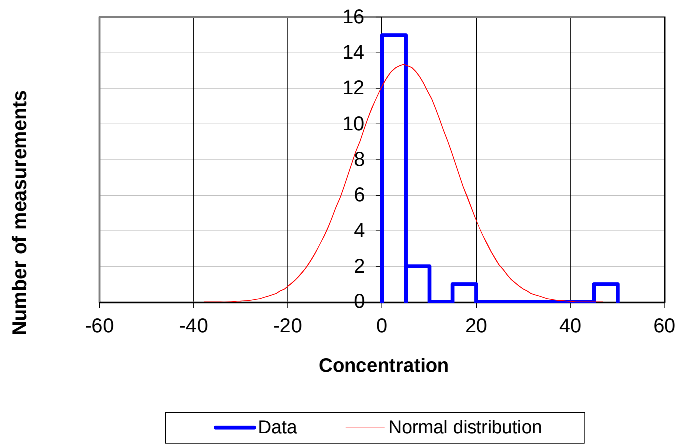
Benzo(ghi)perylene	Potential Outlier?	Sample
0.01		HTP02 @ 0.20
0.67		HTP03 @ 0.50
0.01		HTP04 @ 0.10
0.033		HTP05 @ 0.50
7.8	Yes	HTP06 @ 0.10
1.7		TP1 @ 0.90m
2.2		TP2 @ 0.5
0.5		TP2 @ 1.5
15	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
1		TP4 @ 0.6
0.5		TP4 @ 1.5
45	Yes	TP7 @ 0.7
9.1	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
0.91		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots

Q-q plot



Benzo(ghi)perylene



Basic data — Risk parameter
Human health - residential with plant uptake (2.5%SOM)
46 = GAC (critical conc.) (mg/kg)

19 = no. samples	0 = no. samples > or = GAC
0.01 = min. value	
45 = max. value	0.01 = laboratory reporting limit (RL)
4.575421 = mean	2 = no. samples at RL
10.56107 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-17.09727 = t_0	-17.0973 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
8.776689 = 95% UCL (US_{95})	15.13916 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 15.139163 GAC = 46 (US95 = 0.329 x GAC)

Site reference — **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

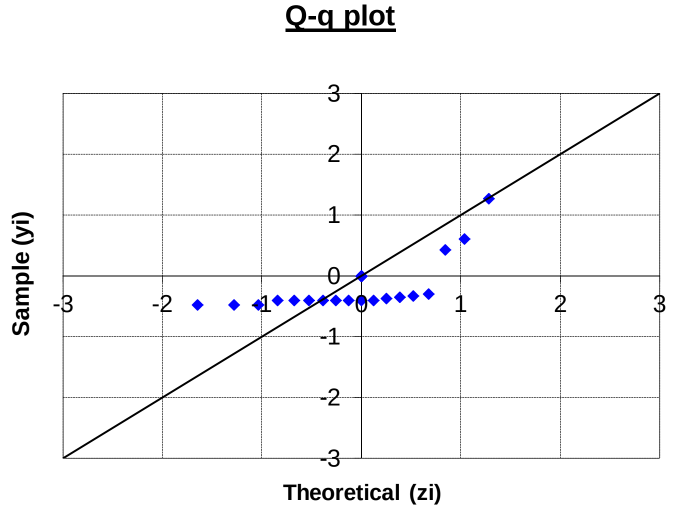
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

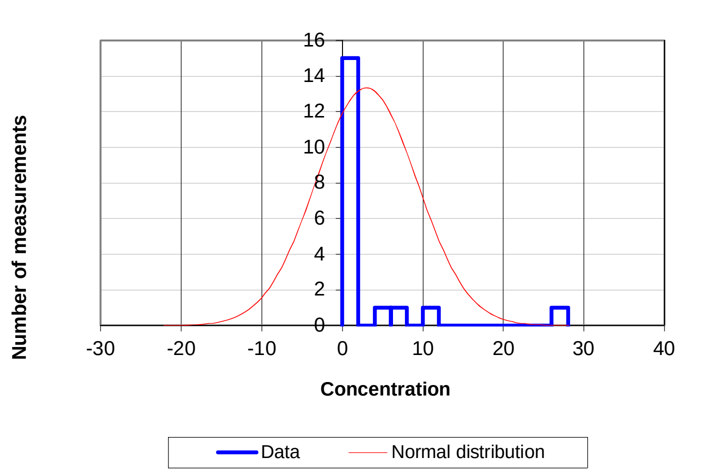
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Benzo(k)fluoranthene	Potential Outlier?	Sample
0.01		HTP02 @ 0.20
0.64		HTP03 @ 0.50
0.012		HTP04 @ 0.10
0.026		HTP05 @ 0.50
5.7	Yes	HTP06 @ 0.10
0.93		TP1 @ 0.90m
1.1		TP2 @ 0.5
0.5		TP2 @ 1.5
11	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
0.5		TP4 @ 0.6
0.5		TP4 @ 1.5
26	Yes	TP7 @ 0.7
6.8	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
0.77		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

9.6 = GAC (critical conc.) (mg/kg)

19 = no. samples
2 = no. samples > or = GAC
0.01 = min. value
26 = max. value
0.01 = laboratory reporting limit (RL)
2.999368 = mean
1 = no. samples at RL
6.279952 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-4.581482 = t_0	-4.58148 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
5.497576 = 95% UCL (US_{95})	9.280907 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 9.2809066 GAC = 9.6 (US95 = 0.967 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

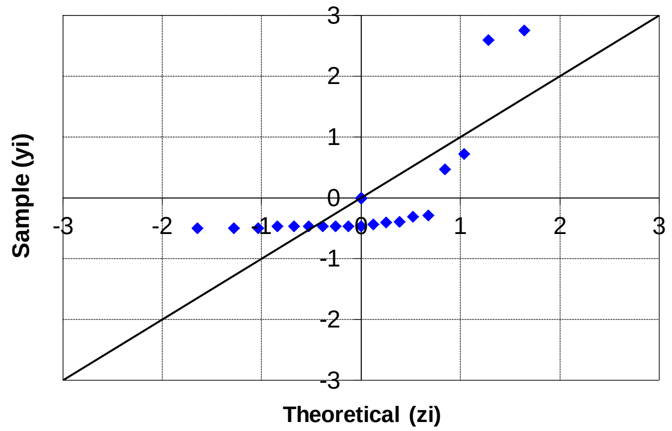
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

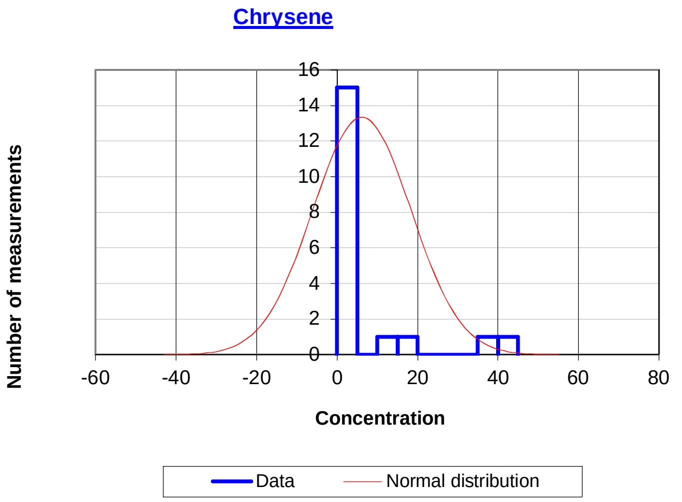
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Chrysene	Potential Outlier?	Sample
0.027		HTP02 @ 0.20
1.3		HTP03 @ 0.50
0.03		HTP04 @ 0.10
0.061		HTP05 @ 0.50
15	Yes	HTP06 @ 0.10
2.4		TP1 @ 0.90m
2.7		TP2 @ 0.5
0.5		TP2 @ 1.5
38	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
0.88		TP4 @ 0.6
0.5		TP4 @ 1.5
40	Yes	TP7 @ 0.7
12	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
1.4		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

8 = GAC (critical conc.) (mg/kg)

19 = no. samples	4 = no. samples > or = GAC
0.027 = min. value	
40 = max. value	0.01 = laboratory reporting limit (RL)
6.173579 = mean	0 = no. samples at RL
12.26576 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-0.649057 = t_0	-0.64906 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
11.05298 = 95% UCL (US_{95})	18.44244 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho accepted, true mean >GAC

US_{95} = 18.442441 GAC = 8 (US95 = 2.305 x GAC)

Site reference **FURTHER ASSESSMENT REQUIRED**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

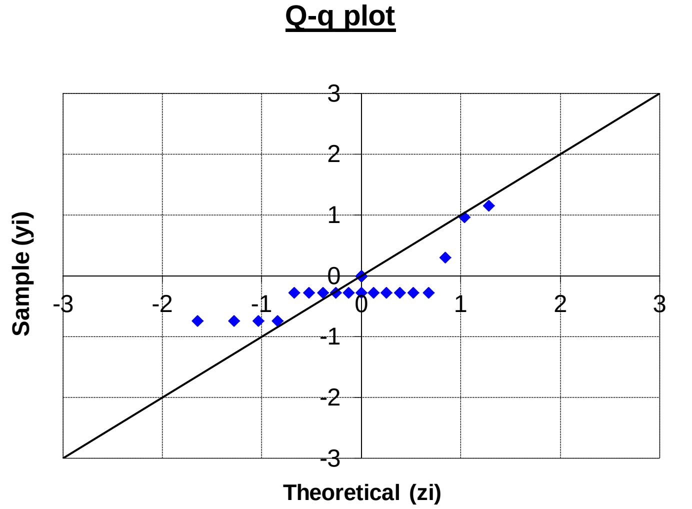
3.5 = critical value of test statistic

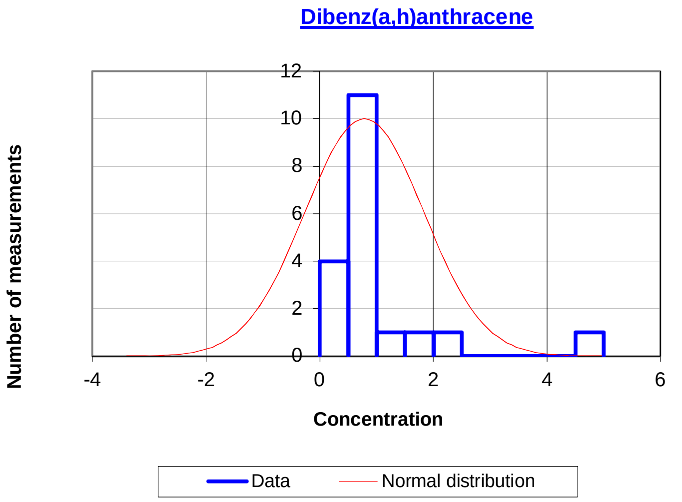
Note - MAD not applicable as 50% or more of values are the same.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

Dibenz(a,h)anthracene	Potential Outlier?	Sample
0.01	n/a	HTP02 @ 0.20
0.01	n/a	HTP03 @ 0.50
0.01	n/a	HTP04 @ 0.10
0.01	n/a	HTP05 @ 0.50
2	n/a	HTP06 @ 0.10
0.5	n/a	TP1 @ 0.90m
0.5	n/a	TP2 @ 0.5
0.5	n/a	TP2 @ 1.5
1.8	n/a	TP3 @ 0.1
0.5	n/a	TP3 @ 1.8
0.5	n/a	TP4 @ 0.6
0.5	n/a	TP4 @ 1.5
4.5	n/a	TP7 @ 0.7
1.1	n/a	TP11 @ 0.3
0.5	n/a	TP12 @ 0.4
0.5	n/a	TP13 @ 0.8
0.5	n/a	TP14 @ 0.4
0.5	n/a	TP15 @ 2.7
0.5	n/a	TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

0.86 = GAC (critical conc.) (mg/kg)

19 = no. samples	4 = no. samples > or = GAC
0.01 = min. value	
4.5 = max. value	0.01 = laboratory reporting limit (RL)
0.786316 = mean	4 = no. samples at RL
1.046232 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-0.306989 = t_0	-0.30699 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
1.202514 = 95% UCL (US_{95})	1.832813 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho accepted, true mean >GAC

US_{95} = 1.8328125 GAC = 0.86 (US95 = 2.131 x GAC)

FURTHER ASSESSMENT REQUIRED

Site reference

Data set: Tip Area (COMBINED)

Client: Bovis Barratt and Taylor Wimpey

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

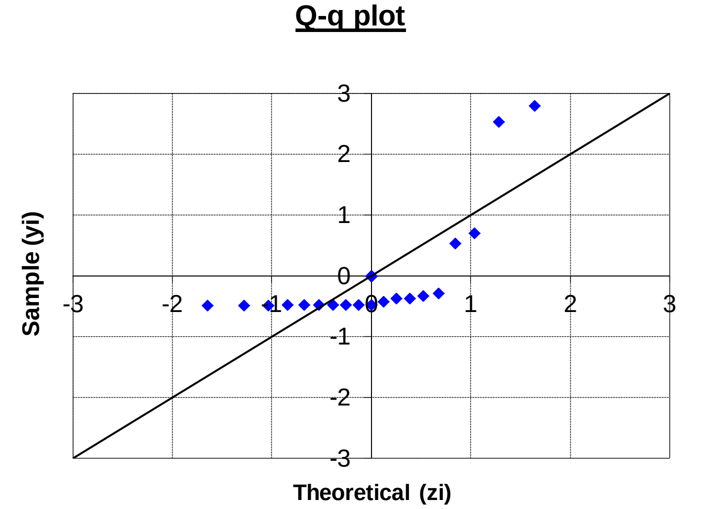
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

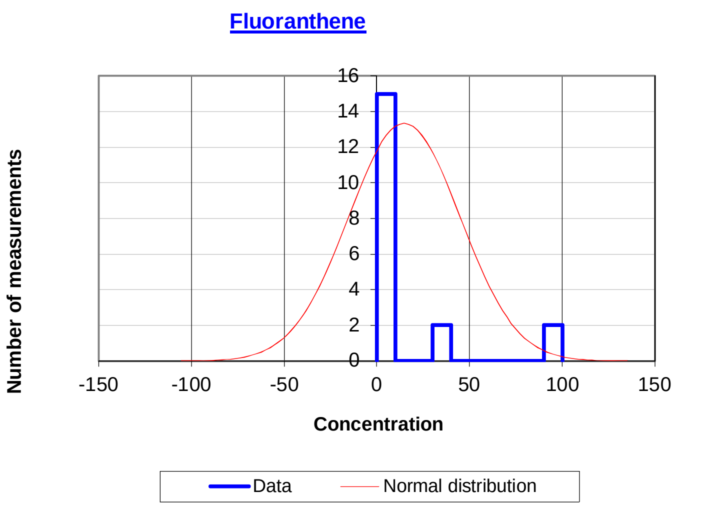
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Fluoranthene	**Potential Outlier?**	**Sample**
0.17		HTP02 @ 0.20
3.6	Yes	HTP03 @ 0.50
0.075		HTP04 @ 0.10
0.2		HTP05 @ 0.50
36	Yes	HTP06 @ 0.10
4.9	Yes	TP1 @ 0.90m
6.2	Yes	TP2 @ 0.5
0.5		TP2 @ 1.5
91	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
2.2		TP4 @ 0.6
0.5		TP4 @ 1.5
99	Yes	TP7 @ 0.7
31	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
3.6	Yes	TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

460 = GAC (critical conc.) (mg/kg)

19 = no. samples	0 = no. samples > or = GAC
0.075 = min. value	
99 = max. value	0.01 = laboratory reporting limit (RL)
14.81289 = mean	0 = no. samples at RL
30.06014 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-64.55477 = t_0	-64.5548 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
26.77103 = 95% UCL (US_{95})	44.88063 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 44.880631 GAC = 460 (US95 = 0.098 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)

Client: Bovis Barratt and Taylor Wimpey

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

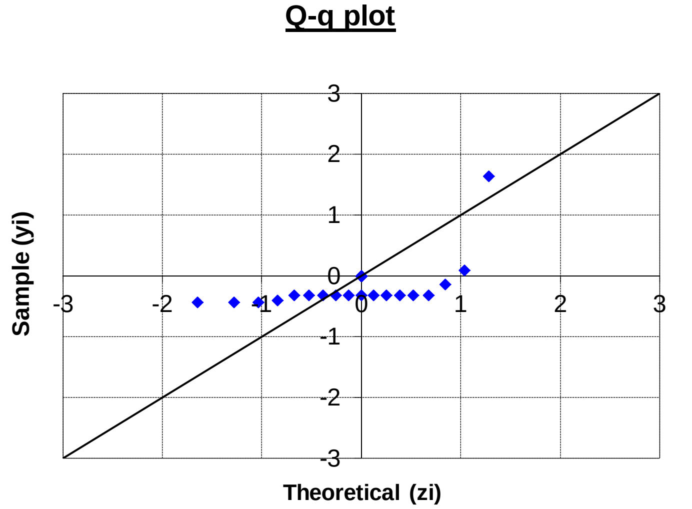
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

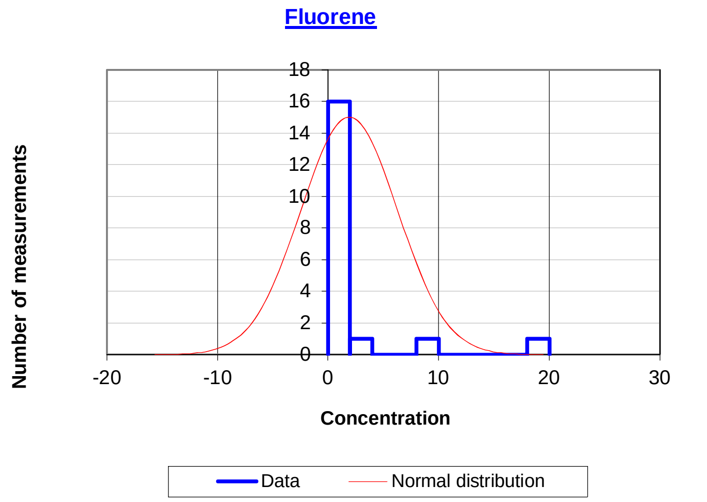
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Fluorene	Potential Outlier?	Sample
0.01	n/a	HTP02 @ 0.20
0.16	n/a	HTP03 @ 0.50
0.01	n/a	HTP04 @ 0.10
0.01	n/a	HTP05 @ 0.50
2.3	n/a	HTP06 @ 0.10
0.5	n/a	TP1 @ 0.90m
0.5	n/a	TP2 @ 0.5
0.5	n/a	TP2 @ 1.5
18	n/a	TP3 @ 0.1
0.5	n/a	TP3 @ 1.8
0.5	n/a	TP4 @ 0.6
0.5	n/a	TP4 @ 1.5
9.1	n/a	TP7 @ 0.7
1.3	n/a	TP11 @ 0.3
0.5	n/a	TP12 @ 0.4
0.5	n/a	TP13 @ 0.8
0.5	n/a	TP14 @ 0.4
0.5	n/a	TP15 @ 2.7
0.5	n/a	TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

380 = GAC (critical conc.) (mg/kg)

19 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
18 = max. value
0.01 = laboratory reporting limit (RL)
1.915263 = mean
3 = no. samples at RL
4.389821 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-375.4215 = t_0
1.734 = $t_{(n-1,0.95)}$
3.661564 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-375.422 = k_0
4.36 = $k_{0.05}$
6.306193 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 6.3061928 GAC = 380 (US95 = 0.017 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

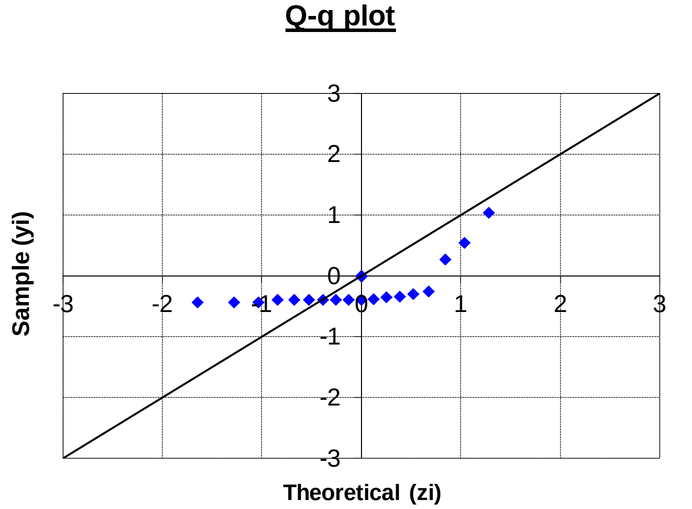
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

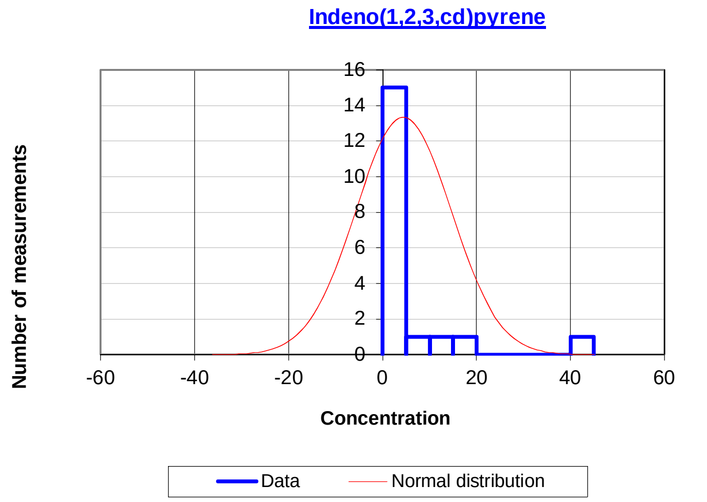
Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

Indeno(1,2,3,cd)pyrene	Potential Outlier?	Sample
0.01		HTP02 @ 0.20
0.53		HTP03 @ 0.50
0.01		HTP04 @ 0.10
0.03		HTP05 @ 0.50
7.2	Yes	HTP06 @ 0.10
1.4		TP1 @ 0.90m
1.8		TP2 @ 0.5
0.5		TP2 @ 1.5
15	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
0.91		TP4 @ 0.6
0.5		TP4 @ 1.5
43	Yes	TP7 @ 0.7
10	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
0.98		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

3.9 = GAC (critical conc.) (mg/kg)

19 = no. samples	4 = no. samples > or = GAC
0.01 = min. value	
43 = max. value	0.01 = laboratory reporting limit (RL)
4.440526 = mean (mean>GAC)	2 = no. samples at RL
10.16588 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
0.231765 = t_0	0.231765 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
8.484585 = 95% UCL (US_{95})	14.60898 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho accepted, true mean >GAC
US_{95} = 14.608978 GAC = 3.9 (US_{95} = 3.746 x GAC)

FURTHER ASSESSMENT REQUIRED

Site reference

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

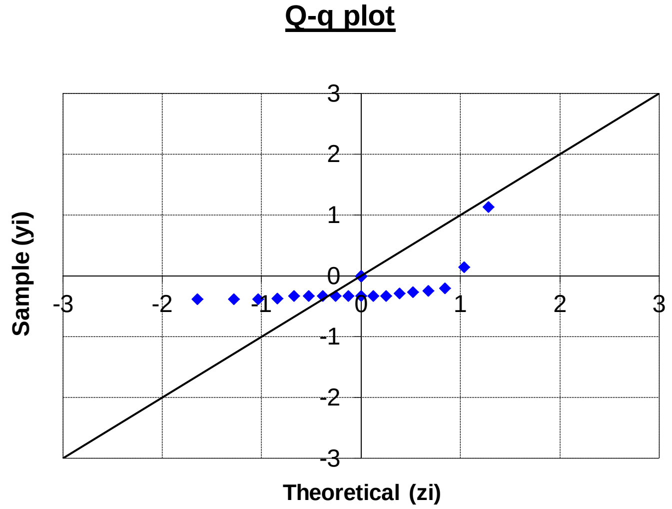
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

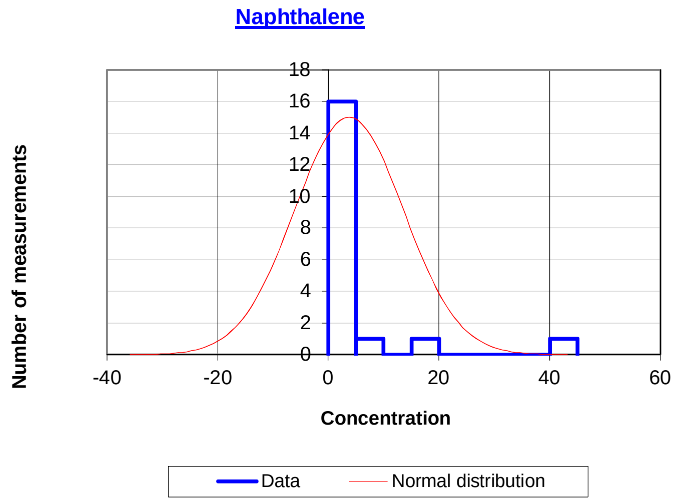
Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Naphthalene	Potential Outlier?	Sample
0.01		HTP02 @ 0.20
0.069		HTP03 @ 0.50
0.01		HTP04 @ 0.10
0.01		HTP05 @ 0.50
1.8		HTP06 @ 0.10
1.3		TP1 @ 0.90m
0.91		TP2 @ 0.5
0.5		TP2 @ 1.5
42	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
0.5		TP4 @ 0.6
0.5		TP4 @ 1.5
15	Yes	TP7 @ 0.7
5.2	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
1.1		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

3.7 = GAC (critical conc.) (mg/kg)

19 = no. samples
3 = no. samples > or = GAC
0.01 = min. value
42 = max. value
0.01 = laboratory reporting limit (RL)
3.758368 = mean (mean>GAC)
3 = no. samples at RL
9.878798 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
0.025754 = t_0
1.734 = $t_{(n-1,0.95)}$
7.688222 = 95% UCL (US_{95})

One-sided Chebychev Theorem
0.025754 = k_0
4.36 = $k_{0.05}$
13.63966 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho accepted, true mean >GAC
US_{95} = 13.639662 GAC = 3.7 (US95 = 3.686 x GAC)

FURTHER ASSESSMENT REQUIRED

Site reference
Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

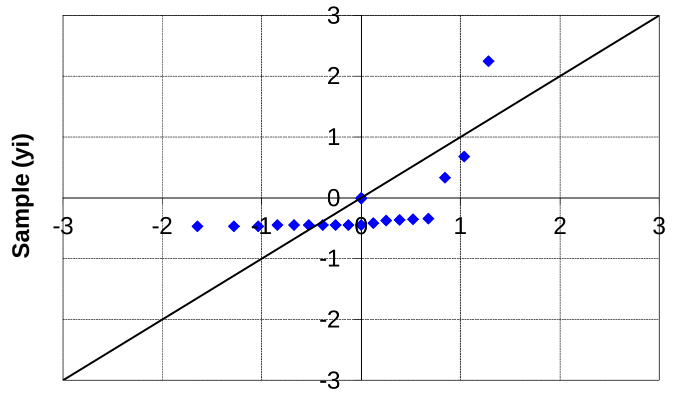
3.5 = critical value of test statistic

Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

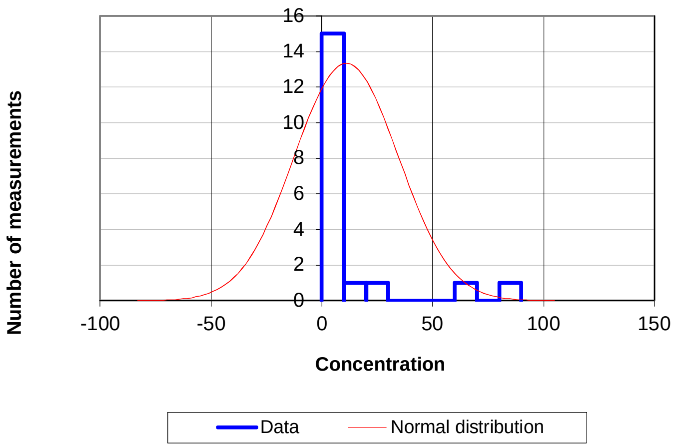
Phenanthrene	**Potential Outlier?**	**Sample**
0.088		HTP02 @ 0.20
2.7		HTP03 @ 0.50
0.014		HTP04 @ 0.10
0.049		HTP05 @ 0.50
27	**Yes**	HTP06 @ 0.10
3		TP1 @ 0.90m
2.6		TP2 @ 0.5
0.5		TP2 @ 1.5
84	**Yes**	TP3 @ 0.1
0.5		TP3 @ 1.8
1.3		TP4 @ 0.6
0.5		TP4 @ 1.5
64	**Yes**	TP7 @ 0.7
19	**Yes**	TP11 @ 0.3
0.5		TP12 @ 0.4
2.4		TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots

Q-q plot



Phenanthrene



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

200 = GAC (critical conc.) (mg/kg)

19 = no. samples	0 = no. samples > or = GAC
0.014 = min. value	
84 = max. value	0.01 = laboratory reporting limit (RL)
11.03426 = mean	0 = no. samples at RL
23.52412 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-35.01438 = t_0	-35.0144 = k_0
1.734 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
20.39232 = 95% UCL (US_{95})	34.56433 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 34.564325 GAC = 200 (US95 = 0.173 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set:	Tip Area (COMBINED)
Client:	Bovis Barratt and Taylor Wimpey
Site:	Land at Bankside, Banbury
Job no:	C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

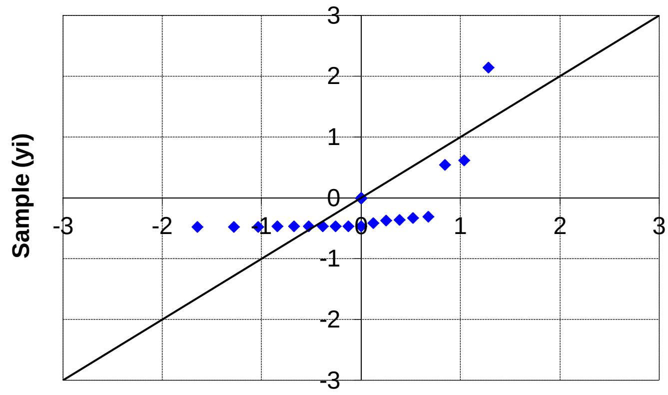
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

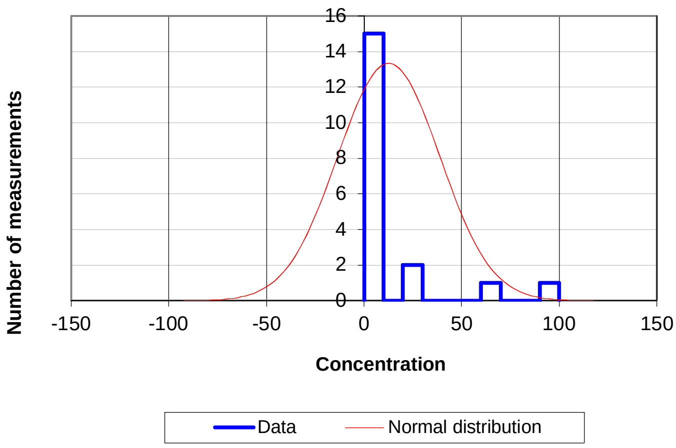
Pyrene	Potential Outlier?	Sample
0.11		HTP02 @ 0.20
2.9	Yes	HTP03 @ 0.50
0.066		HTP04 @ 0.10
0.16		HTP05 @ 0.50
29	Yes	HTP06 @ 0.10
4.1	Yes	TP1 @ 0.90m
4.7	Yes	TP2 @ 0.5
0.5		TP2 @ 1.5
69	Yes	TP3 @ 0.1
0.5		TP3 @ 1.8
1.8		TP4 @ 0.6
0.5		TP4 @ 1.5
95	Yes	TP7 @ 0.7
27	Yes	TP11 @ 0.3
0.5		TP12 @ 0.4
3.1	Yes	TP13 @ 0.8
0.5		TP14 @ 0.4
0.5		TP15 @ 2.7
0.5		TP16 @ 0.7

Visual assessment - Q-q & histogram plots

Q-q plot



Pyrene



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

1000 = GAC (critical conc.) (mg/kg)

19 = no. samples
0.066 = min. value
95 = max. value
12.65453 = mean
26.22059 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-164.1359 = t_0
1.734 = $t_{(n-1,0.95)}$
23.08526 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-164.136 = k_0
4.36 = $k_{0.05}$
38.88174 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 38.88174 GAC = 1000 (US95 = 0.039 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

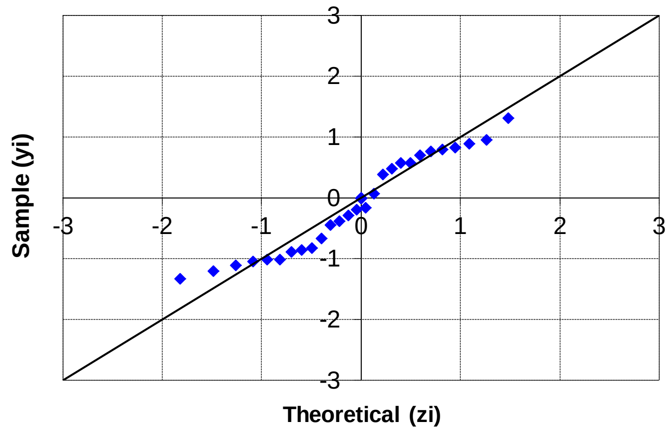
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

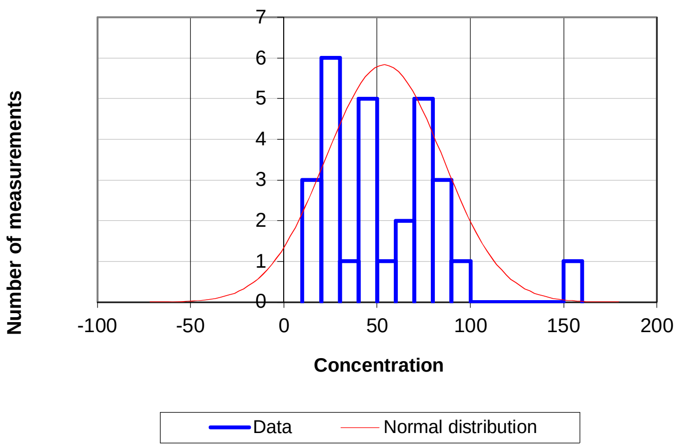
Arsenic	Potential Outlier?	Sample
28		HTP02 @ 0.20
84		HTP03 @ 0.50
56		HTP04 @ 0.10
33		HTP05 @ 0.50
48		HTP06 @ 0.10
150		TP1 @ 0.4
76		TP1 @ 0.90m
26		TP2 @ 0.5
22		TP2 @ 1.5
42		TP3 @ 0.1
40		TP3 @ 0.5
78		TP3 @ 1.8
27		TP4 @ 0.6
22		TP4 @ 1.5
72		TP7 @ 0.2
72		TP7 @ 0.7
45		TP10 @ 0.9
49		TP11 @ 0.3
69		TP12 @ 0.2
66		TP12 @ 0.4
82		TP13 @ 0.3
95		TP13 @ 0.8
12		TP14 @ 0.4
16		TP15 @ 2.7
19		TP16 @ 0.4
80		TP16 @ 0.7
21		TP23 @ 0.4
79		TP24 @ 0.4

Visual assessment - Q-q & histogram plots

Q-q plot



Arsenic



Basic data

Risk parameter
Plant life pH >7

250 = GAC (critical conc.) (mg/kg)
28 = no. samples
12 = min. value
150 = max. value
53.89286 = mean
31.41401 = standard deviation

0 = no. samples > or = GAC
2 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
$-33.03308 = t_0$	$-33.0331 = k_0$
$1.703 = t_{(n-1,0.95)}$	$4.36 = k_{0.05}$
64.00304 = 95% UCL (US_{95})	79.77682 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 79.776824 GAC = 250 (US95 = 0.319 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Boron	**Potential Outlier?**	**Sample**
0.8		HTP02 @ 0.20
1		HTP03 @ 0.50
1		HTP04 @ 0.10
0.6		HTP05 @ 0.50
1.2		HTP06 @ 0.10
1.6		TP1 @ 0.4
1.6		TP1 @ 0.90m
2.3		TP2 @ 0.5
0.86		TP2 @ 1.5
2.8		TP3 @ 0.1
1.4		TP3 @ 0.5
2.2		TP3 @ 1.8
1.7		TP4 @ 0.6
0.68		TP4 @ 1.5
2.4		TP7 @ 0.2
3.8	Yes	TP7 @ 0.7
1		TP10 @ 0.9
2.8		TP11 @ 0.3
1.2		TP12 @ 0.2
1.2		TP12 @ 0.4
2.2		TP13 @ 0.3
2.1		TP13 @ 0.8
0.94		TP14 @ 0.4
1.3		TP15 @ 2.7
0.89		TP16 @ 0.4
1.2		TP16 @ 0.7
0.88		TP23 @ 0.4
0.81		TP24 @ 0.4

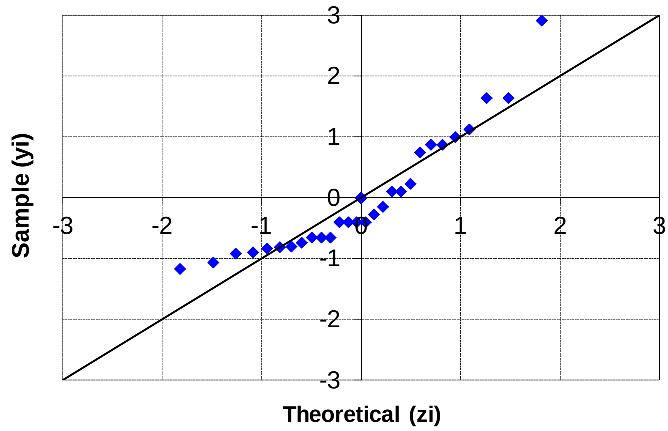
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

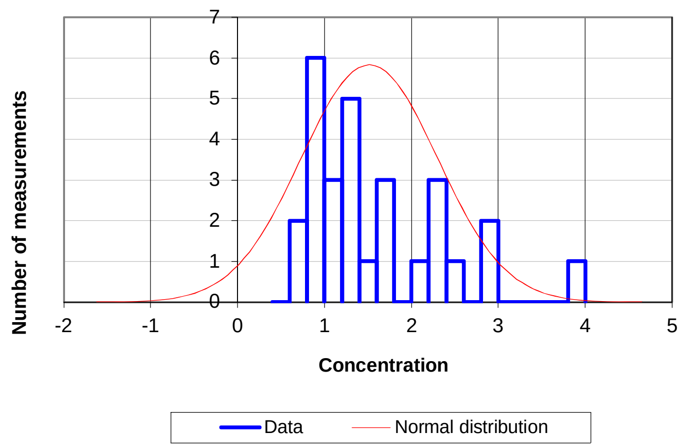
3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots

Q-q plot



Boron



Basic data — Risk parameter

Plant life pH >7

3 = GAC (critical conc.) (mg/kg)

28 = no. samples
0.6 = min. value
3.8 = max. value
1.516429 = mean
0.784116 = standard deviation

1 = no. samples > or = GAC
0.4 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-10.01168 = t_0	-10.0117 = k_0
1.703 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
1.768786 = 95% UCL (US_{95})	2.162511 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 2.1625112 GAC = 3 (US95 = 0.721 x GAC)

Site reference — **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

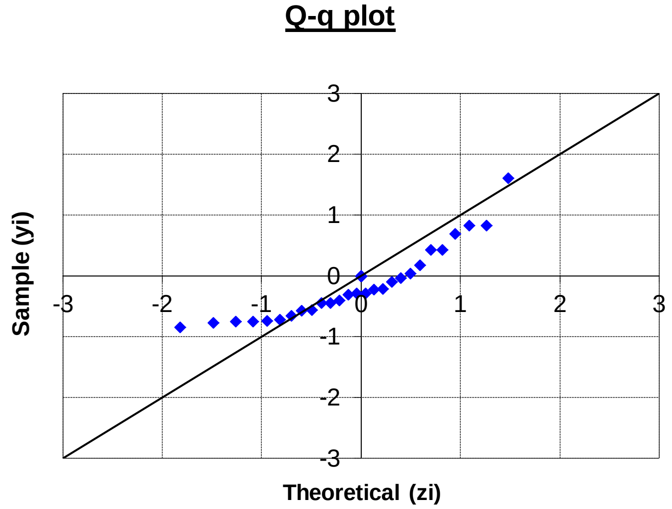
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

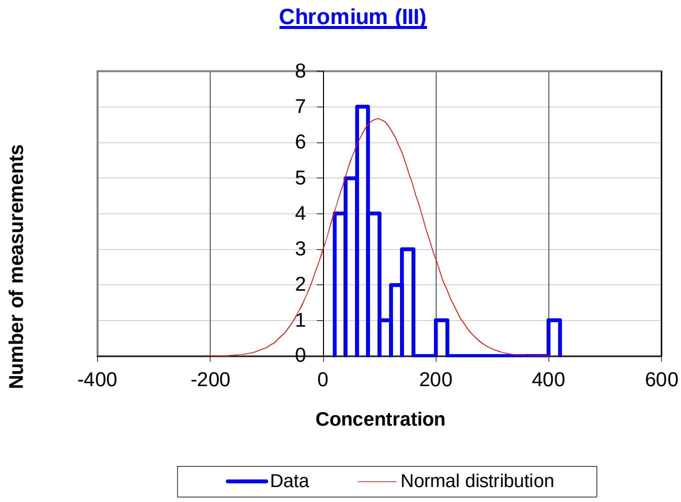
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC) Chromium (III)	Potential Outlier?	Sample
46.5		HTP02 @ 0.20
149.5		HTP03 @ 0.50
99.5		HTP04 @ 0.10
74.5		HTP05 @ 0.50
79.5		HTP06 @ 0.10
410	Yes	TP1 @ 0.4
159.9		TP1 @ 0.90m
38.89		TP2 @ 0.5
31.9		TP2 @ 1.5
74.9		TP3 @ 0.1
63		TP3 @ 0.5
129.9		TP3 @ 1.8
62.88		TP4 @ 0.6
37.67		TP4 @ 1.5
80		TP7 @ 0.2
109.85		TP7 @ 0.7
39		TP10 @ 0.9
72.85		TP11 @ 0.3
66		TP12 @ 0.2
129.9		TP12 @ 0.4
94		TP13 @ 0.3
159.9		TP13 @ 0.8
53.76		TP14 @ 0.4
41.7		TP15 @ 2.7
53		TP16 @ 0.4
219.9		TP16 @ 0.7
40		TP23 @ 0.4
89		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data

Risk parameter
Plant life pH >7

400 = GAC (critical conc.) (mg/kg)
28 = no. samples
1 = no. samples > or = GAC
31.9 = min. value
410 = max. value
5 = laboratory reporting limit (RL)
96.69286 = mean
0 = no. samples at RL
76.68242 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-20.92984 = t_0	-20.9298 = k_0
1.703 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
121.3721 = 95% UCL (US_{95})	159.8763 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 159.8763 GAC = 400 (US95 = 0.4 x GAC)

Site reference
POTENTIALLY SUITABLE FOR USE

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

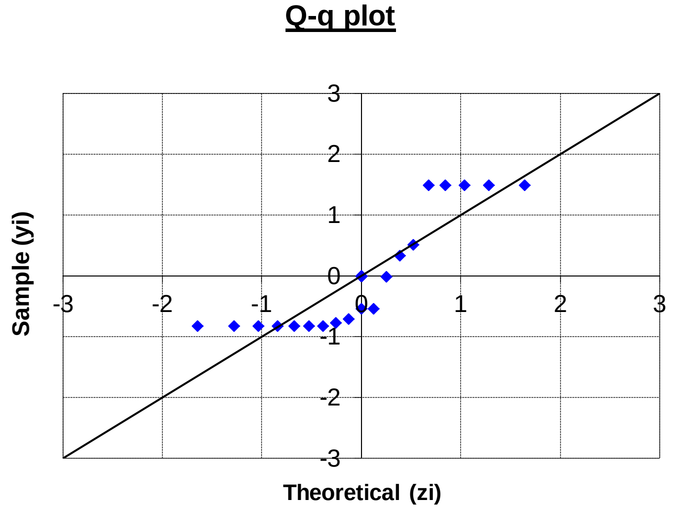
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

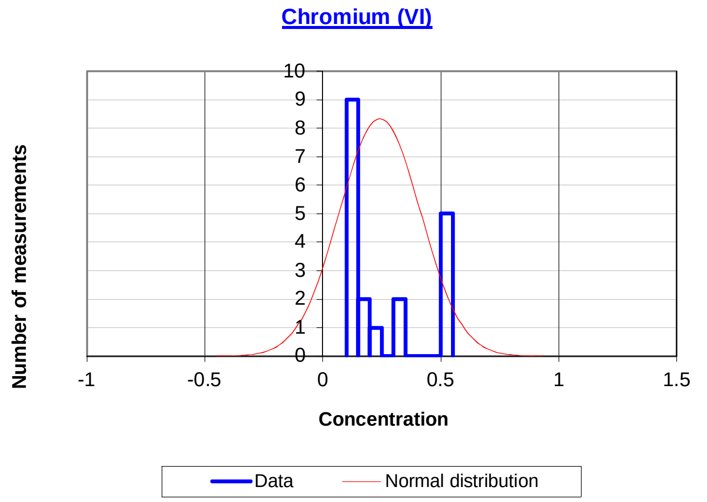
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Chromium (VI)	**Potential Outlier?**	**Sample**
0.5	**Yes**	HTP02 @ 0.20
0.5	**Yes**	HTP03 @ 0.50
0.5	**Yes**	HTP04 @ 0.10
0.5	**Yes**	HTP05 @ 0.50
0.5	**Yes**	HTP06 @ 0.10
0.1		TP1 @ 0.90m
0.11		TP2 @ 0.5
0.1		TP2 @ 1.5
0.1		TP3 @ 0.1
0.1		TP3 @ 1.8
0.12		TP4 @ 0.6
0.33		TP4 @ 1.5
0.15		TP7 @ 0.7
0.15		TP11 @ 0.3
0.1		TP12 @ 0.4
0.1		TP13 @ 0.8
0.24		TP14 @ 0.4
0.3		TP15 @ 2.7
0.1		TP16 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data

Risk parameter
Plant life pH >7

25 = GAC (critical conc.) (mg/kg)

19 = no. samples
0 = no. samples > or = GAC
0.1 = min. value
0.5 = max. value
0.5 = laboratory reporting limit (RL)
0.242105 = mean
19 = no. samples at RL
0.172291 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-626.3654 = t_0
1.734 = $t_{(n-1,0.95)}$
0.310644 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-626.365 = k_0
4.36 = $k_{0.05}$
0.41444 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.4144398 GAC = 25 (US95 = 0.017 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

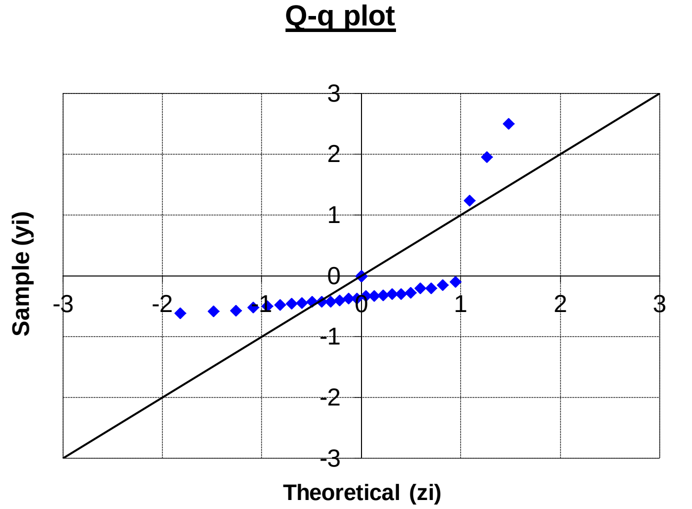
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

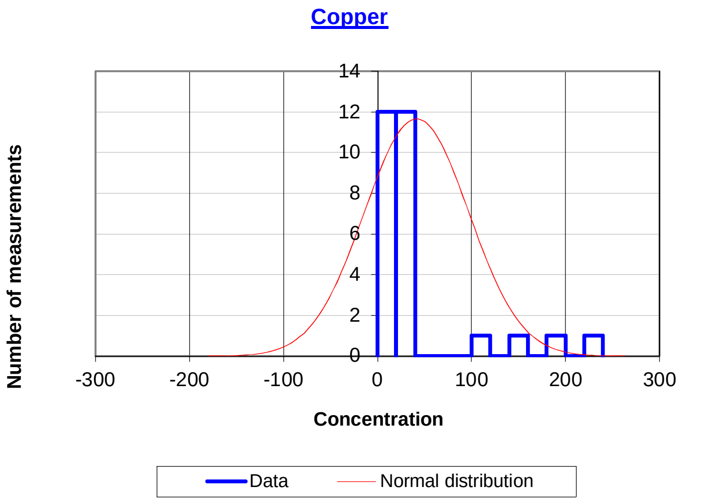
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Copper	Potential Outlier?	Sample
18		HTP02 @ 0.20
36		HTP03 @ 0.50
26		HTP04 @ 0.10
18		HTP05 @ 0.50
150	Yes	HTP06 @ 0.10
7.3		TP1 @ 0.4
33		TP1 @ 0.90m
23		TP2 @ 0.5
13		TP2 @ 1.5
180	Yes	TP3 @ 0.1
23		TP3 @ 0.5
16		TP3 @ 1.8
21		TP4 @ 0.6
19		TP4 @ 1.5
25		TP7 @ 0.2
110	Yes	TP7 @ 0.7
24		TP10 @ 0.9
230	Yes	TP11 @ 0.3
25		TP12 @ 0.2
17		TP12 @ 0.4
30		TP13 @ 0.3
30		TP13 @ 0.8
21		TP14 @ 0.4
15		TP15 @ 2.7
18		TP16 @ 0.4
14		TP16 @ 0.7
9.5		TP23 @ 0.4
10		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data

Risk parameter
Plant life pH >7

200 = GAC (critical conc.) (mg/kg)
28 = no. samples
7.3 = min. value
230 = max. value
41.49286 = mean
55.45507 = standard deviation

1 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-15.12469 = t_0
1.703 = $t_{(n-1,0.95)}$
59.34034 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-15.1247 = k_0
4.36 = $k_{0.05}$
87.18576 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 87.185755 GAC = 200 (US95 = 0.436 x GAC)

Site reference
POTENTIALLY SUITABLE FOR USE

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

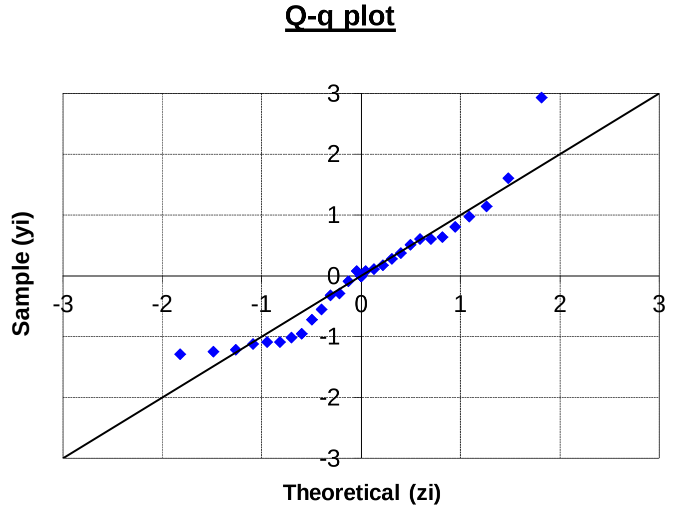
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

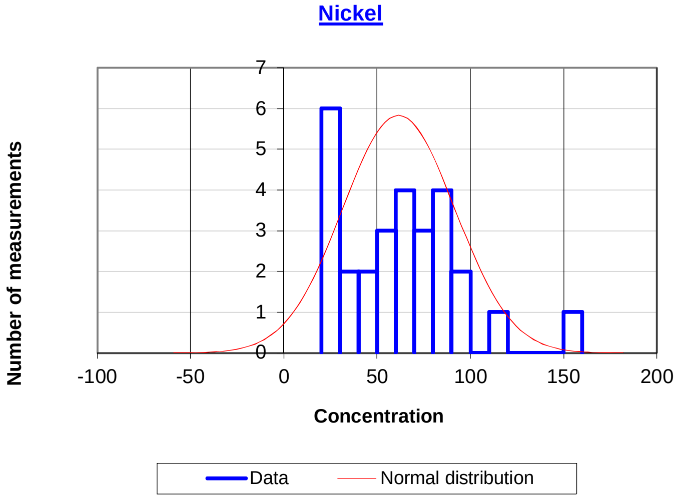
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Nickel	Potential Outlier?	Sample
25		HTP02 @ 0.20
64		HTP03 @ 0.50
67		HTP04 @ 0.10
45		HTP05 @ 0.50
53		HTP06 @ 0.10
150		TP1 @ 0.4
80		TP1 @ 0.90m
23		TP2 @ 0.5
28		TP2 @ 1.5
52		TP3 @ 0.1
80		TP3 @ 0.5
59		TP3 @ 1.8
31		TP4 @ 0.6
33		TP4 @ 1.5
81		TP7 @ 0.2
64		TP7 @ 0.7
70		TP10 @ 0.9
77		TP11 @ 0.3
110		TP12 @ 0.2
65		TP12 @ 0.4
91		TP13 @ 0.3
73		TP13 @ 0.8
40		TP14 @ 0.4
29		TP15 @ 2.7
29		TP16 @ 0.4
96		TP16 @ 0.7
24		TP23 @ 0.4
86		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data

Risk parameter
Plant life pH >7

110 = GAC (critical conc.) (mg/kg)

28 = no. samples
23 = min. value
150 = max. value
61.60714 = mean
30.12977 = standard deviation

2 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-8.498935 = t_0
1.703 = $t_{(n-1,0.95)}$
71.30401 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-8.49893 = k_0
4.36 = $k_{0.05}$
86.43294 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 86.432943 GAC = 110 (US95 = 0.786 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

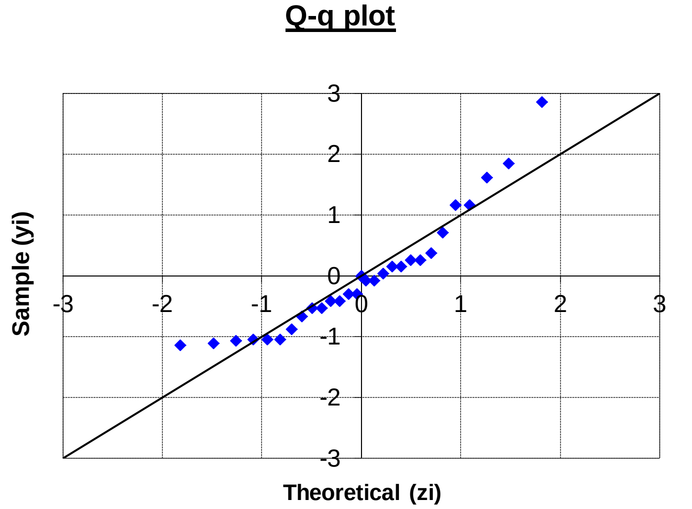
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

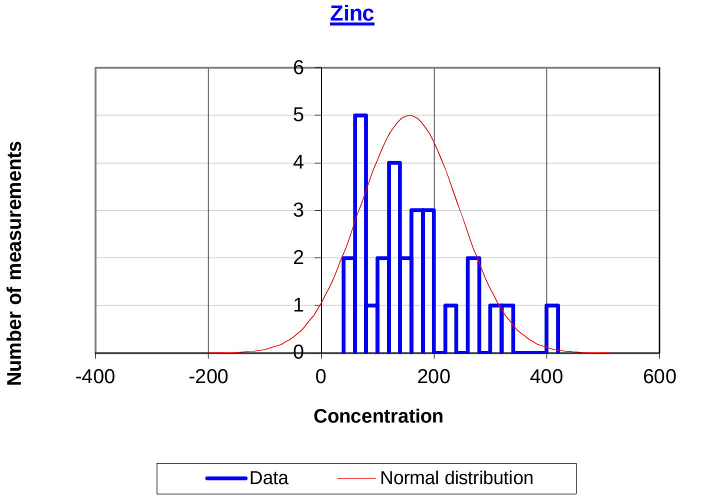
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Zinc	Potential Outlier?	Sample
79		HTP02 @ 0.20
170		HTP03 @ 0.50
190		HTP04 @ 0.10
110		HTP05 @ 0.50
410	Yes	HTP06 @ 0.10
260		TP1 @ 0.4
180		TP1 @ 0.90m
130		TP2 @ 0.5
64		TP2 @ 1.5
300		TP3 @ 0.1
59		TP3 @ 0.5
160		TP3 @ 1.8
98		TP4 @ 0.6
64		TP4 @ 1.5
130		TP7 @ 0.2
260		TP7 @ 0.7
64		TP10 @ 0.9
320		TP11 @ 0.3
120		TP12 @ 0.2
150		TP12 @ 0.4
170		TP13 @ 0.3
180		TP13 @ 0.8
120		TP14 @ 0.4
56		TP15 @ 2.7
110		TP16 @ 0.4
150		TP16 @ 0.7
62		TP23 @ 0.4
220		TP24 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data

Risk parameter
Plant life pH >7

300 = GAC (critical conc.) (mg/kg)
28 = no. samples
56 = min. value
410 = max. value
156.6429 = mean
88.56018 = standard deviation

3 = no. samples > or = GAC
10 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-8.565641 = t_0
1.703 = $t_{(n-1,0.95)}$
185.1448 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-8.56564 = k_0
4.36 = $k_{0.05}$
229.6131 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 229.61313 GAC = 300 (US95 = 0.765 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: Tip Area (COMBINED)
Client: Bovis Barratt and Taylor Wimpey
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Assessment of Chemicals of Potential Concern to Human Health

Hydrock

All values in mg/kg unless otherwise stated						Soil Type	NAT	NAT	NAT	NAT	NAT	NAT
						Location & Depth	HTP07	HTP09	HTP10	HTP13	TP19	TP21
Chemical of Potential Concern	**Lab. RL**	**No. Samples**	**Min. Value**	**Max. Value**	**No. Samples > or = GAC**	**GAC**	**0.50**	**0.20**	**0.50**	**0.20**	**0.5**	**0.4**
Arsenic	2	6	10	22	0	32	18	22	18	17	10	21
Beryllium	1	4	1	1	0	51	1	1	1	1		
Boron	0.4	6	0.4	0.77	0	290	0.5	0.4	0.5	0.7	0.65	0.77
Cadmium	0.1	6	0.1	0.5	0	11	0.1	0.1	0.1	0.1	0.5	0.5
Chromium (III)	5	6	38.5	48.5	0	630	48.5	40.5	41.5	38.5	42	45
Chromium (VI)	0.5	4	0.5	0.5	0	4.3	0.5	0.5	0.5	0.5		
Copper	5	6	5.9	15	0	2300	15	12	10	12	11	5.9
Lead	5	6	14	29	0	450	26	16	24	29	14	17
Mercury, inorganic	0.1	6	0.1	0.2	0	170	0.1	0.1	0.1	0.1	0.2	0.2
Nickel	5	6	21	33	0	130	33	22	22	21	31	26
Selenium	0.2	6	0.2	0.3	0	350	0.2	0.2	0.2	0.2	0.3	0.3
Vanadium	5	4	53	61	0	74	61	58	58	53		
Zinc	10	6	59	85	0	3700	85	59	66	61	60	69
Cyanide (free)	0.5	6	0.5	2	0	750	0.5	0.5	0.5	0.5	2	2
Phenol (total)	0.3	6	0.3	0.5	0	290	0.3	0.3	0.3	0.3	0.5	0.5
Acenaphthene	0.01	4	0.01	0.01	0	480	0.01	0.01	0.01	0.01		
Acenaphthylene	0.01	4	0.01	0.01	0	400	0.01	0.01	0.01	0.01		
Anthracene	0.01	4	0.01	0.01	0	4900	0.01	0.01	0.01	0.01		
Benz(a)anthracene	0.01	4	0.01	0.023	0	4.7	0.023	0.01	0.012	0.021		
Benzo(a)pyrene	0.01	4	0.01	0.01	0	0.94	0.01	0.01	0.01	0.01		
Benzo(b)fluoranthene	0.01	4	0.01	0.01	0	6.5	0.01	0.01	0.01	0.01		
Benzo(ghi)perylene	0.01	4	0.01	0.01	0	46	0.01	0.01	0.01	0.01		
Benzo(k)fluoranthene	0.01	4	0.01	0.01	0	9.6	0.01	0.01	0.01	0.01		
Chrysene	0.01	4	0.01	0.013	0	8	0.013	0.01	0.01	0.012		
Dibenz(a,h)anthracene	0.01	4	0.01	0.01	0	0.86	0.01	0.01	0.01	0.01		
Fluoranthene	0.01	4	0.01	0.088	0	460	0.047	0.01	0.031	0.088		
Fluorene	0.01	4	0.01	0.01	0	380	0.01	0.01	0.01	0.01		
Indeno(1,2,3,cd)pyrene	0.01	4	0.01	0.01	0	3.9	0.01	0.01	0.01	0.01		
Naphthalene	0.01	4	0.01	0.01	0	3.7	0.01	0.01	0.01	0.01		
Phenanthrene	0.01	4	0.01	0.018	0	200	0.018	0.01	0.01	0.014		
Pyrene	0.01	4	0.01	0.061	0	1000	0.035	0.01	0.017	0.061		
	Mean											
FOC (dimensionless)	0.013						0.023	0.0046	0.019	0.018	0.003081	0.00814
SOM (calculated)	2.18%						3.97%	0.79%	3.28%	3.10%	0.53%	1.40%
pH (su)	7.3						7.1	6.9	7.3	7.3	7.6	7.5

Risk parameter: **Human health - residential with plant uptake (2.5%SOM)**
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Legend: Values in blue are at or below the laboratory reporting limit (where a single value is indicated) and are considered as being at the detection limit for the purposes of statistical analysis, as a conservative estimate.
Values in red are equal to, or greater than, the generic assessment criterion (GAC).
MG denotes Made Ground
NAT denotes natural ground

Assessment of Chemicals of Potential Concern to Plant Life

Hydrock

						Soil Type	NAT	NAT	NAT	NAT	NAT	NAT
	All values in mg/kg unless otherwise stated					Location & Depth	HTP07	HTP09	HTP10	HTP13	TP19	TP21
Chemical of Potential Concern	**Lab. RL**	**No. Samples**	**Min. Value**	**Max. Value**	**No. Samples > or = GAC**	**GAC**	**0.50**	**0.20**	**0.50**	**0.20**	**0.5**	**0.4**
Arsenic	2	6	10	22	0	250	18	22	18	17	10	21
Boron	0.4	6	0.4	0.77	0	3	0.5	0.4	0.5	0.7	0.65	0.77
Chromium (III)	5	6	38.5	48.5	0	400	48.5	40.5	41.5	38.5	42	45
Chromium (VI)	0.5	4	0.5	0.5	0	25	0.5	0.5	0.5	0.5		
Copper	5	6	5.9	15	0	135	15	12	10	12	11	5.9
Nickel	5	6	21	33	0	75	33	22	22	21	31	26
Zinc	10	6	59	85	0	300	85	59	66	61	60	69
	Mean											
pH (su)	7.3						7.1	6.9	7.3	7.3	7.6	7.5

Risk parameter: **Plant life pH 7**
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Legend: Values in blue are at or below the laboratory reporting limit (where a single value is indicated) and are considered as being at the detection limit for the purposes of statistical analysis, as a conservative estimate.
Values in red are equal to, or greater than, the generic assessment criterion (GAC).
MG denotes Made Ground
NAT denotes natural ground

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

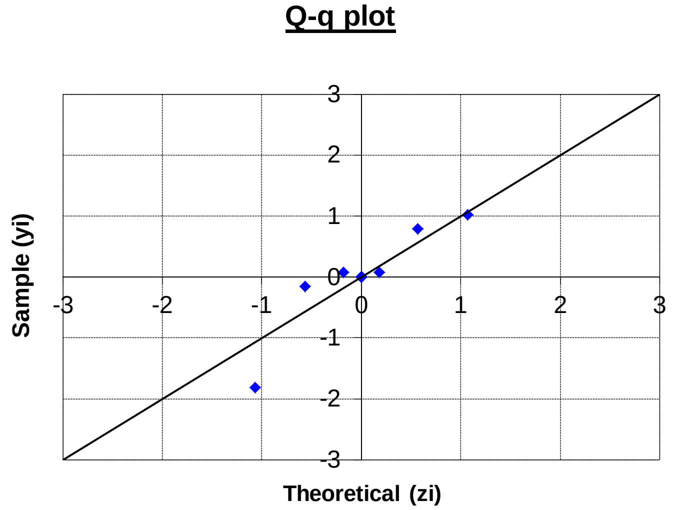
Mean Absolute Deviation for potential outliers

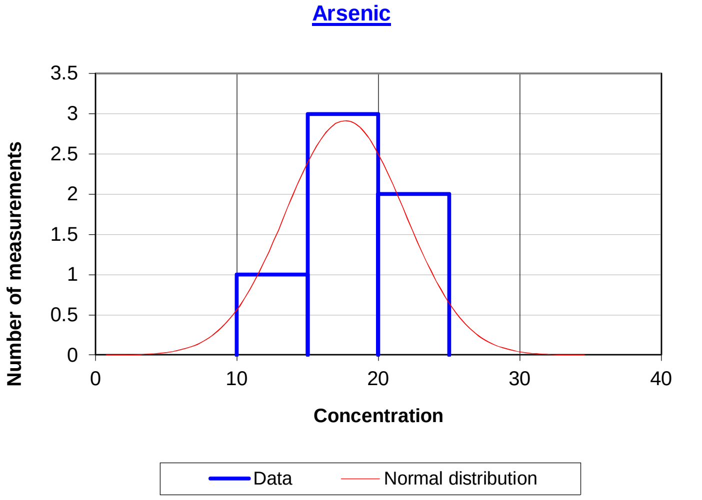
3.5 = critical value of test statistic

Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Arsenic	Potential Outlier?	Sample
18		HTP07 @ 0.50
22		HTP09 @ 0.20
18		HTP10 @ 0.50
17		HTP13 @ 0.20
10		TP19 @ 0.5
21		TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

32 = GAC (critical conc.) (mg/kg)

6 = no. samples	0 = no. samples > or = GAC
10 = min. value	
22 = max. value	2 = laboratory reporting limit (RL)
17.66667 = mean	0 = no. samples at RL
4.226898 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-8.306175 = t_0	-8.30617 = k_0
2.015 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
21.1438 = 95% UCL (US_{95})	25.19039 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 25.190387 GAC = 32 (US95 = 0.787 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Beryllium	**Potential Outlier?**	**Sample**
1	n/a	HTP07 @ 0.50
1	n/a	HTP09 @ 0.20
1	n/a	HTP10 @ 0.50
1	n/a	HTP13 @ 0.20

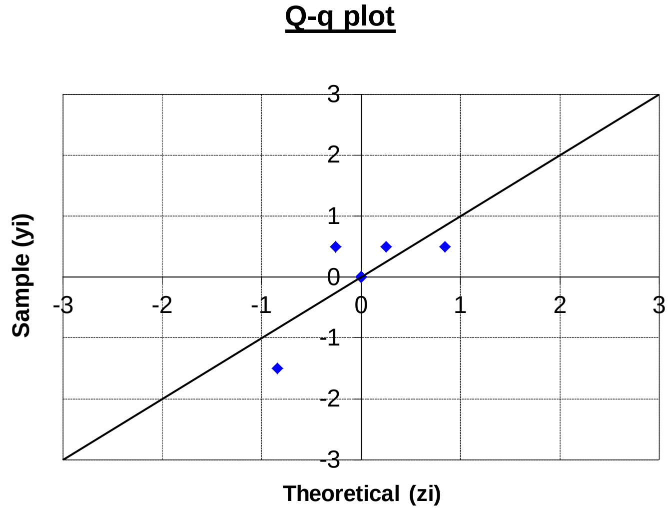
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

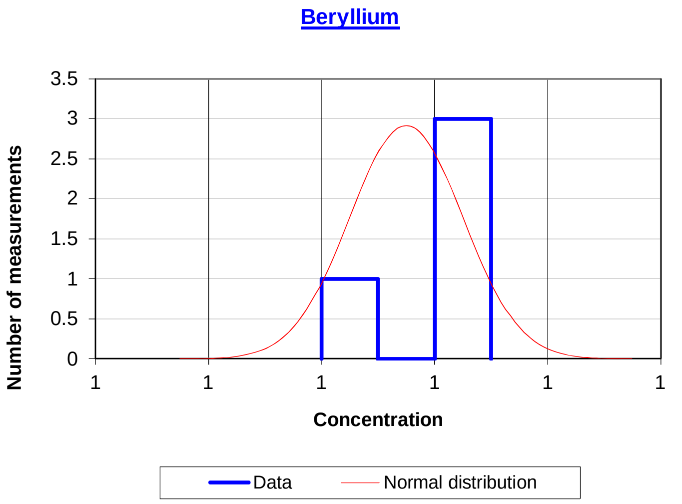
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Note - MAD not applicable as 50% or more of values are the same.

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

51 = GAC (critical conc.) (mg/kg)

4 = no. samples
1 = min. value
1 = max. value
1 = mean
5E-11 = standard deviation

0 = no. samples > or = GAC
1 = laboratory reporting limit (RL)
4 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-2E+12 = t_0
2.353 = $t_{(n-1,0.95)}$
1 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-2E+12 = k_0
4.36 = $k_{0.05}$
1 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 1 **GAC = 51** (US95 = 0.02 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

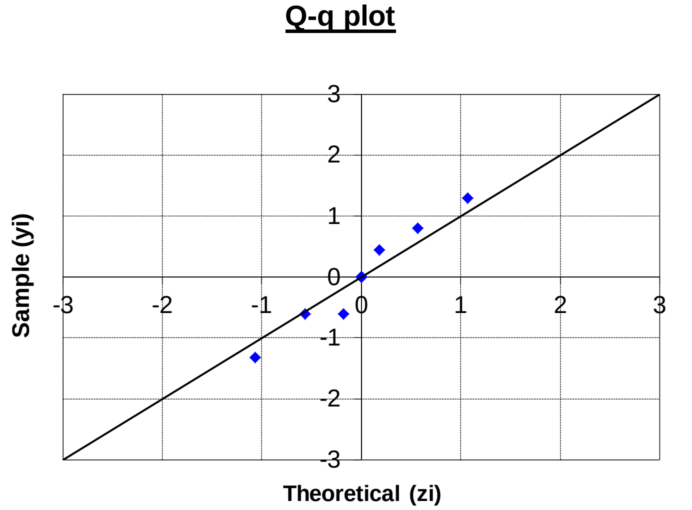
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

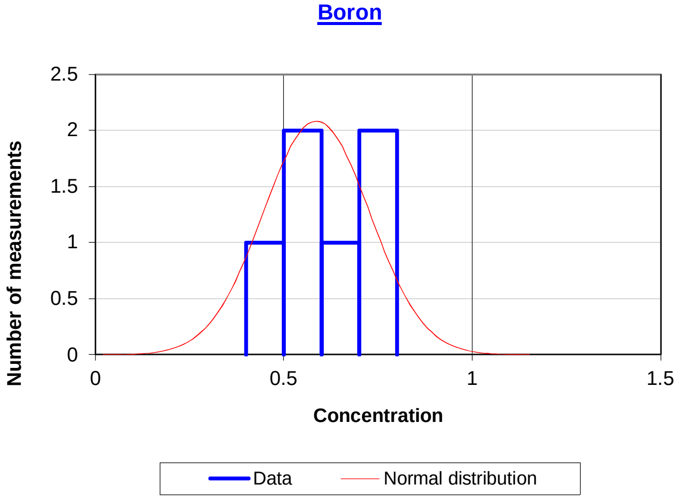
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Boron		
0.5		HTP07 @ 0.50
0.4		HTP09 @ 0.20
0.5		HTP10 @ 0.50
0.7		HTP13 @ 0.20
0.65		TP19 @ 0.5
0.77		TP21 @ 0.4

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
290 = GAC (critical conc.) (mg/kg)
6 = no. samples
0 = no. samples > or = GAC
0.4 = min. value
0.77 = max. value
0.4 = laboratory reporting limit (RL)
0.586667 = mean
1 = no. samples at RL
0.141657 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-5004.452 = t_0
2.015 = $t_{(n-1,0.95)}$
0.703196 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-5004.45 = k_0
4.36 = $k_{0.05}$
0.838811 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.8388106 GAC = 290 (US95 = 0.003 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

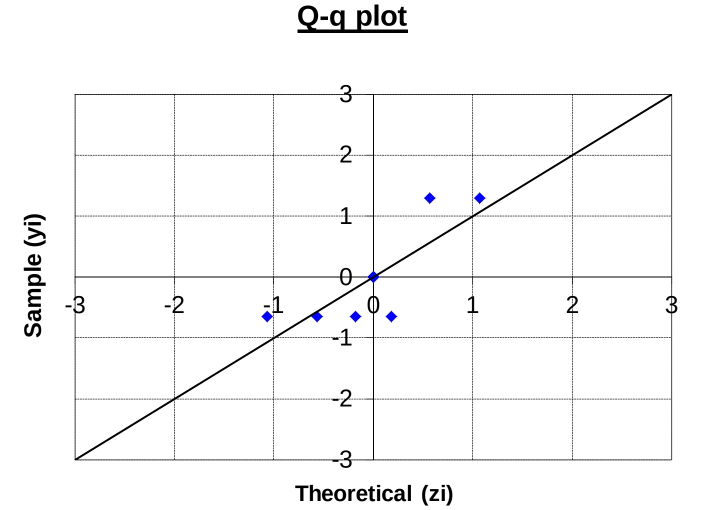
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

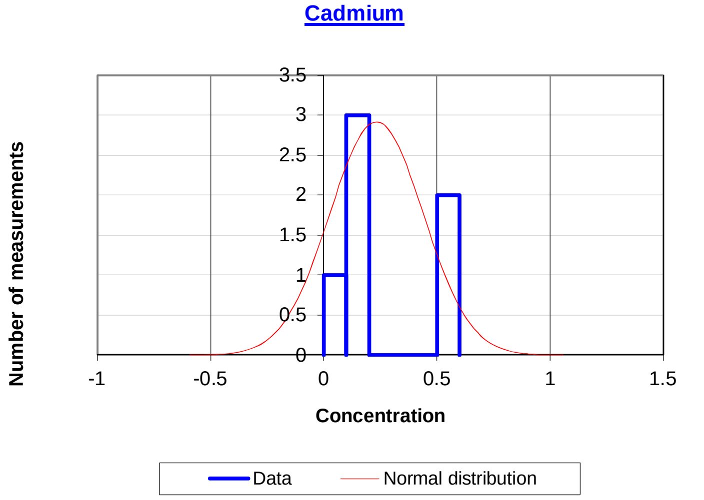
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Cadmium		
0.1		HTP07 @ 0.50
0.1		HTP09 @ 0.20
0.1		HTP10 @ 0.50
0.1		HTP13 @ 0.20
0.5	**Yes**	TP19 @ 0.5
0.5	**Yes**	TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data | Risk parameter

Human health - residential with plant uptake (2.5%SOM)

11 = GAC (critical conc.) (mg/kg)

6 = no. samples
0 = no. samples > or = GAC
0.1 = min. value
0.5 = max. value
0.1 = laboratory reporting limit (RL)
0.233333 = mean
4 = no. samples at RL
0.206559 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-127.677 = t_0

2.015 = $t_{(n-1,0.95)}$

0.403253 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-127.677 = k_0

4.36 = $k_{0.05}$

0.601001 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.6010008 GAC = 11 (US95 = 0.055 x GAC)

Site reference | **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

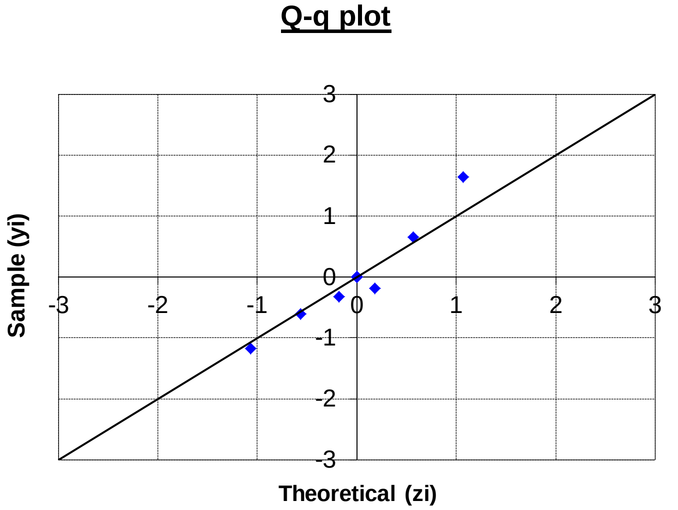
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

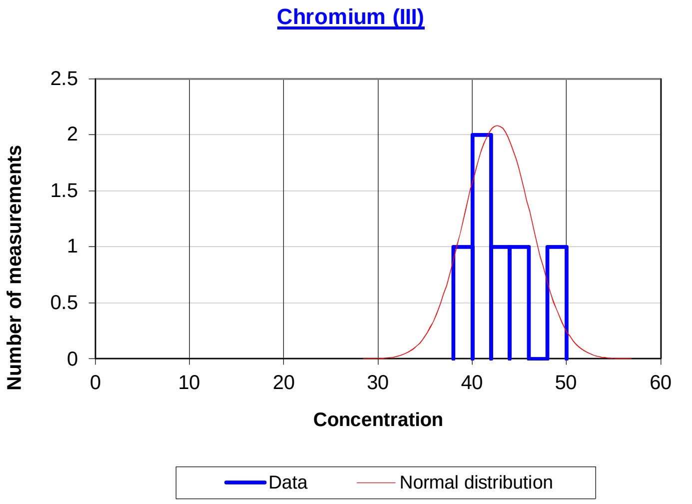
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chromium (III)	Potential Outlier?	Sample
48.5		HTP07 @ 0.50
40.5		HTP09 @ 0.20
41.5		HTP10 @ 0.50
38.5		HTP13 @ 0.20
42		TP19 @ 0.5
45		TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

630 = GAC (critical conc.) (mg/kg)

6 = no. samples
38.5 = min. value
48.5 = max. value
42.66667 = mean
3.559026 = standard deviation

0 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-404.2305 = t_0	-404.231 = k_0
2.015 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
45.59439 = 95% UCL (US_{95})	49.0016 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 49.0016 GAC = 630 (US95 = 0.078 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

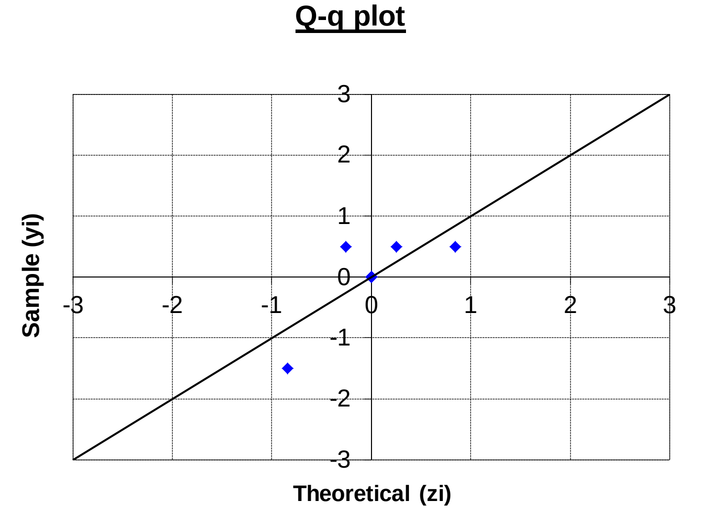
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

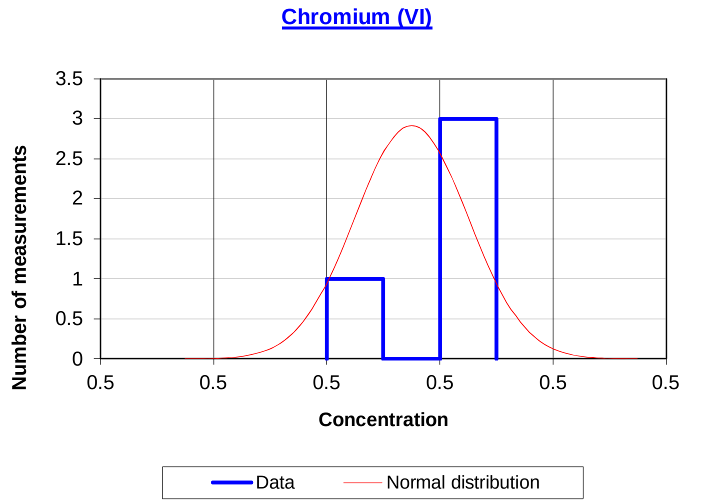
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Chromium (VI)	Potential Outlier?	Sample
0.5	n/a	HTP07 @ 0.50
0.5	n/a	HTP09 @ 0.20
0.5	n/a	HTP10 @ 0.50
0.5	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
4.3 = GAC (critical conc.) (mg/kg)

4 = no. samples	0 = no. samples > or = GAC
0.5 = min. value	
0.5 = max. value	0.5 = laboratory reporting limit (RL)
0.5 = mean	4 = no. samples at RL
5E-12 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-1.52E+12 = t_0	-1.5E+12 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.5 = 95% UCL (US_{95})	0.5 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.5 **GAC = 4.3** (US95 = 0.116 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

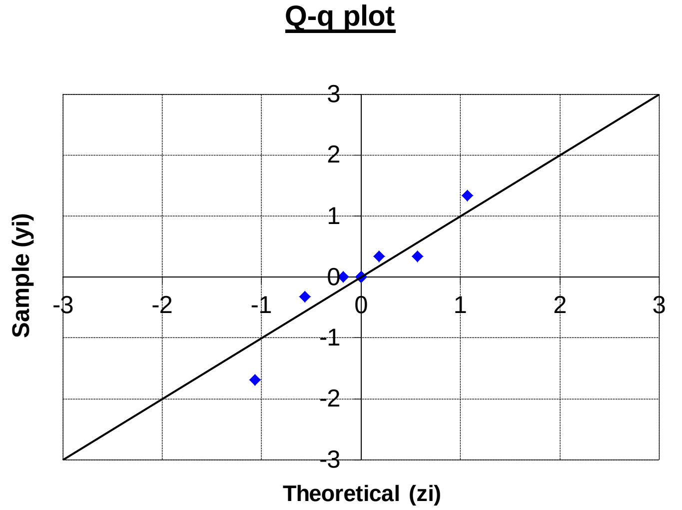
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

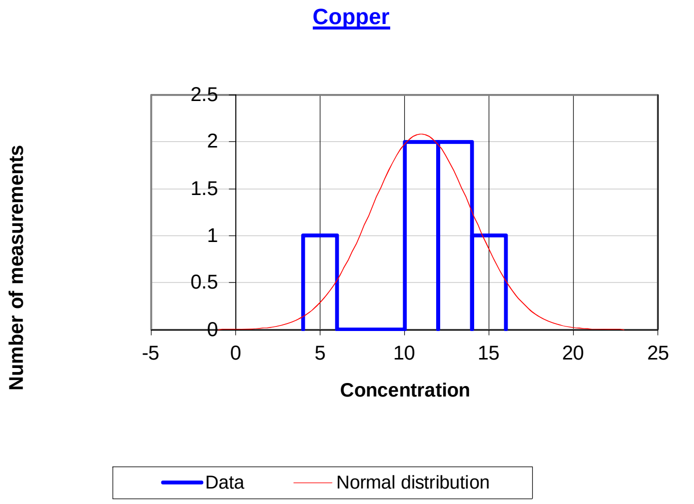
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC) Copper	Potential Outlier?	Sample
15		HTP07 @ 0.50
12		HTP09 @ 0.20
10		HTP10 @ 0.50
12		HTP13 @ 0.20
11		TP19 @ 0.5
5.9	Yes	TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

2300 = GAC (critical conc.) (mg/kg)

6 = no. samples

5.9 = min. value

15 = max. value

10.98333 = mean

3.000278 = standard deviation

0 = no. samples > or = GAC

5 = laboratory reporting limit (RL)

0 = no. samples at RL

RL is limit of detection of the method used

Statistical tests

One-sample t-test

-1868.801 = t_0

2.015 = $t_{(n-1,0.95)}$

13.45142 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-1868.8 = k_0

4.36 = $k_{0.05}$

16.32372 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 16.323715 GAC = 2300 (US95 = 0.007 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

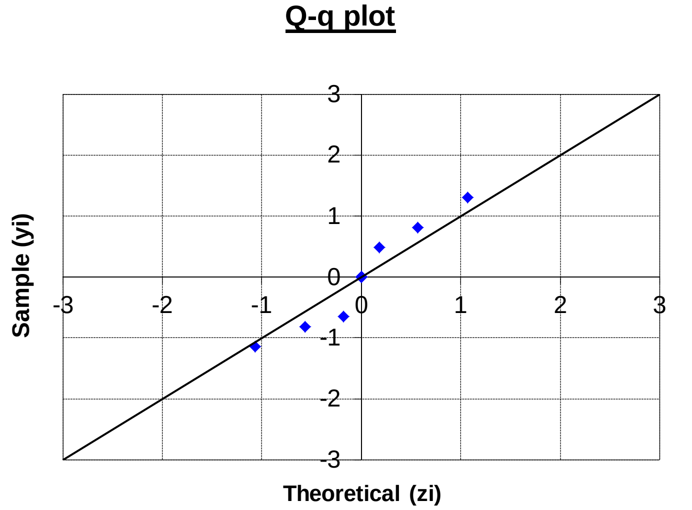
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Lead		
26		HTP07 @ 0.50
16		HTP09 @ 0.20
24		HTP10 @ 0.50
29		HTP13 @ 0.20
14		TP19 @ 0.5
17		TP21 @ 0.4

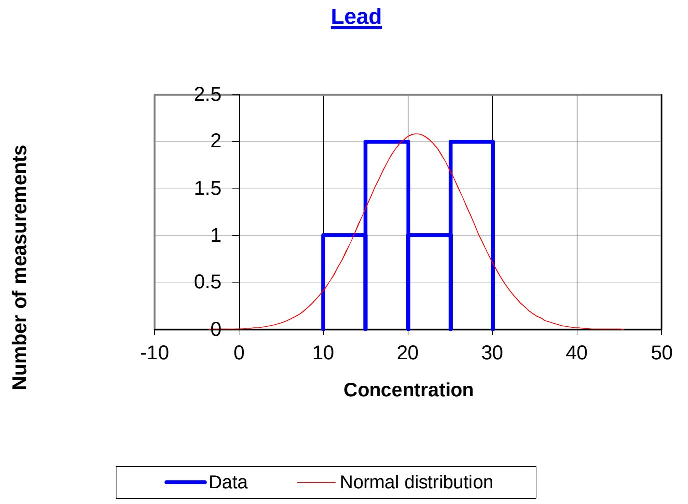
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter

Human health - residential with plant uptake (2.5%SOM)

450 = GAC (critical conc.) (mg/kg)

6 = no. samples — 0 = no. samples > or = GAC

14 = min. value

29 = max. value — 5 = laboratory reporting limit (RL)

21 = mean — 0 = no. samples at RL

6.131884 = standard deviation — RL is limit of detection of the method used

Statistical tests

One-sample t-test

-171.3717 = t_0

2.015 = $t_{(n-1,0.95)}$

26.04421 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-171.372 = k_0

4.36 = $k_{0.05}$

31.91452 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 31.914524 GAC = 450 (US95 = 0.071 x GAC)

Site reference

POTENTIALLY SUITABLE FOR USE

Data set: CMF & DF

Client: Bovis Barratt and Taylor Wimpy

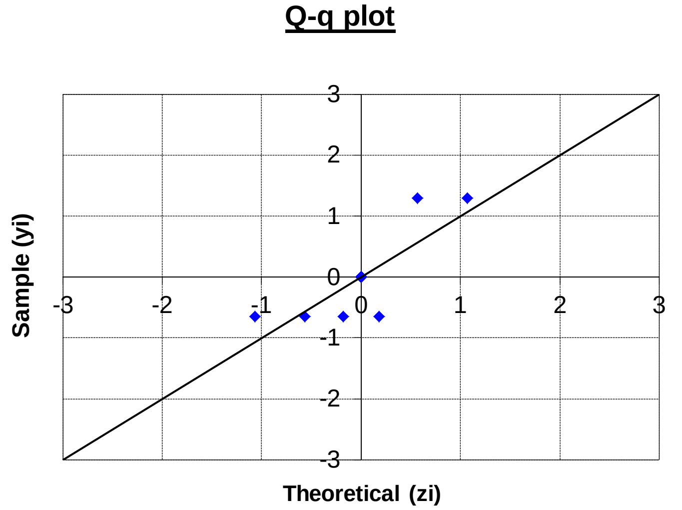
Site: Land at Bankside, Banbury

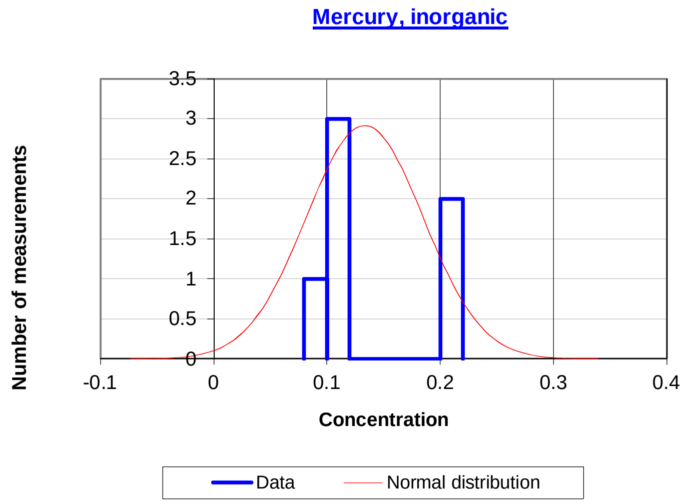
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA	
	Mean Absolute Deviation for potential outliers	
	3.5 = critical value of test statistic	
Mercury, inorganic	**Potential Outlier?**	**Sample**
0.1		HTP07 @ 0.50
0.1		HTP09 @ 0.20
0.1		HTP10 @ 0.50
0.1		HTP13 @ 0.20
0.2	Yes	TP19 @ 0.5
0.2	Yes	TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

170 = GAC (critical conc.) (mg/kg)

6 = no. samples	0 = no. samples > or = GAC
0.1 = min. value	
0.2 = max. value	0.1 = laboratory reporting limit (RL)
0.133333 = mean	4 = no. samples at RL
0.05164 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-8057.483 = t_0	-8057.48 = k_0
2.015 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.175813 = 95% UCL (US_{95})	0.22525 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.2252502 GAC = 170 (US95 = 0.001 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set:	CMF & DF
Client:	Bovis Barratt and Taylor Wimpy
Site:	Land at Bankside, Banbury
Job no:	C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

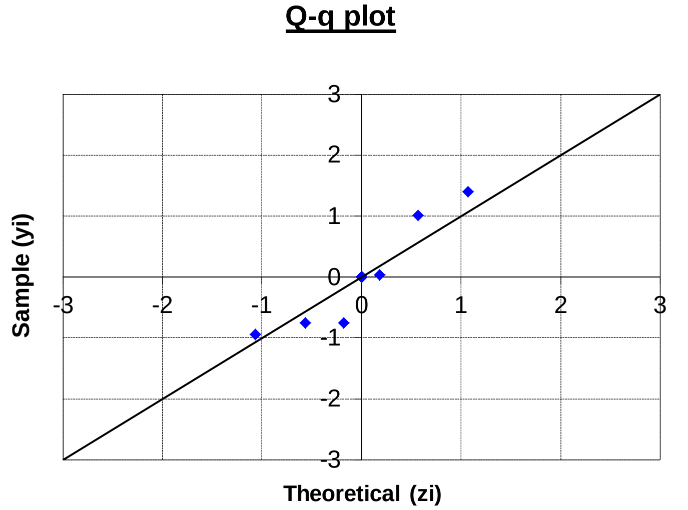
Mean Absolute Deviation for potential outliers

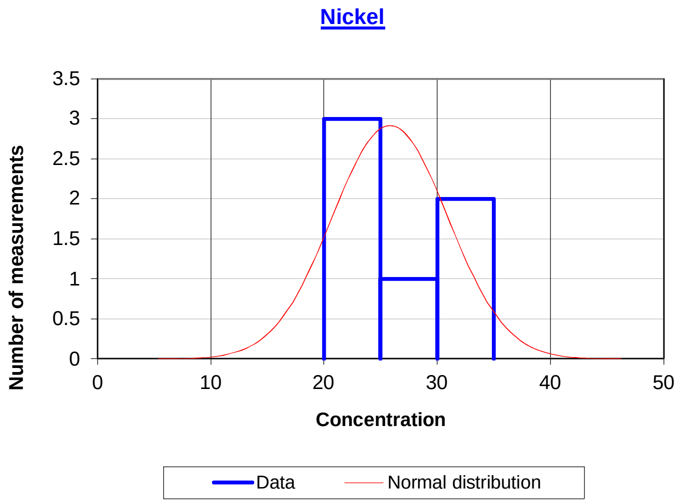
3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

Nickel	Potential Outlier?	Sample
33		HTP07 @ 0.50
22		HTP09 @ 0.20
22		HTP10 @ 0.50
21		HTP13 @ 0.20
31		TP19 @ 0.5
26		TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

130 = GAC (critical conc.) (mg/kg)

6 = no. samples	0 = no. samples > or = GAC
21 = min. value	
33 = max. value	5 = laboratory reporting limit (RL)
25.83333 = mean	0 = no. samples at RL
5.115336 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-49.88043 = t_0	-49.8804 = k_0
2.015 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
30.04131 = 95% UCL (US_{95})	34.93844 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 34.938441 GAC = 130 (US95 = 0.269 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

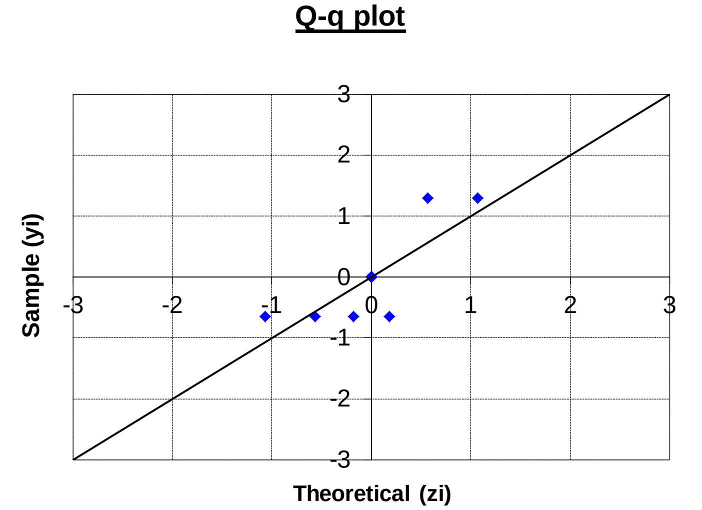
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

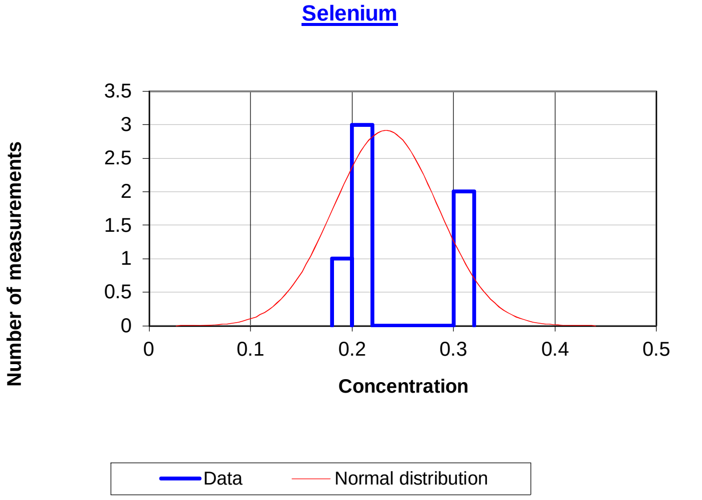
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Selenium	Potential Outlier?	Sample
0.2		HTP07 @ 0.50
0.2		HTP09 @ 0.20
0.2		HTP10 @ 0.50
0.2		HTP13 @ 0.20
0.3	Yes	TP19 @ 0.5
0.3	Yes	TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

350 = GAC (critical conc.) (mg/kg)

6 = no. samples
0.2 = min. value
0.3 = max. value
0.233333 = mean
0.05164 = standard deviation

0 = no. samples > or = GAC
0.2 = laboratory reporting limit (RL)
4 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-16590.89 = t_0
2.015 = $t_{(n-1,0.95)}$
0.275813 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-16590.9 = k_0
4.36 = $k_{0.05}$
0.32525 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.3252502 GAC = 350 (US95 = 0.001 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

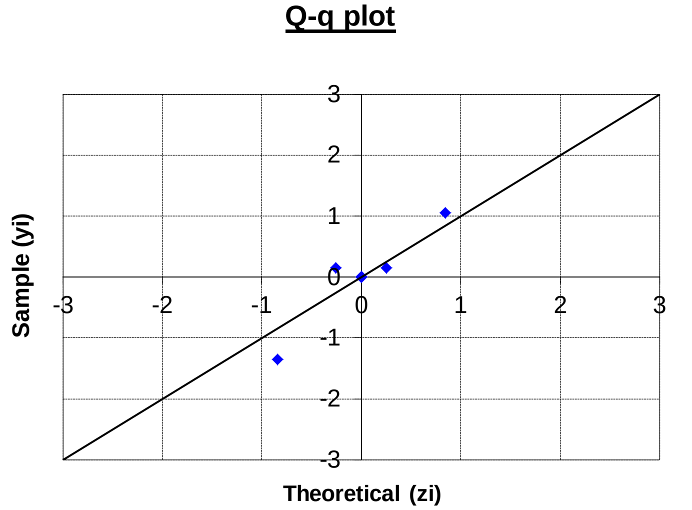
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

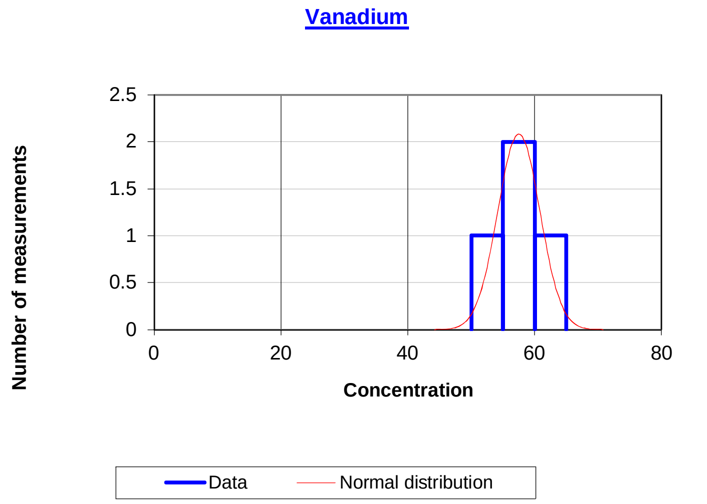
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Vanadium	Potential Outlier?	Sample
61		HTP07 @ 0.50
58		HTP09 @ 0.20
58		HTP10 @ 0.50
53		HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
74 = GAC (critical conc.) (mg/kg)

4 = no. samples	0 = no. samples > or = GAC
53 = min. value	
61 = max. value	5 = laboratory reporting limit (RL)
57.5 = mean	0 = no. samples at RL
3.316625 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-9.949874 = t_0	-9.94987 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
61.40201 = 95% UCL (US_{95})	64.73024 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 64.730242 GAC = 74 (US95 = 0.875 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

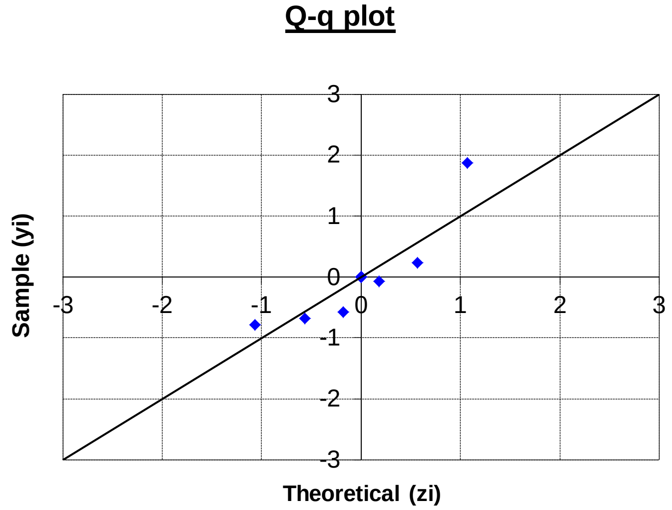
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

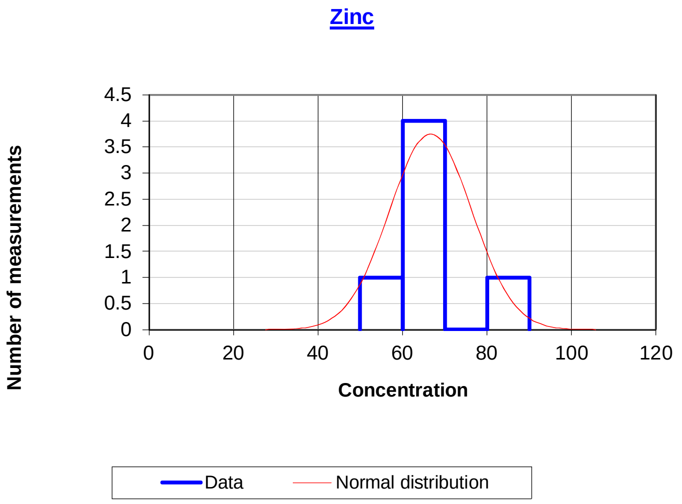
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC) Zinc	Potential Outlier?	Sample
85	Yes	HTP07 @ 0.50
59		HTP09 @ 0.20
66		HTP10 @ 0.50
61		HTP13 @ 0.20
60		TP19 @ 0.5
69		TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

3700 = GAC (critical conc.) (mg/kg)

6 = no. samples	0 = no. samples > or = GAC
59 = min. value	
85 = max. value	10 = laboratory reporting limit (RL)
66.66667 = mean	0 = no. samples at RL
9.770705 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-910.867 = t_0	-910.867 = k_0
2.015 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
74.70425 = 95% UCL (US_{95})	84.05815 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 84.058155 GAC = 3700 (US95 = 0.023 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

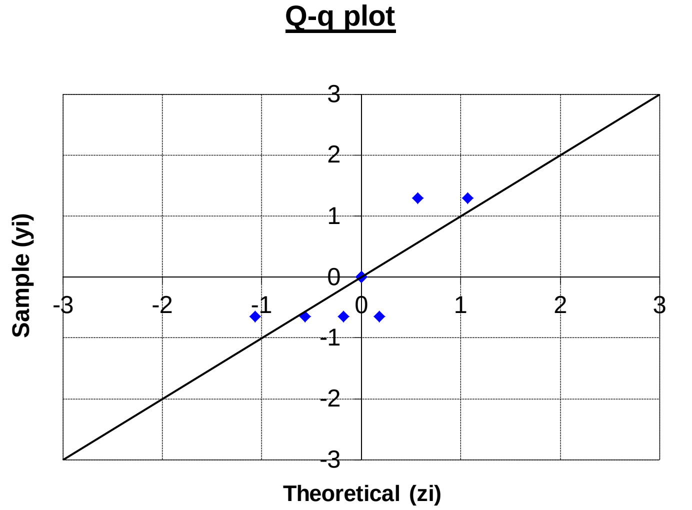
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

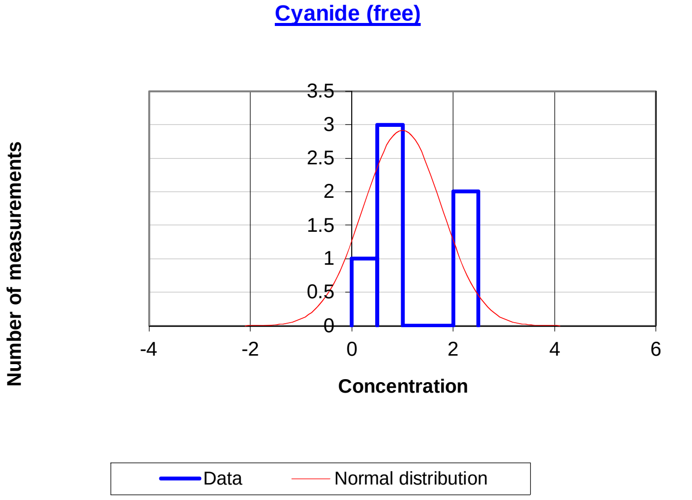
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Cyanide (free)	Potential Outlier?	Sample
0.5		HTP07 @ 0.50
0.5		HTP09 @ 0.20
0.5		HTP10 @ 0.50
0.5		HTP13 @ 0.20
2	Yes	TP19 @ 0.5
2	Yes	TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
750 = GAC (critical conc.) (mg/kg)

6 = no. samples
0.5 = min. value
2 = max. value
1 = mean
0.774597 = standard deviation

0 = no. samples > or = GAC
0.5 = laboratory reporting limit (RL)
4 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-2368.546 = t_0
2.015 = $t_{(n-1,0.95)}$
1.637199 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-2368.55 = k_0
4.36 = $k_{0.05}$
2.378753 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 2.3787531 GAC = 750 (US95 = 0.003 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

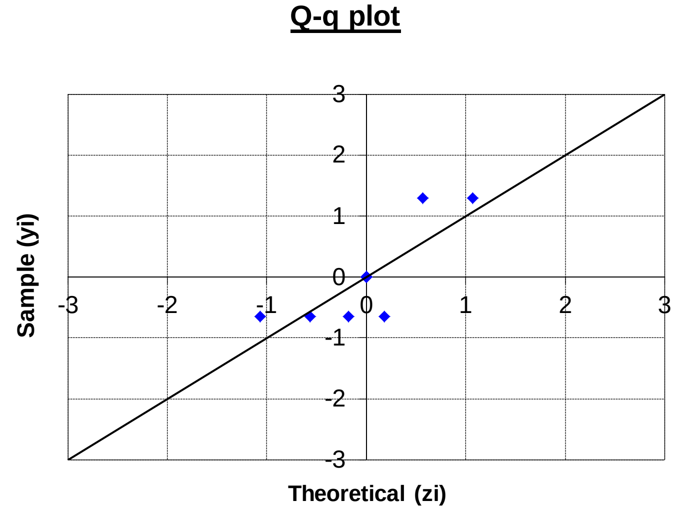
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

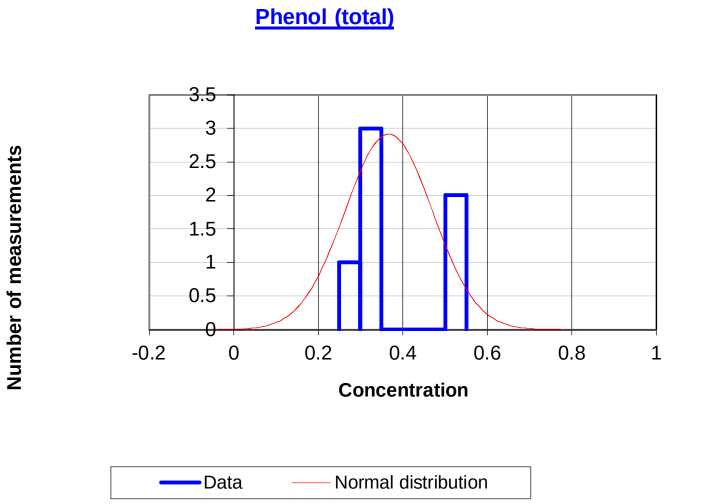
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Phenol (total)	Potential Outlier?	Sample
0.3		HTP07 @ 0.50
0.3		HTP09 @ 0.20
0.3		HTP10 @ 0.50
0.3		HTP13 @ 0.20
0.5	Yes	TP19 @ 0.5
0.5	Yes	TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

290 = GAC (critical conc.) (mg/kg)

6 = no. samples
0 = no. samples > or = GAC
0.3 = min. value
0.5 = max. value
0.3 = laboratory reporting limit (RL)
0.366667 = mean
4 = no. samples at RL
0.10328 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-6869.258 = t_0

2.015 = $t_{(n-1,0.95)}$

0.451627 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-6869.26 = k_0

4.36 = $k_{0.05}$

0.5505 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.5505004 GAC = 290 (US95 = 0.002 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Acenaphthene	**Potential Outlier?**	**Sample**
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

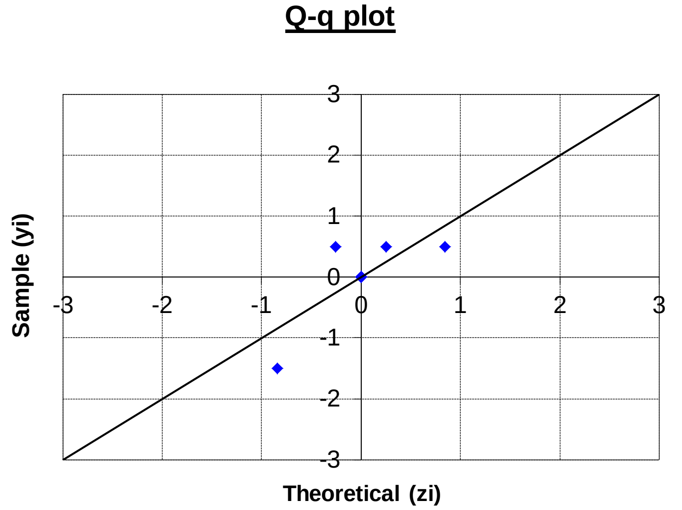
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

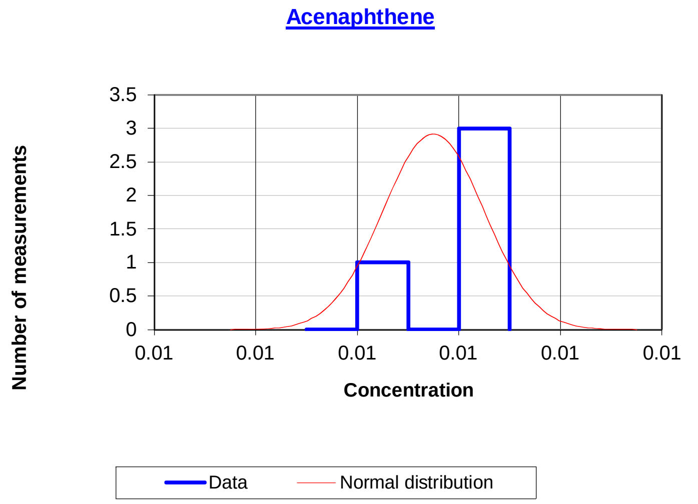
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Note - MAD not applicable as 50% or more of values are the same.

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

480 = GAC (critical conc.) (mg/kg)

4 = no. samples	0 = no. samples > or = GAC
0.01 = min. value	
0.01 = max. value	0.01 = laboratory reporting limit (RL)
0.01 = mean	4 = no. samples at RL
5E-13 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-1.92E+15 = t_0	-1.9E+15 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})	0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.01 **GAC = 480** (US95 = 0 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

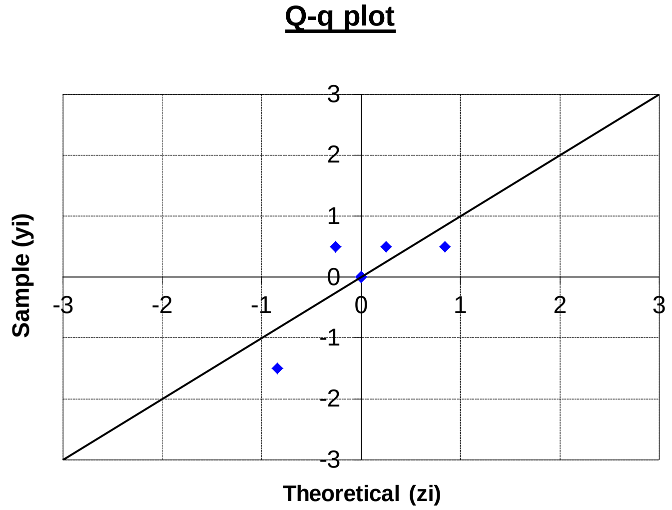
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

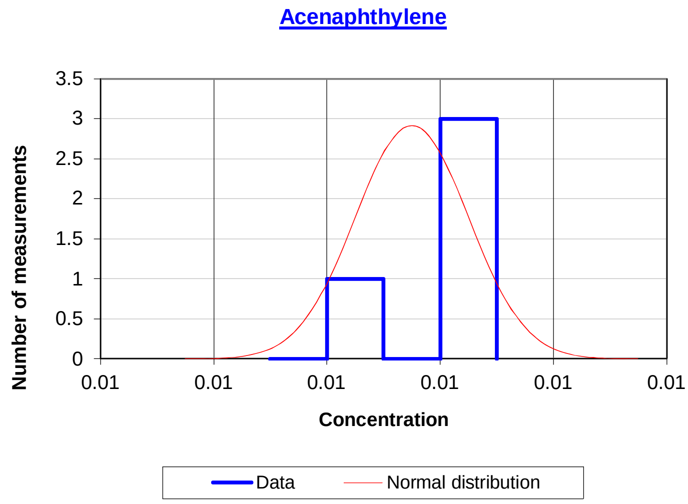
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Acenaphthylene	Potential Outlier?	Sample
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
400 = GAC (critical conc.) (mg/kg)
4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.01 = max. value
0.01 = laboratory reporting limit (RL)
0.01 = mean
4 = no. samples at RL
5E-13 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-1.6E+15 = t_0	-1.6E+15 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})	0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.01 **GAC = 400** (US95 = 0 x GAC)

Site reference
POTENTIALLY SUITABLE FOR USE

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Anthracene		
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

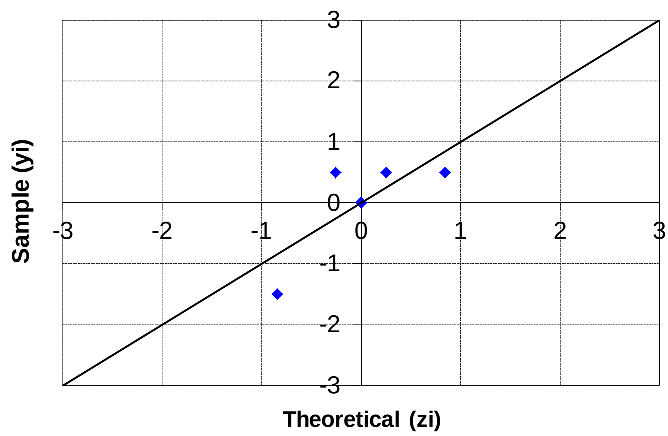
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

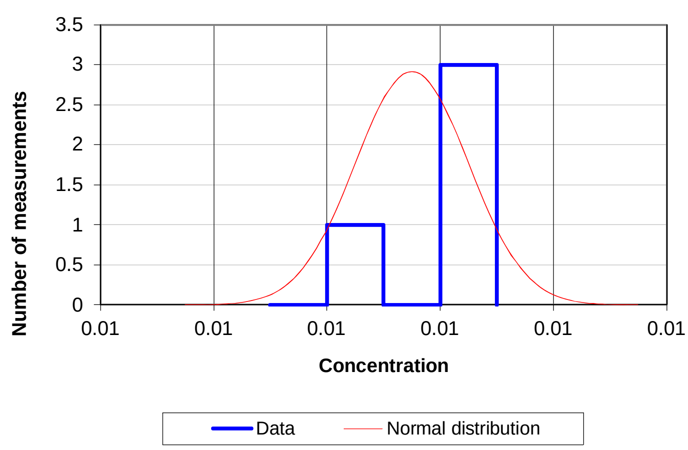
Note - MAD not applicable as 50% or more of values are the same.

Visual assessment - Q-q & histogram plots

Q-q plot



Anthracene



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

4900 = GAC (critical conc.) (mg/kg)

4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.01 = max. value
0.01 = laboratory reporting limit (RL)
0.01 = mean
4 = no. samples at RL
5E-13 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-1.96E+16 = t_0

2.353 = $t_{(n-1,0.95)}$

0.01 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-2E+16 = k_0

4.36 = $k_{0.05}$

0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.01 **GAC = 4900** (US95 = 0 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Benz(a)anthracene	Potential Outlier?	Sample
0.023		HTP07 @ 0.50
0.01		HTP09 @ 0.20
0.012		HTP10 @ 0.50
0.021		HTP13 @ 0.20

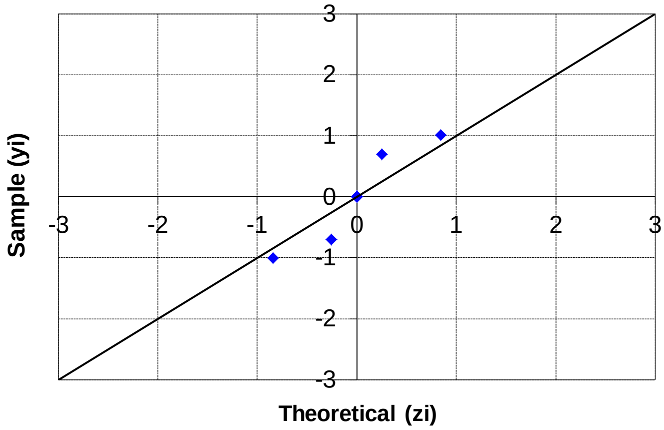
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

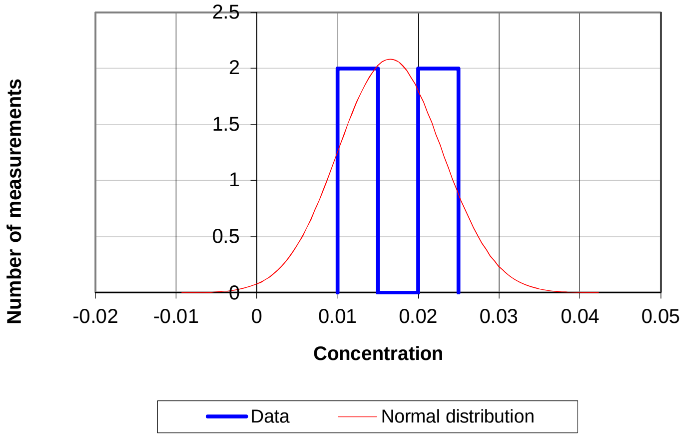
3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots

Q-q plot



Benz(a)anthracene



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

4.7 = GAC (critical conc.) (mg/kg)

4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.023 = max. value
0.01 = laboratory reporting limit (RL)
0.0165 = mean
1 = no. samples at RL
0.006455 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-1451.129 = t_0

2.353 = $t_{(n-1,0.95)}$

0.024094 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-1451.13 = k_0

4.36 = $k_{0.05}$

0.030572 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.0305718 GAC = 4.7 (US95 = 0.007 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

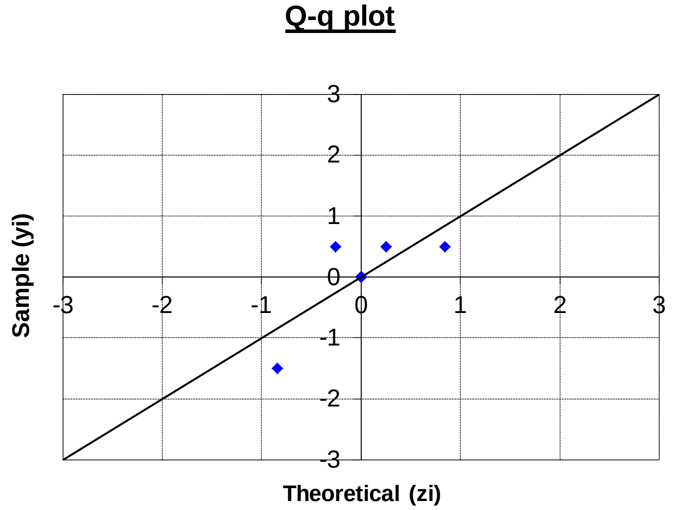
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

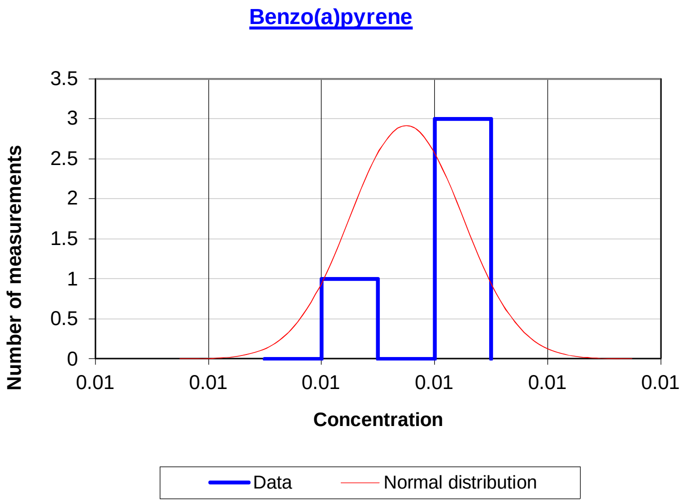
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Benzo(a)pyrene	Potential Outlier?	Sample
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter
Human health - residential with plant uptake (2.5%SOM)
0.94 = GAC (critical conc.) (mg/kg)

4 = no. samples
0.01 = min. value
0.01 = max. value
0.01 = mean
5E-13 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
4 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-3.72E+12 = t_0
2.353 = $t_{(n-1,0.95)}$
0.01 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-3.7E+12 = k_0
4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.01 **GAC = 0.94** (US95 = 0.011 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

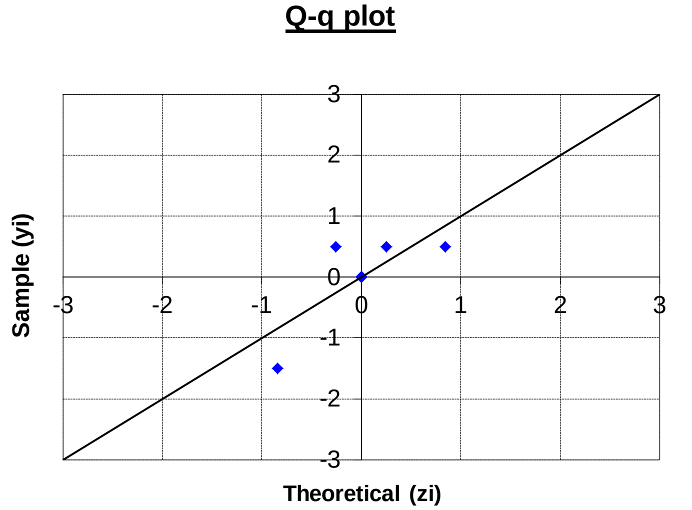
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

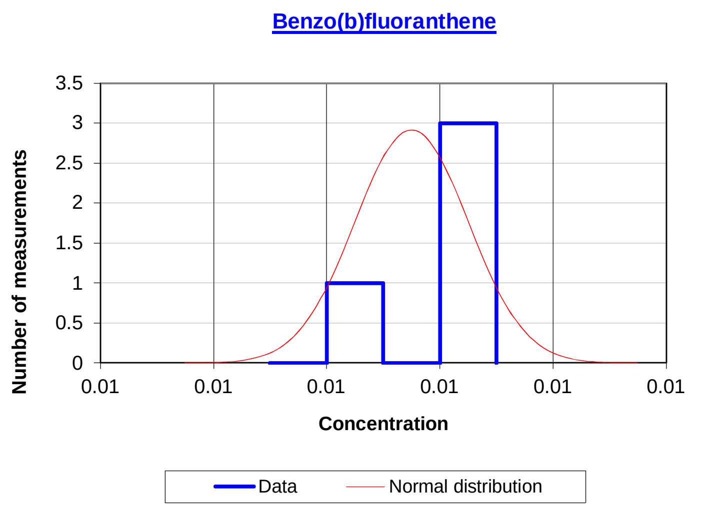
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Benzo(b)fluoranthene	Potential Outlier?	Sample
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
6.5 = GAC (critical conc.) (mg/kg)

4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.01 = max. value
0.01 = laboratory reporting limit (RL)
0.01 = mean
4 = no. samples at RL
5E-13 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-2.6E+13 = t_0	-2.6E+13 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})	0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.01 **GAC = 6.5** (US95 = 0.002 x GAC)

Site reference
POTENTIALLY SUITABLE FOR USE

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

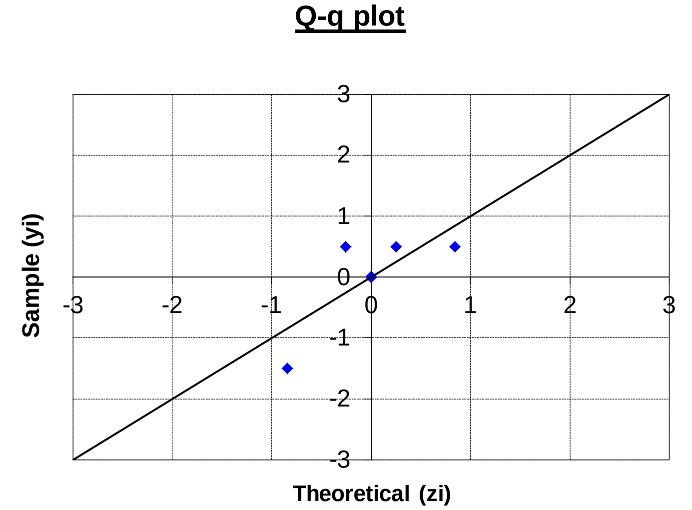
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

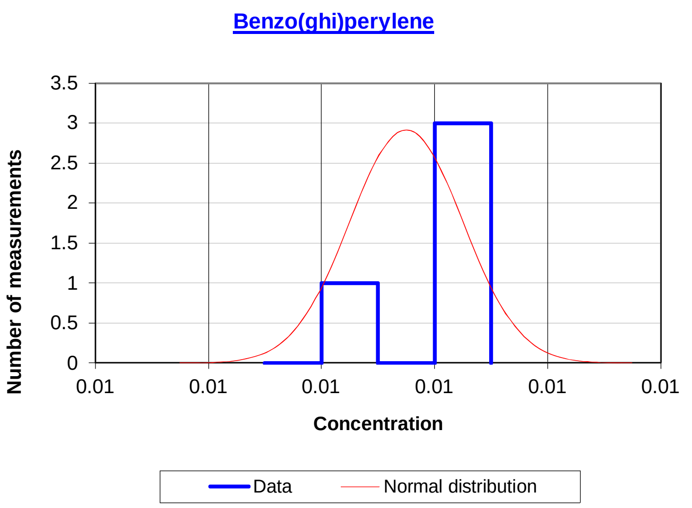
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Benzo(ghi)perylene	Potential Outlier?	Sample
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
46 = GAC (critical conc.) (mg/kg)

4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.01 = max. value
0.01 = laboratory reporting limit (RL)
0.01 = mean
4 = no. samples at RL
5E-13 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-1.84E+14 = t_0	-1.8E+14 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})	0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.01 **GAC = 46** (US95 = 0 x GAC)

Site reference
POTENTIALLY SUITABLE FOR USE

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

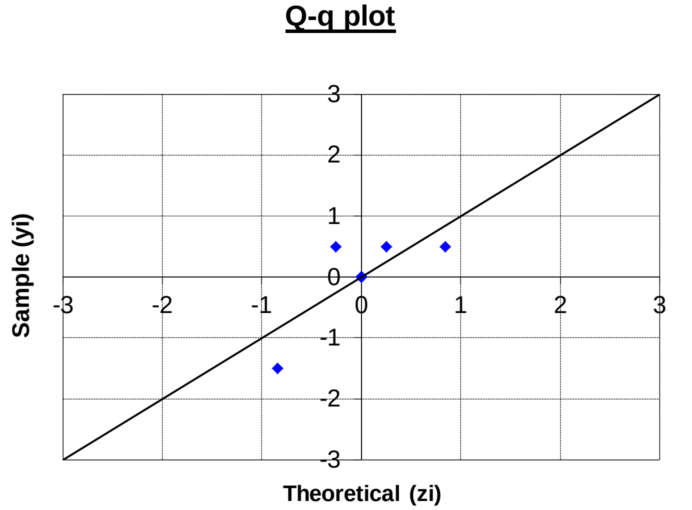
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

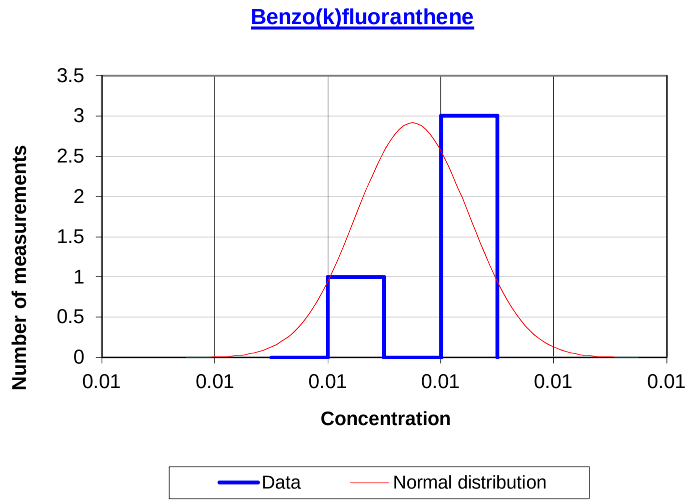
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Benzo(k)fluoranthene	Potential Outlier?	Sample
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

9.6 = GAC (critical conc.) (mg/kg)

4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.01 = max. value
0.01 = laboratory reporting limit (RL)
0.01 = mean
4 = no. samples at RL
5E-13 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-3.84E+13 = t_0	-3.8E+13 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})	0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.01 **GAC = 9.6** (US95 = 0.001 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

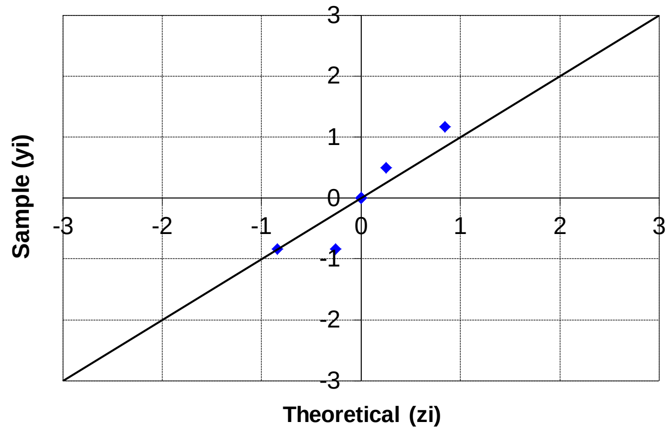
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA	
Chrysene	Potential Outlier?	Sample
0.013		HTP07 @ 0.50
0.01		HTP09 @ 0.20
0.01		HTP10 @ 0.50
0.012		HTP13 @ 0.20

Mean Absolute Deviation for potential outliers

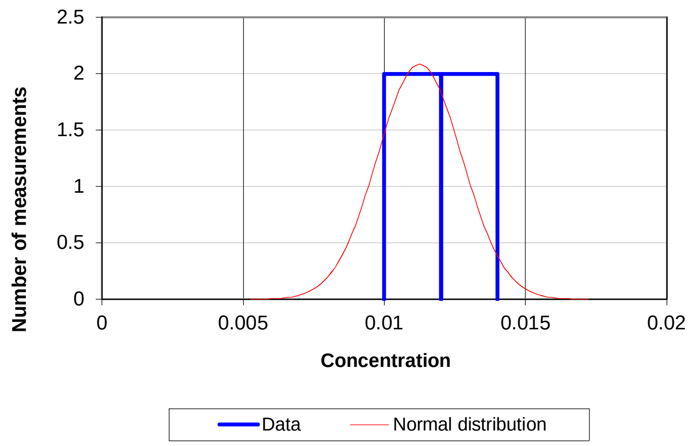
3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots

Q-q plot



Chrysene



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

8 = GAC (critical conc.) (mg/kg)

4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.013 = max. value
0.01 = laboratory reporting limit (RL)
0.01125 = mean
2 = no. samples at RL
0.0015 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-10651.67 = t_0	-10651.7 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.013015 = 95% UCL (US_{95})	0.01452 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.01452 GAC = 8 (US95 = 0.002 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

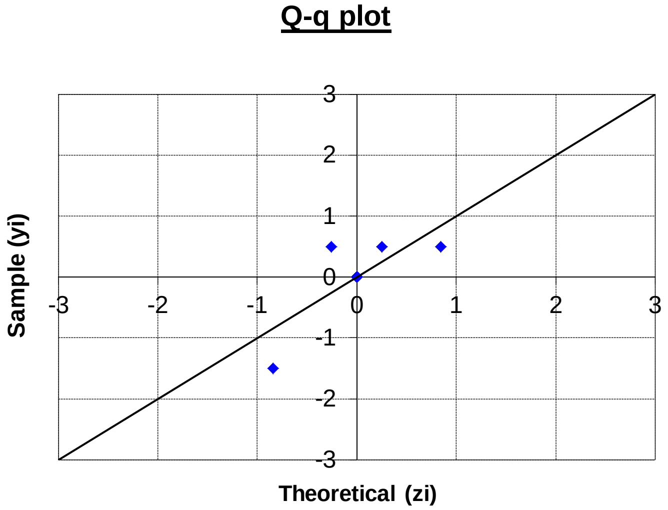
Mean Absolute Deviation for potential outliers

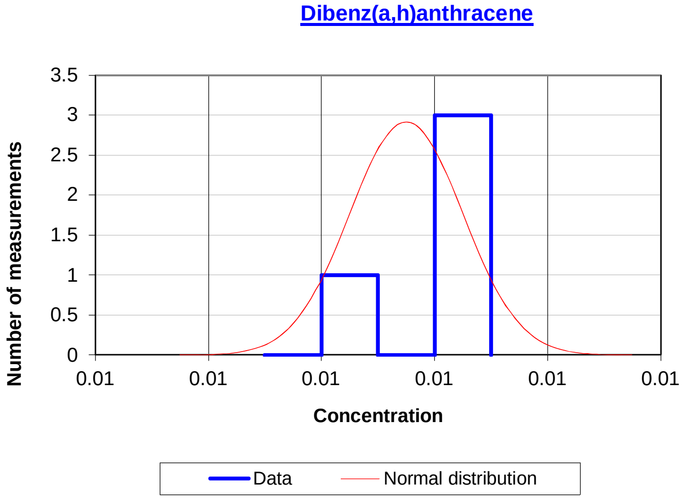
3.5 = critical value of test statistic

Note - MAD not applicable as 50% or more of values are the same.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Dibenz(a,h)anthracene		
0.01	**n/a**	HTP07 @ 0.50
0.01	**n/a**	HTP09 @ 0.20
0.01	**n/a**	HTP10 @ 0.50
0.01	**n/a**	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

0.86 = GAC (critical conc.) (mg/kg)

4 = no. samples	0 = no. samples > or = GAC
0.01 = min. value	
0.01 = max. value	0.01 = laboratory reporting limit (RL)
0.01 = mean	4 = no. samples at RL
5E-13 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-3.4E+12 = t_0	-3.4E+12 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})	0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.01 **GAC = 0.86** (US95 = 0.012 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

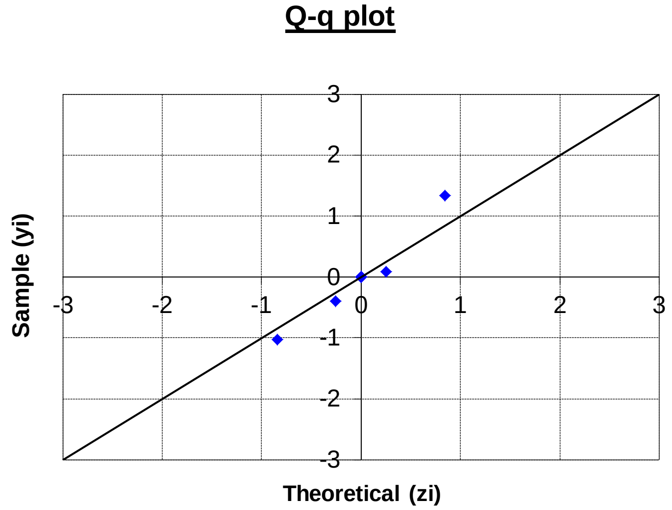
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Fluoranthene	Potential Outlier?	Sample
0.047		HTP07 @ 0.50
0.01		HTP09 @ 0.20
0.031		HTP10 @ 0.50
0.088		HTP13 @ 0.20

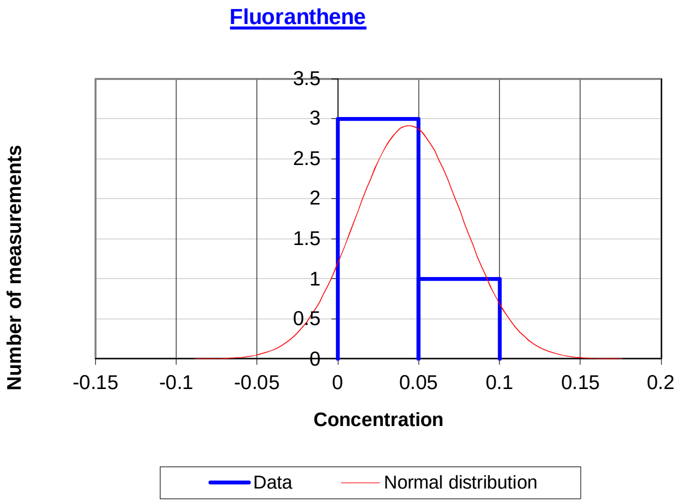
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

460 = GAC (critical conc.) (mg/kg)

4 = no. samples	0 = no. samples > or = GAC
0.01 = min. value	
0.088 = max. value	0.01 = laboratory reporting limit (RL)
0.044 = mean	1 = no. samples at RL
0.033015 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-27863.33 = t_0	-27863.3 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.082842 = 95% UCL (US_{95})	0.115973 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.115973 GAC = 460 (US95 = 0 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

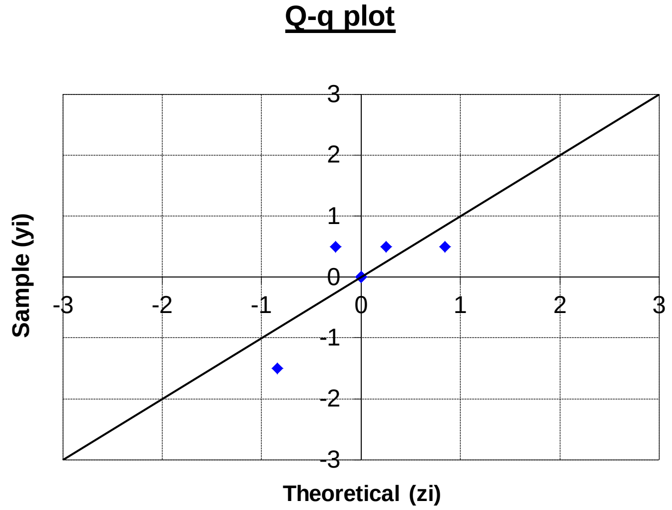
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

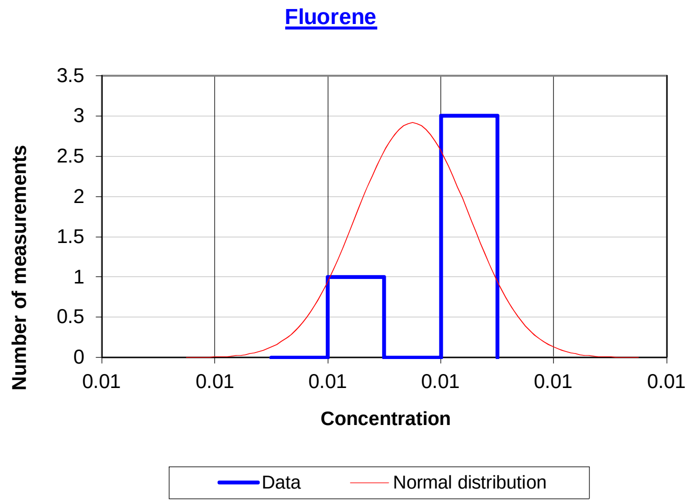
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC) Fluorene	Potential Outlier?	Sample
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
380 = GAC (critical conc.) (mg/kg)

4	= no. samples	0	= no. samples > or = GAC
0.01	= min. value		
0.01	= max. value	0.01	= laboratory reporting limit (RL)
0.01	= mean	4	= no. samples at RL
5E-13	= standard deviation		RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-1.52E+15 = t_0	-1.5E+15 = k_0
2.353 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})	0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.01 **GAC = 380** (US95 = 0 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

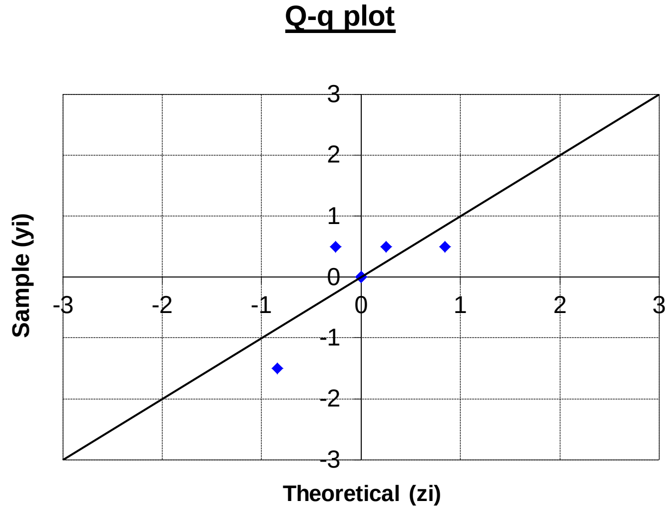
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

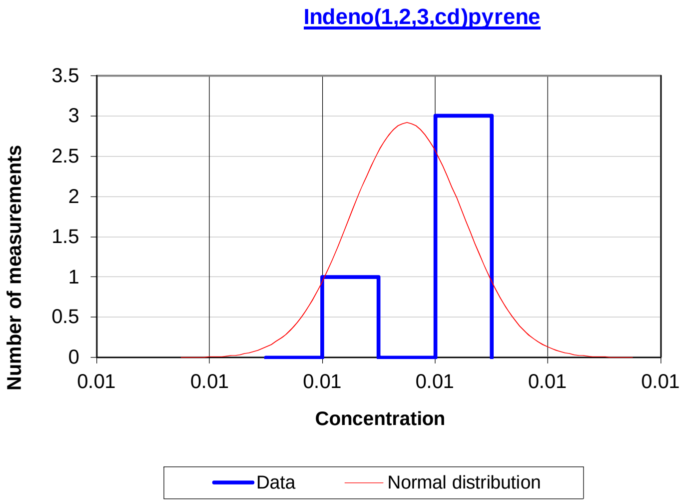
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Indeno(1,2,3,cd)pyrene	Potential Outlier?	Sample
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
3.9 = GAC (critical conc.) (mg/kg)

4 = no. samples
0.01 = min. value
0.01 = max. value
0.01 = mean
5E-13 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
4 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-1.56E+13 = t_0
2.353 = $t_{(n-1,0.95)}$
0.01 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-1.6E+13 = k_0
4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.01 **GAC = 3.9** (US95 = 0.003 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

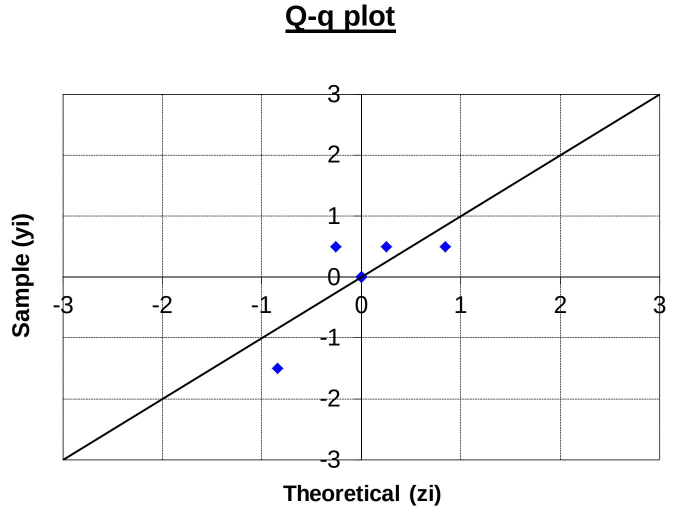
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

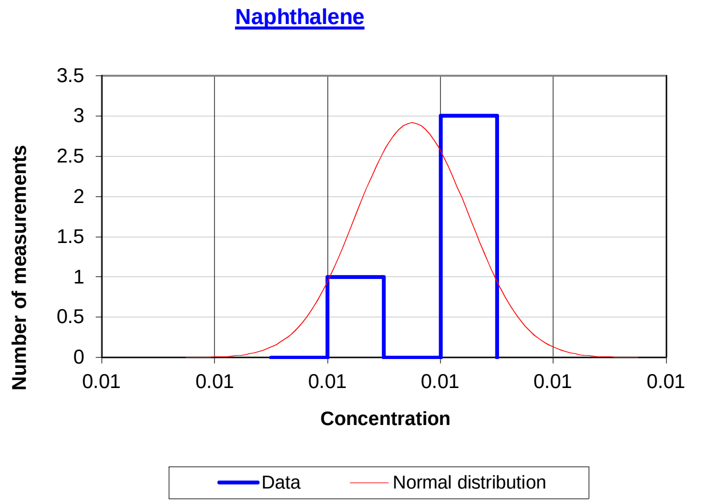
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Naphthalene	Potential Outlier?	Sample
0.01	n/a	HTP07 @ 0.50
0.01	n/a	HTP09 @ 0.20
0.01	n/a	HTP10 @ 0.50
0.01	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

3.7 = GAC (critical conc.) (mg/kg)

4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.01 = max. value
0.01 = laboratory reporting limit (RL)
0.01 = mean
4 = no. samples at RL
5E-13 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-1.48E+13 = t_0
2.353 = $t_{(n-1,0.95)}$
0.01 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-1.5E+13 = k_0
4.36 = $k_{0.05}$
0.01 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.01 **GAC = 3.7** (US95 = 0.003 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

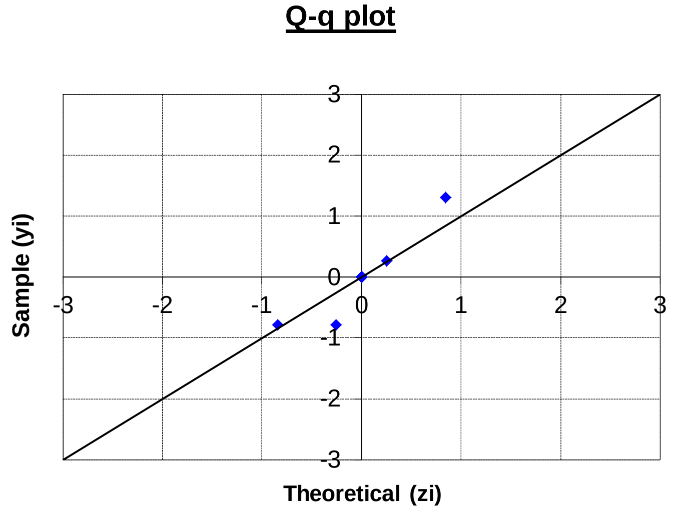
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

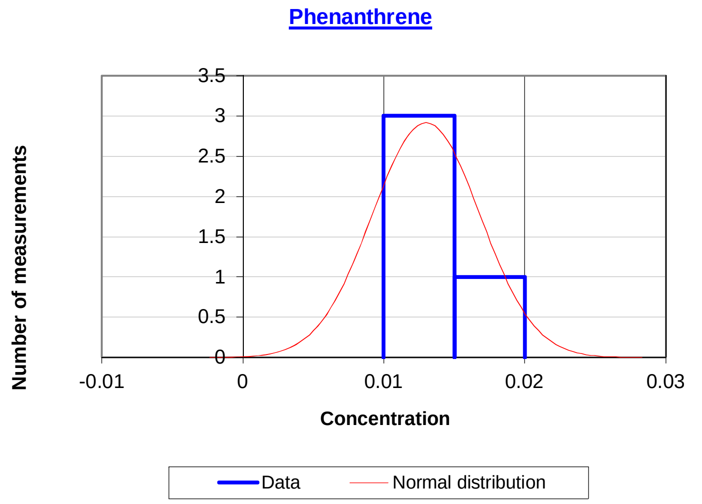
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Phenanthrene	Potential Outlier?	Sample
0.018		HTP07 @ 0.50
0.01		HTP09 @ 0.20
0.01		HTP10 @ 0.50
0.014		HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

200 = GAC (critical conc.) (mg/kg)

4 = no. samples
0.01 = min. value
0.018 = max. value
0.013 = mean
0.00383 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
2 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-104439.8 = t_0
2.353 = $t_{(n-1,0.95)}$
0.017506 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-104440 = k_0
4.36 = $k_{0.05}$
0.021349 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.0213488 GAC = 200 (US95 = 0 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

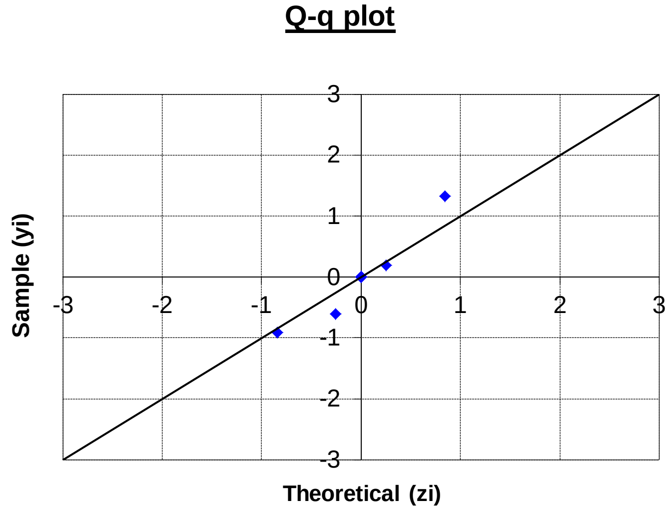
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

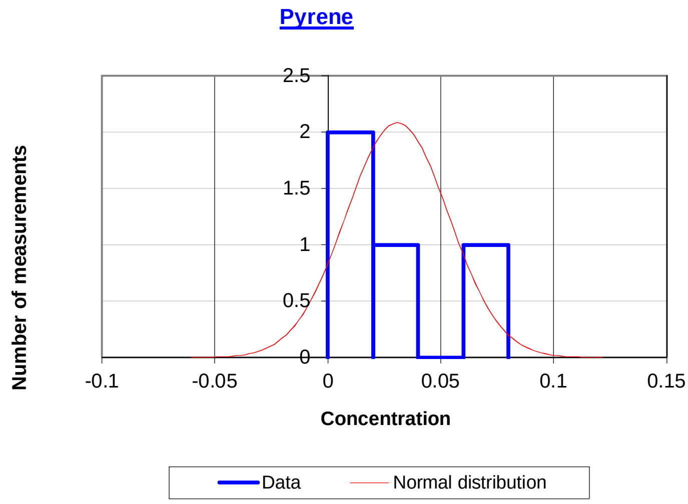
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Pyrene	Potential Outlier?	Sample
0.035		HTP07 @ 0.50
0.01		HTP09 @ 0.20
0.017		HTP10 @ 0.50
0.061		HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
1000 = GAC (critical conc.) (mg/kg)

4 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.061 = max. value
0.01 = laboratory reporting limit (RL)
0.03075 = mean
1 = no. samples at RL
0.02275 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-87907.62 = t_0
2.353 = $t_{(n-1,0.95)}$
0.057516 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-87907.6 = k_0
4.36 = $k_{0.05}$
0.080346 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.080346 GAC = 1000 (US95 = 0 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

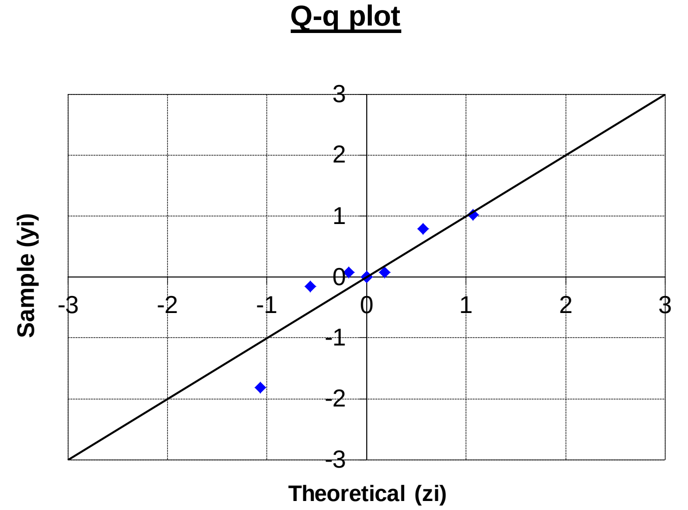
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

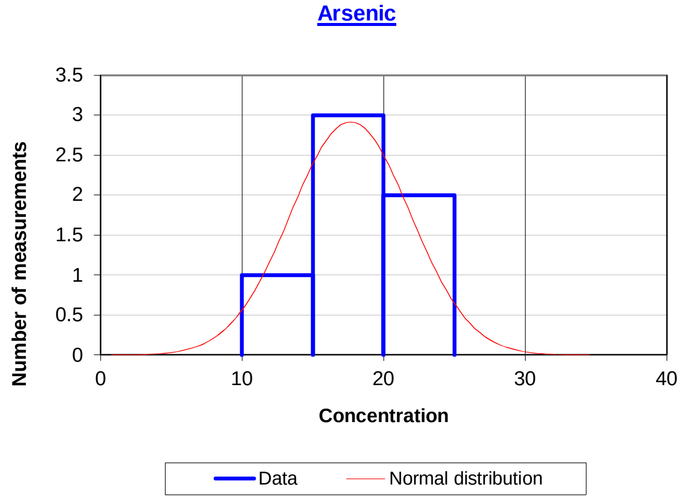
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Arsenic	Potential Outlier?	Sample
18		HTP07 @ 0.50
22		HTP09 @ 0.20
18		HTP10 @ 0.50
17		HTP13 @ 0.20
10		TP19 @ 0.5
21		TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Plant life pH 7

250 = GAC (critical conc.) (mg/kg)
6 = no. samples
10 = min. value
22 = max. value
17.66667 = mean
4.226898 = standard deviation

0 = no. samples > or = GAC
2 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-134.6373 = t_0
2.015 = $t_{(n-1,0.95)}$
21.1438 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-134.637 = k_0
4.36 = $k_{0.05}$
25.19039 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 25.190387 GAC = 250 (US95 = 0.101 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

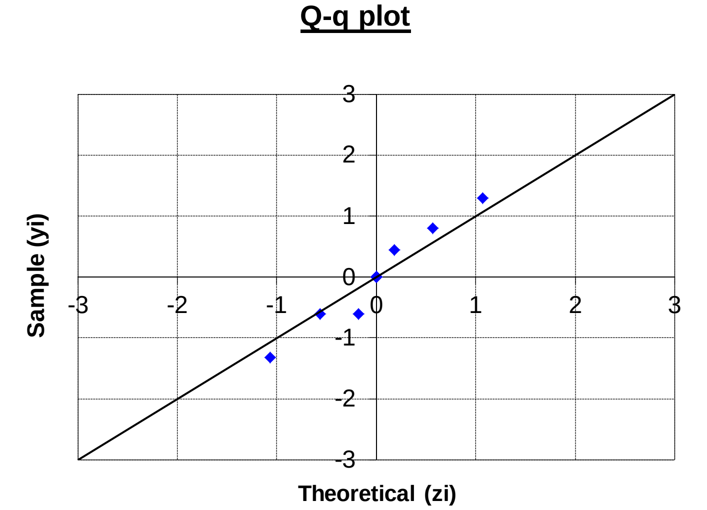
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

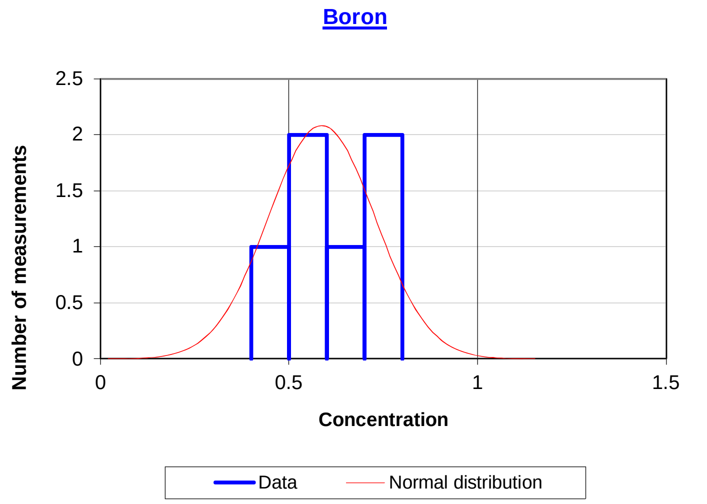
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Boron	Potential Outlier?	Sample
0.5		HTP07 @ 0.50
0.4		HTP09 @ 0.20
0.5		HTP10 @ 0.50
0.7		HTP13 @ 0.20
0.65		TP19 @ 0.5
0.77		TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data

Risk parameter
Plant life pH 7

3 = GAC (critical conc.) (mg/kg)

6 = no. samples	0 = no. samples > or = GAC
0.4 = min. value	
0.77 = max. value	0.4 = laboratory reporting limit (RL)
0.586667 = mean	1 = no. samples at RL
0.141657 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-41.73067 = t_0	-41.7307 = k_0
2.015 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.703196 = 95% UCL (US_{95})	0.838811 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.8388106 GAC = 3 (US95 = 0.28 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

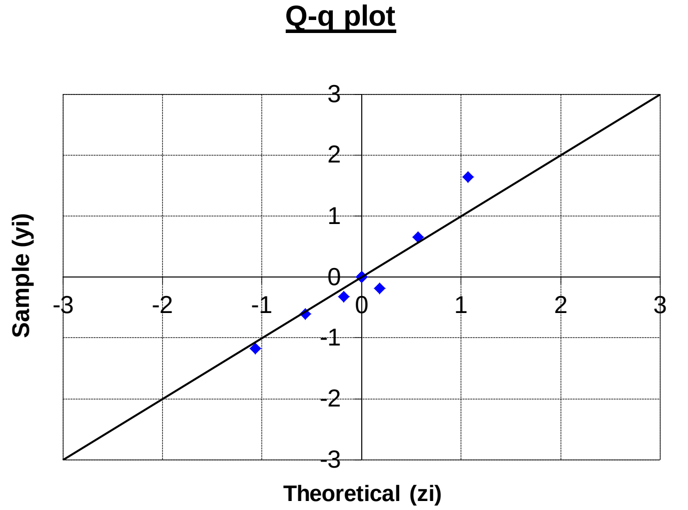
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Chromium (III)		
48.5		HTP07 @ 0.50
40.5		HTP09 @ 0.20
41.5		HTP10 @ 0.50
38.5		HTP13 @ 0.20
42		TP19 @ 0.5
45		TP21 @ 0.4

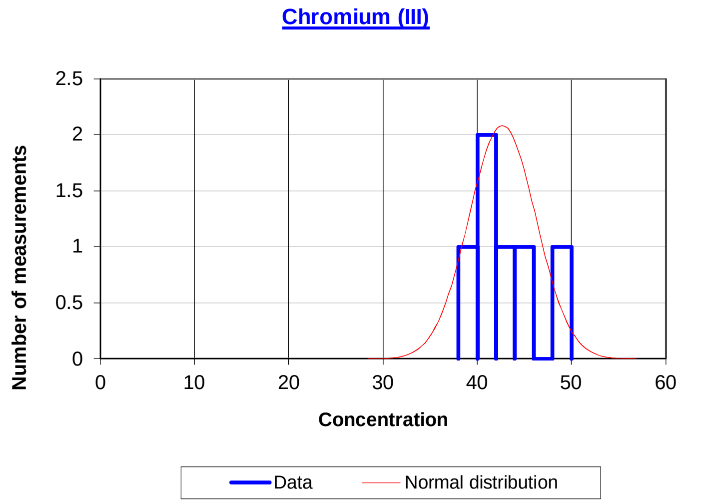
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots





Basic data

Risk parameter
Plant life pH 7

400 = GAC (critical conc.) (mg/kg)

6 = no. samples
38.5 = min. value
48.5 = max. value
42.66667 = mean
3.559026 = standard deviation

0 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-245.9337 = t_0
2.015 = $t_{(n-1,0.95)}$
45.59439 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-245.934 = k_0
4.36 = $k_{0.05}$
49.0016 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 49.0016 GAC = 400 (US95 = 0.123 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

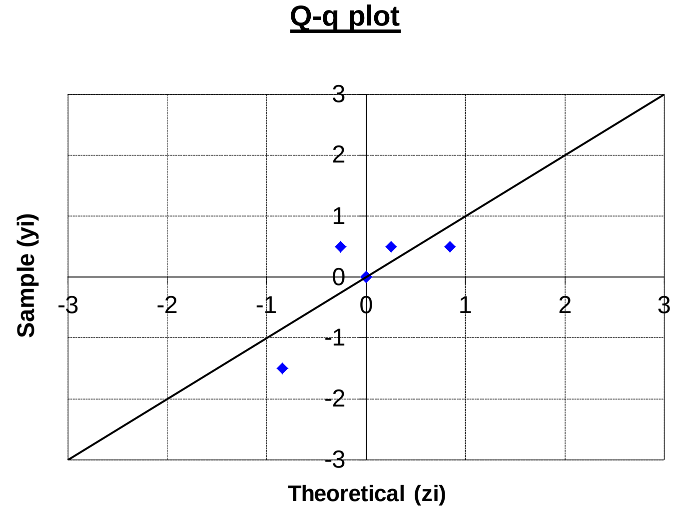
3.5 = critical value of test statistic

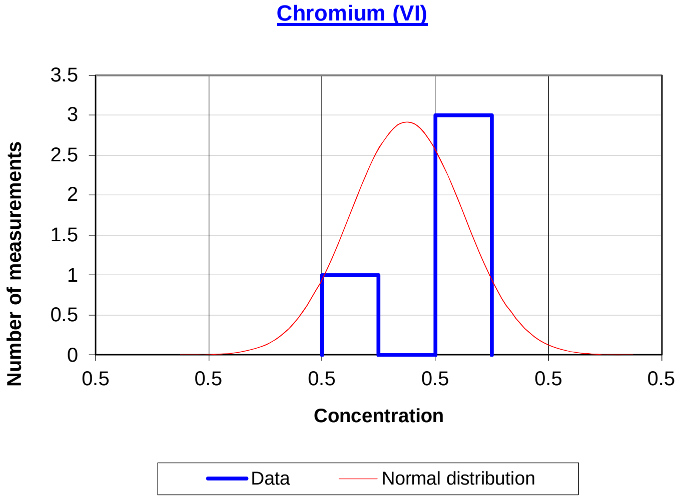
Note - MAD not applicable as 50% or more of values are the same.

Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Chromium (VI)	Potential Outlier?	Sample
0.5	n/a	HTP07 @ 0.50
0.5	n/a	HTP09 @ 0.20
0.5	n/a	HTP10 @ 0.50
0.5	n/a	HTP13 @ 0.20

Visual assessment - Q-q & histogram plots





Basic data

Risk parameter
Plant life pH 7

25 = GAC (critical conc.) (mg/kg)

4 = no. samples
0.5 = min. value
0.5 = max. value
0.5 = mean
5E-12 = standard deviation

0 = no. samples > or = GAC
0.5 = laboratory reporting limit (RL)
4 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-9.8E+12 = t_0
2.353 = $t_{(n-1,0.95)}$
0.5 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-9.8E+12 = k_0
4.36 = $k_{0.05}$
0.5 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.5 **GAC = 25** (US95 = 0.02 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Copper	**Potential Outlier?**	**Sample**
15		HTP07 @ 0.50
12		HTP09 @ 0.20
10		HTP10 @ 0.50
12		HTP13 @ 0.20
11		TP19 @ 0.5
5.9	Yes	TP21 @ 0.4

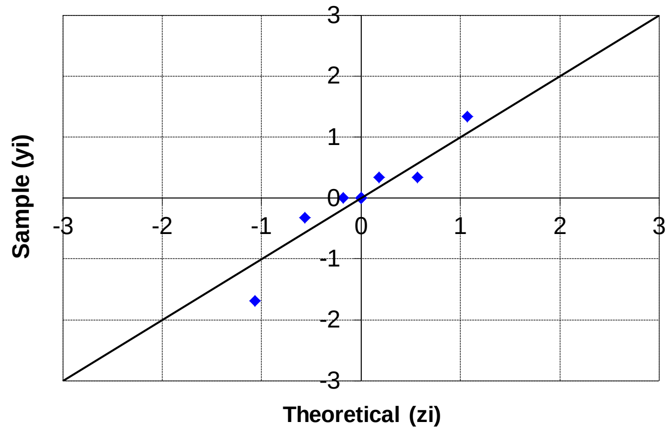
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

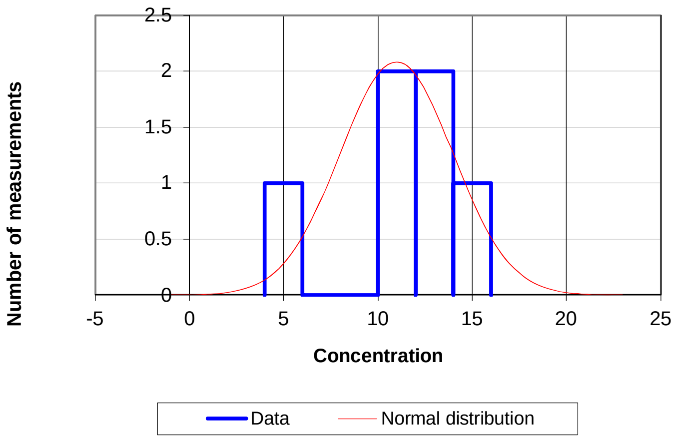
3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots

Q-q plot



Copper



Basic data

Risk parameter
Plant life pH 7

135 = GAC (critical conc.) (mg/kg)

6 = no. samples	0 = no. samples > or = GAC
5.9 = min. value	
15 = max. value	5 = laboratory reporting limit (RL)
10.98333 = mean	0 = no. samples at RL
3.000278 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-101.2498 = t_0	-101.25 = k_0
2.015 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
13.45142 = 95% UCL (US_{95})	16.32372 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 16.323715 GAC = 135 (US95 = 0.121 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

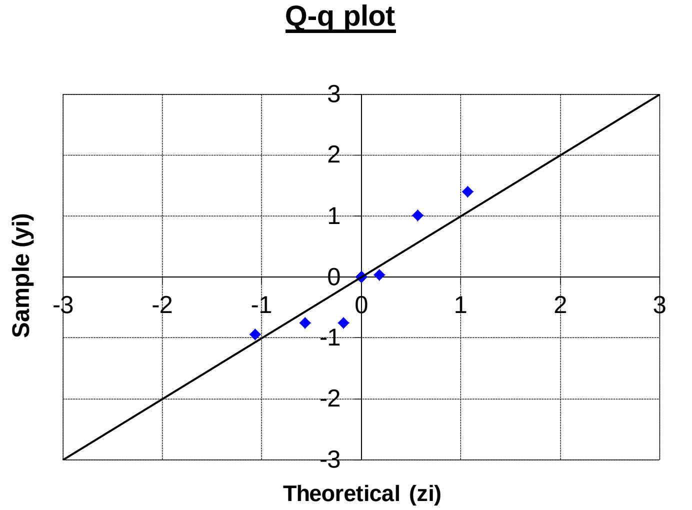
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

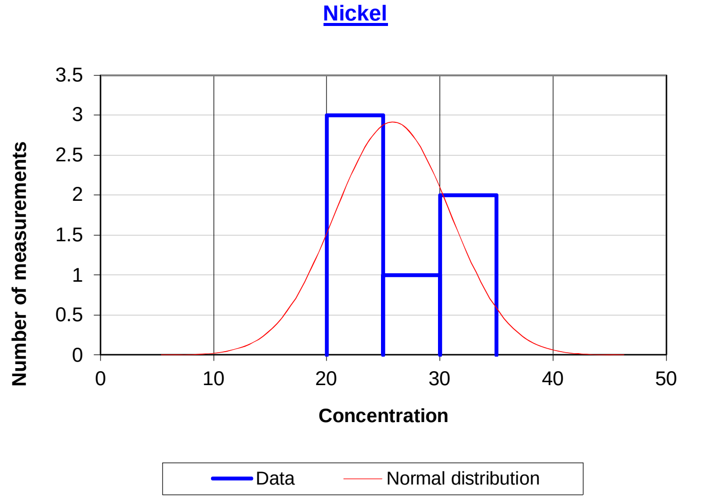
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Nickel	Potential Outlier?	Sample
33		HTP07 @ 0.50
22		HTP09 @ 0.20
22		HTP10 @ 0.50
21		HTP13 @ 0.20
31		TP19 @ 0.5
26		TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter

Plant life pH 7

75 = GAC (critical conc.) (mg/kg)

6 = no. samples
21 = min. value
33 = max. value
25.83333 = mean
5.115336 = standard deviation

0 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-23.54356 = t_0
2.015 = $t_{(n-1,0.95)}$
30.04131 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-23.5436 = k_0
4.36 = $k_{0.05}$
34.93844 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 34.938441 GAC = 75 (US95 = 0.466 x GAC)

POTENTIALLY SUITABLE FOR USE

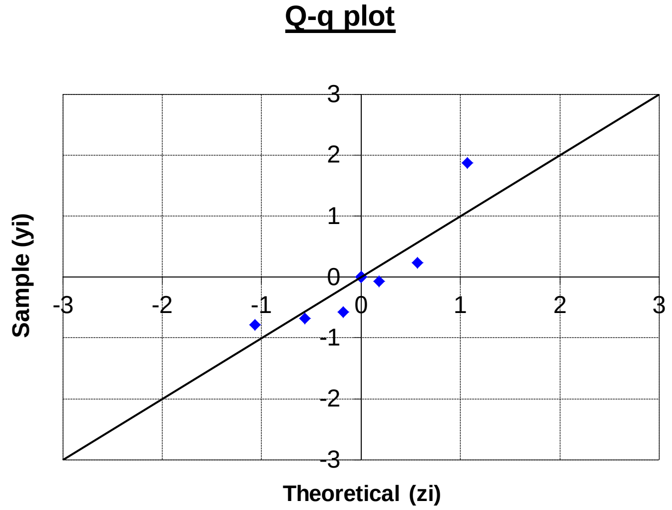
Site reference

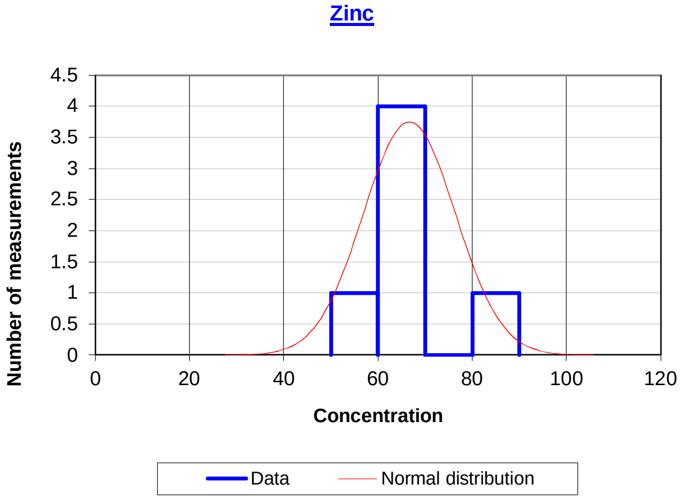
Data set: CMF & DF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA	
	Mean Absolute Deviation for potential outliers	
	3.5 = critical value of test statistic	
Zinc	**Potential Outlier?**	**Sample**
85	Yes	HTP07 @ 0.50
59		HTP09 @ 0.20
66		HTP10 @ 0.50
61		HTP13 @ 0.20
60		TP19 @ 0.5
69		TP21 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter: **Plant life pH 7**

300 = GAC (critical conc.) (mg/kg)

6 = no. samples	0 = no. samples > or = GAC
59 = min. value	
85 = max. value	10 = laboratory reporting limit (RL)
66.66667 = mean	0 = no. samples at RL
9.770705 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-58.49605 = t_0	-58.496 = k_0
2.015 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
74.70425 = 95% UCL (US_{95})	84.05815 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 84.058155 GAC = 300 (US95 = 0.28 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: CMF & DF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Assessment of Chemicals of Potential Concern to Human Health

Hydrock

								Soil Type	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT
	All values in mg/kg unless otherwise stated							Location & Depth	HTP15	HTP17	HTP20	HTP22	HTP24	HTP25	HTP26	HTP29	HTP33	HTP39	HTP40
Chemical of Potential Concern	**Lab. RL**	**No. Samples**	**Min. Value**	**Max. Value**	**No. Samples > or = GAC**	**GAC**	**US_{95}**	**Result of Significance Test**	0.25	0.15	0.15	0.20	0.20	0.15	0.10	0.15	0.25	0.20	0.20
Arsenic	2	40	17	230	37	32	110.5811	FURTHER ASSESSMENT REQUIRED	110	66	68	86	79	140	120	58	76	52	58
Beryllium	1	18	0.5	5.6	0	51	4.442717	POTENTIALLY SUITABLE FOR USE	4.1	1.6	2.3	2.5	2	4.2	3.7	1.6	2.1	1.4	1.6
Boron	0.4	20	0.5	2.2	0	290	1.440611	POTENTIALLY SUITABLE FOR USE	0.8	0.9	1.4	0.7	0.9	0.5	1.1	1.3	1.2	0.7	0.9
Cadmium	0.1	23	0.1	1.8	0	11	0.693381	POTENTIALLY SUITABLE FOR USE	0.1	0.1	0.28	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Chromium (III)	5	23	46.6	589.5	0	630	329.0309	POTENTIALLY SUITABLE FOR USE	269.5	77.5	87.5	109.5	109.5	269.5	239.5	77.5	99.5	77.5	81.5
Chromium (VI)	0.5	20	0.2	1.2	0	4.3	0.683627	POTENTIALLY SUITABLE FOR USE	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Copper	5	23	6	49	0	2300	38.32559	POTENTIALLY SUITABLE FOR USE	21	23	31	31	31	41	46	28	40	23	26
Lead	5	23	19	120	0	450	82.2043	POTENTIALLY SUITABLE FOR USE	39	46	62	55	51	70	120	48	71	44	49
Mercury, inorganic	0.1	23	0.1	0.6	0	170	0.349307	POTENTIALLY SUITABLE FOR USE	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Nickel	5	40	29	210	8	130	110.2809	POTENTIALLY SUITABLE FOR USE	110	62	99	100	92	150	120	69	79	52	60
Selenium	0.2	23	0.2	3	0	350	1.454144	POTENTIALLY SUITABLE FOR USE	0.2	0.2	0.2	0.2	0.2	0.22	0.2	0.2	0.2	0.2	0.2
Vanadium	5	16	100	740	16	74	549.9117	FURTHER ASSESSMENT REQUIRED	410	120	150	150	160	380	320	120	150	100	120
Zinc	10	23	74	970	0	3700	393.701	POTENTIALLY SUITABLE FOR USE	190	110	180	140	160	300	260	110	150	100	120
Cyanide (free)	0.5	20	0.5	5	0	750	3.200455	POTENTIALLY SUITABLE FOR USE	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Phenol (total)	0.3	20	0.01	1.1	0	290	0.539339	POTENTIALLY SUITABLE FOR USE	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Acenaphthene	0.01	20	0.01	0.5	0	480	0.312093	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Acenaphthylene	0.01	20	0.01	0.5	0	400	0.309073	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.073	0.026
Anthracene	0.01	20	0.01	0.78	0	4900	0.363842	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.11	0.01	0.01	0.01	0.01	0.012	0.01	0.14	0.064
Benz(a)anthracene	0.01	20	0.01	0.95	0	4.7	0.507781	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.36	0.01	0.01	0.01	0.047	0.099	0.023	0.95	0.48
Benzo(a)pyrene	0.01	20	0.01	0.95	1	0.94	0.483634	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.38	0.01	0.01	0.01	0.01	0.07	0.018	0.69	0.33
Benzo(b)fluoranthene	0.01	20	0.01	1.2	0	6.5	0.575744	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.5	0.01	0.01	0.01	0.046	0.12	0.021	1.2	0.62
Benzo(ghi)perylene	0.01	20	0.01	0.5	0	46	0.320275	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.12	0.01	0.01	0.01	0.01	0.013	0.01	0.21	0.076
Benzo(k)fluoranthene	0.01	20	0.01	0.5	0	9.6	0.333785	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.13	0.01	0.01	0.01	0.01	0.011	0.01	0.35	0.099
Chrysene	0.01	20	0.01	0.78	0	8	0.454279	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.3	0.01	0.01	0.01	0.029	0.08	0.024	0.78	0.32
Dibenz(a,h)anthracene	0.01	20	0.01	0.5	0	0.86	0.30405	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fluoranthene	0.01	20	0.01	2.3	0	460	1.011848	POTENTIALLY SUITABLE FOR USE	0.096	0.019	0.81	0.043	0.01	0.028	0.13	0.26	0.076	1.7	0.84
Fluorene	0.01	20	0.01	0.5	0	380	0.311894	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Indeno(1,2,3,cd)pyrene	0.01	20	0.01	0.5	0	3.9	0.318916	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.083	0.01	0.01	0.01	0.01	0.01	0.01	0.22	0.069
Naphthalene	0.01	20	0.01	2	0	3.7	1.049686	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Phenanthrene	0.01	20	0.01	2.1	0	200	0.725232	POTENTIALLY SUITABLE FOR USE	0.039	0.01	0.39	0.01	0.01	0.01	0.043	0.059	0.029	0.28	0.17
Pyrene	0.01	20	0.01	2.3	0	1000	0.928259	POTENTIALLY SUITABLE FOR USE	0.037	0.028	0.64	0.03	0.01	0.024	0.1	0.21	0.056	1.4	0.65
	Mean																		
FOC (dimensionless)	0.020								0.0099	0.017	0.023	0.021	0.057	0.012	0.013	0.023	0.017	0.011	0.013
SOM (calculated)	3.40%								1.71%	2.93%	3.97%	3.62%	9.83%	2.07%	2.24%	3.97%	2.93%	1.90%	2.24%
pH (su)	7.7								7.1	7.5	7.7	8.3	7.7	7.7	7.9	7.9	7.6	7.6	7.3

Risk parameter: Human health - residential with plant uptake (2.5%SOM)
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Legend: Values in blue are at or below the laboratory reporting limit (where a single value is indicated) and are
considered as being at the detection limit for the purposes of statistical analysis, as a conservative es
Values in red are equal to, or greater than, the generic assessment criterion (GAC).
MG denotes Made Ground
NAT denotes natural ground

Assessment of Chemicals of Potential Concern to Human Health

Hydrock

								Soil Type	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT
All values in mg/kg unless otherwise stated								Location & Depth	HTP41	HTP43	HTP44	HTP45	HTP46	TP5	TP8	TP8	TP9	HS1 TS1
Chemical of Potential Concern	Lab. RL	No. Samples	Min. Value	Max. Value	No. Samples > or = GAC	GAC	US_{95}	Result of Significance Test	0.1	0.2	0.7	0.4	0.7	0.1	0.4	2.8	0.6	0.21
Arsenic	2	40	17	230	37	32	110.5811	FURTHER ASSESSMENT REQUIRED	190	130	230	120	170	19	58	17	27	120
Beryllium	1	18	0.5	5.6	0	51	4.442717	POTENTIALLY SUITABLE FOR USE	5.4	3.6	5.6	3.3	4.8	0.5	0.5			
Boron	0.4	20	0.5	2.2	0	290	1.440611	POTENTIALLY SUITABLE FOR USE	1	1	0.7	1	1.2	1.8	1	2.2	0.7	
Cadmium	0.1	23	0.1	1.8	0	11	0.693381	POTENTIALLY SUITABLE FOR USE	0.36	0.37	0.27	0.4	0.23	0.5	0.5	0.5	0.5	
Chromium (III)	5	23	46.6	589.5	0	630	329.0309	POTENTIALLY SUITABLE FOR USE	479.5	209.5	539.5	189.5	589.5	55.57	109.8	53.8	46.6	
Chromium (VI)	0.5	20	0.2	1.2	0	4.3	0.683627	POTENTIALLY SUITABLE FOR USE	0.5	0.5	0.5	0.5	0.5	0.43	0.2	1.2	0.4	
Copper	5	23	6	49	0	2300	38.32559	POTENTIALLY SUITABLE FOR USE	40	49	35	43	25	11	18	13	12	
Lead	5	23	19	120	0	450	82.2043	POTENTIALLY SUITABLE FOR USE	81	90	84	81	33	32	37	25	19	
Mercury, inorganic	0.1	23	0.1	0.6	0	170	0.349307	POTENTIALLY SUITABLE FOR USE	0.19	0.19	0.13	0.17	0.1	0.2	0.27	0.2	0.2	
Nickel	5	40	29	210	8	130	110.2809	POTENTIALLY SUITABLE FOR USE	170	160	210	130	180	29	57	32	43	100
Selenium	0.2	23	0.2	3	0	350	1.454144	POTENTIALLY SUITABLE FOR USE	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	
Vanadium	5	16	100	740	16	74	549.9117	FURTHER ASSESSMENT REQUIRED	670	330	710	290	740					
Zinc	10	23	74	970	0	3700	393.701	POTENTIALLY SUITABLE FOR USE	340	290	380	220	970	82	130	74	84	
Cyanide (free)	0.5	20	0.5	5	0	750	3.200455	POTENTIALLY SUITABLE FOR USE	0.5	0.5	0.5	0.5	0.5	5	5	5	5	
Phenol (total)	0.3	20	0.01	1.1	0	290	0.539339	POTENTIALLY SUITABLE FOR USE	0.01	0.1	0.044	0.054	0.091	0.5	0.5	1.1	0.5	
Acenaphthene	0.01	20	0.01	0.5	0	480	0.312093	POTENTIALLY SUITABLE FOR USE	0.01	0.1	0.044	0.054	0.091	0.5	0.5	0.5	0.5	
Acenaphthylene	0.01	20	0.01	0.5	0	400	0.309073	POTENTIALLY SUITABLE FOR USE	0.01	0.063	0.03	0.028	0.01	0.5	0.5	0.5	0.5	
Anthracene	0.01	20	0.01	0.78	0	4900	0.363842	POTENTIALLY SUITABLE FOR USE	0.03	0.02	0.01	0.01	0.031	0.5	0.78	0.5	0.5	
Benz(a)anthracene	0.01	20	0.01	0.95	0	4.7	0.507781	POTENTIALLY SUITABLE FOR USE	0.11	0.04	0.01	0.01	0.01	0.5	0.76	0.5	0.5	
Benzo(a)pyrene	0.01	20	0.01	0.95	1	0.94	0.483634	POTENTIALLY SUITABLE FOR USE	0.055	0.023	0.01	0.01	0.01	0.5	0.95	0.5	0.5	
Benzo(b)fluoranthene	0.01	20	0.01	1.2	0	6.5	0.575744	POTENTIALLY SUITABLE FOR USE	0.18	0.056	0.01	0.01	0.01	0.5	0.7	0.5	0.5	
Benzo(ghi)perylene	0.01	20	0.01	0.5	0	46	0.320275	POTENTIALLY SUITABLE FOR USE	0.032	0.01	0.01	0.01	0.01	0.5	0.5	0.5	0.5	
Benzo(k)fluoranthene	0.01	20	0.01	0.5	0	9.6	0.333785	POTENTIALLY SUITABLE FOR USE	0.014	0.023	0.01	0.01	0.01	0.5	0.5	0.5	0.5	
Chrysene	0.01	20	0.01	0.78	0	8	0.454279	POTENTIALLY SUITABLE FOR USE	0.11	0.054	0.01	0.01	0.01	0.5	0.72	0.5	0.5	
Dibenz(a,h)anthracene	0.01	20	0.01	0.5	0	0.86	0.30405	POTENTIALLY SUITABLE FOR USE	0.01	0.01	0.01	0.01	0.01	0.5	0.5	0.5	0.5	
Fluoranthene	0.01	20	0.01	2.3	0	460	1.011848	POTENTIALLY SUITABLE FOR USE	0.24	0.17	0.091	0.071	0.096	0.5	2.3	0.5	0.5	
Fluorene	0.01	20	0.01	0.5	0	380	0.311894	POTENTIALLY SUITABLE FOR USE	0.01	0.08	0.038	0.053	0.11	0.5	0.5	0.5	0.5	
Indeno(1,2,3,cd)pyrene	0.01	20	0.01	0.5	0	3.9	0.318916	POTENTIALLY SUITABLE FOR USE	0.025	0.01	0.01	0.01	0.01	0.5	0.5	0.5	0.5	
Naphthalene	0.01	20	0.01	2	0	3.7	1.049686	POTENTIALLY SUITABLE FOR USE	0.8	1.5	0.95	1.2	2	0.5	1.1	0.5	0.5	
Phenanthrene	0.01	20	0.01	2.1	0	200	0.725232	POTENTIALLY SUITABLE FOR USE	0.22	0.17	0.1	0.08	0.24	0.5	2.1	0.5	0.5	
Pyrene	0.01	20	0.01	2.3	0	1000	0.928259	POTENTIALLY SUITABLE FOR USE	0.17	0.12	0.072	0.045	0.063	0.5	2.3	0.5	0.5	
	Mean																	
FOC (dimensionless)	0.020								0.023	0.018	0.012	0.022	0.0053					0.025
SOM (calculated)	3.40%								3.97%	3.10%	2.07%	3.79%	0.91%					4.31%
pH (su)	7.7								7.7	7.5	7.6	6.9	7.9	7.2	8.1	7.4	7.1	8.2

Risk parameter: **Human health - residential with plant uptake (2.5%SOM)**

stimate.

Data set: MRB & WMF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Assessment of Chemicals of Potential Concern to Human Health

								Soil Type	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT
All values in mg/kg unless otherwise stated								Location & Depth	HS1 TS2	HS1 SS1	HS1 SS1	HS2 TS1	HS2 TS2	HS2 SS1	HS3 TS1	HS3 TS2	HS3 TS2	HS3SS1	HS4 TS1
Chemical of Potential Concern	**Lab. RL**	**No. Samples**	**Min. Value**	**Max. Value**	**No. Samples > or = GAC**	**GAC**	**US_{95}**	**Result of Significance Test**	**0.15**	**0.33**	**No depth**	**0.22**	**0.28**	**0.35**	**0.24**	**0.25**	**No depth**	**0.4**	**0.22**
Arsenic	2	40	17	230	37	32	110.5811	FURTHER ASSESSMENT REQUIRED	140	150	150	110	110	110	60	66	86	58	79
Beryllium	1	18	0.5	5.6	0	51	4.442717	POTENTIALLY SUITABLE FOR USE											
Boron	0.4	20	0.5	2.2	0	290	1.440611	POTENTIALLY SUITABLE FOR USE											
Cadmium	0.1	23	0.1	1.8	0	11	0.693381	POTENTIALLY SUITABLE FOR USE											
Chromium (III)	5	23	46.6	589.5	0	630	329.0309	POTENTIALLY SUITABLE FOR USE											
Chromium (VI)	0.5	20	0.2	1.2	0	4.3	0.683627	POTENTIALLY SUITABLE FOR USE											
Copper	5	23	6	49	0	2300	38.32559	POTENTIALLY SUITABLE FOR USE											
Lead	5	23	19	120	0	450	82.2043	POTENTIALLY SUITABLE FOR USE											
Mercury, inorganic	0.1	23	0.1	0.6	0	170	0.349307	POTENTIALLY SUITABLE FOR USE											
Nickel	5	40	29	210	8	130	110.2809	POTENTIALLY SUITABLE FOR USE	100	130	150	110	110	110	75	75	87	65	83
Selenium	0.2	23	0.2	3	0	350	1.454144	POTENTIALLY SUITABLE FOR USE											
Vanadium	5	16	100	740	16	74	549.9117	FURTHER ASSESSMENT REQUIRED											
Zinc	10	23	74	970	0	3700	393.701	POTENTIALLY SUITABLE FOR USE											
Cyanide (free)	0.5	20	0.5	5	0	750	3.200455	POTENTIALLY SUITABLE FOR USE											
Phenol (total)	0.3	20	0.01	1.1	0	290	0.539339	POTENTIALLY SUITABLE FOR USE											
Acenaphthene	0.01	20	0.01	0.5	0	480	0.312093	POTENTIALLY SUITABLE FOR USE											
Acenaphthylene	0.01	20	0.01	0.5	0	400	0.309073	POTENTIALLY SUITABLE FOR USE											
Anthracene	0.01	20	0.01	0.78	0	4900	0.363842	POTENTIALLY SUITABLE FOR USE											
Benz(a)anthracene	0.01	20	0.01	0.95	0	4.7	0.507781	POTENTIALLY SUITABLE FOR USE											
Benzo(a)pyrene	0.01	20	0.01	0.95	1	0.94	0.483634	POTENTIALLY SUITABLE FOR USE											
Benzo(b)fluoranthene	0.01	20	0.01	1.2	0	6.5	0.575744	POTENTIALLY SUITABLE FOR USE											
Benzo(ghi)perylene	0.01	20	0.01	0.5	0	46	0.320275	POTENTIALLY SUITABLE FOR USE											
Benzo(k)fluoranthene	0.01	20	0.01	0.5	0	9.6	0.333785	POTENTIALLY SUITABLE FOR USE											
Chrysene	0.01	20	0.01	0.78	0	8	0.454279	POTENTIALLY SUITABLE FOR USE											
Dibenz(a,h)anthracene	0.01	20	0.01	0.5	0	0.86	0.30405	POTENTIALLY SUITABLE FOR USE											
Fluoranthene	0.01	20	0.01	2.3	0	460	1.011848	POTENTIALLY SUITABLE FOR USE											
Fluorene	0.01	20	0.01	0.5	0	380	0.311894	POTENTIALLY SUITABLE FOR USE											
Indeno(1,2,3,cd)pyrene	0.01	20	0.01	0.5	0	3.9	0.318916	POTENTIALLY SUITABLE FOR USE											
Naphthalene	0.01	20	0.01	2	0	3.7	1.049686	POTENTIALLY SUITABLE FOR USE											
Phenanthrene	0.01	20	0.01	2.1	0	200	0.725232	POTENTIALLY SUITABLE FOR USE											
Pyrene	0.01	20	0.01	2.3	0	1000	0.928259	POTENTIALLY SUITABLE FOR USE											
	Mean																		
FOC (dimensionless)	0.020								0.021512	0.012791		0.024419		0.026744	0.026163	0.024419		0.013372	0.025581
SOM (calculated)	3.40%								3.71%	2.21%		4.21%		4.61%	4.51%	4.21%		2.31%	4.41%
pH (su)	7.7								8.1	8.1		8.1	8.1	8.1	8	8		8	7.9

Risk parameter: **Human health - residential with plant uptake (2.5%SOM)**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Assessment of Chemicals of Potential Concern to Human Health

Hydrock

								Soil Type	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT
All values in mg/kg unless otherwise stated								Location & Depth	HS4TS2	HS4 SS1	HS5 TS1	HS5 TS1	HS5TS2	WAHS1	WAHS2	WAHS4
Chemical of Potential Concern	**Lab. RL**	**No. Samples**	**Min. Value**	**Max. Value**	**No. Samples > or = GAC**	**GAC**	**US_{95}**	**Result of Significance Test**	0.19	0.38	0.16	No depth	0.17	No depth	No depth	No depth
Arsenic	2	40	17	230	37	32	110.5811	FURTHER ASSESSMENT REQUIRED	60	70	130	110	110	150	120	69
Beryllium	1	18	0.5	5.6	0	51	4.442717	POTENTIALLY SUITABLE FOR USE								
Boron	0.4	20	0.5	2.2	0	290	1.440611	POTENTIALLY SUITABLE FOR USE								
Cadmium	0.1	23	0.1	1.8	0	11	0.693381	POTENTIALLY SUITABLE FOR USE						1.8	0.7	0.7
Chromium (III)	5	23	46.6	589.5	0	630	329.0309	POTENTIALLY SUITABLE FOR USE						270	150	87
Chromium (VI)	0.5	20	0.2	1.2	0	4.3	0.683627	POTENTIALLY SUITABLE FOR USE								
Copper	5	23	6	49	0	2300	38.32559	POTENTIALLY SUITABLE FOR USE						6	6	14
Lead	5	23	19	120	0	450	82.2043	POTENTIALLY SUITABLE FOR USE						46	110	49
Mercury, inorganic	0.1	23	0.1	0.6	0	170	0.349307	POTENTIALLY SUITABLE FOR USE						0.6	0.6	0.6
Nickel	5	40	29	210	8	130	110.2809	POTENTIALLY SUITABLE FOR USE	78	86	110	120	110	110	98	79
Selenium	0.2	23	0.2	3	0	350	1.454144	POTENTIALLY SUITABLE FOR USE						3	3	3
Vanadium	5	16	100	740	16	74	549.9117	FURTHER ASSESSMENT REQUIRED								
Zinc	10	23	74	970	0	3700	393.701	POTENTIALLY SUITABLE FOR USE						310	290	170
Cyanide (free)	0.5	20	0.5	5	0	750	3.200455	POTENTIALLY SUITABLE FOR USE								
Phenol (total)	0.3	20	0.01	1.1	0	290	0.539339	POTENTIALLY SUITABLE FOR USE								
Acenaphthene	0.01	20	0.01	0.5	0	480	0.312093	POTENTIALLY SUITABLE FOR USE								
Acenaphthylene	0.01	20	0.01	0.5	0	400	0.309073	POTENTIALLY SUITABLE FOR USE								
Anthracene	0.01	20	0.01	0.78	0	4900	0.363842	POTENTIALLY SUITABLE FOR USE								
Benz(a)anthracene	0.01	20	0.01	0.95	0	4.7	0.507781	POTENTIALLY SUITABLE FOR USE								
Benzo(a)pyrene	0.01	20	0.01	0.95	1	0.94	0.483634	POTENTIALLY SUITABLE FOR USE								
Benzo(b)fluoranthene	0.01	20	0.01	1.2	0	6.5	0.575744	POTENTIALLY SUITABLE FOR USE								
Benzo(ghi)perylene	0.01	20	0.01	0.5	0	46	0.320275	POTENTIALLY SUITABLE FOR USE								
Benzo(k)fluoranthene	0.01	20	0.01	0.5	0	9.6	0.333785	POTENTIALLY SUITABLE FOR USE								
Chrysene	0.01	20	0.01	0.78	0	8	0.454279	POTENTIALLY SUITABLE FOR USE								
Dibenz(a,h)anthracene	0.01	20	0.01	0.5	0	0.86	0.30405	POTENTIALLY SUITABLE FOR USE								
Fluoranthene	0.01	20	0.01	2.3	0	460	1.011848	POTENTIALLY SUITABLE FOR USE								
Fluorene	0.01	20	0.01	0.5	0	380	0.311894	POTENTIALLY SUITABLE FOR USE								
Indeno(1,2,3,cd)pyrene	0.01	20	0.01	0.5	0	3.9	0.318916	POTENTIALLY SUITABLE FOR USE								
Naphthalene	0.01	20	0.01	2	0	3.7	1.049686	POTENTIALLY SUITABLE FOR USE								
Phenanthrene	0.01	20	0.01	2.1	0	200	0.725232	POTENTIALLY SUITABLE FOR USE								
Pyrene	0.01	20	0.01	2.3	0	1000	0.928259	POTENTIALLY SUITABLE FOR USE								
	Mean															
FOC (dimensionless)	0.020								0.026744	0.025581	0.024419		0.023256	0.009884	0.012209	0.012209
SOM (calculated)	3.40%								4.61%	4.41%	4.21%		4.01%	1.70%	2.10%	2.10%
pH (su)	7.7								7.6	7.7	7.7		7.8	7.45	7.58	6.88

Risk parameter: **Human health - residential with plant uptake (2.5%SOM)**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Assessment of Chemicals of Potential Concern to Plant Life

All values in mg/kg unless otherwise stated								Soil Type	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT
								Location & Depth	HTP15	HTP17	HTP20	HTP22	HTP24	HTP25	HTP26	HTP29	HTP33	HTP39	HTP40	HTP41	HTP43	HTP44
Chemical of Potential Concern	Lab. RL	No. Samples	Min. Value	Max. Value	No. Samples > or = GAC	GAC	US_{95}	Result of Significance Test	0.25	0.15	0.15	0.20	0.20	0.15	0.10	0.15	0.25	0.20	0.20	0.1	0.2	0.7
Arsenic	2	40	17	230	0	250	130.0778	POTENTIALLY SUITABLE FOR USE	110	66	68	86	79	140	120	58	76	52	58	190	130	230
Boron	0.4	20	0.5	2.2	0	3	1.440611	POTENTIALLY SUITABLE FOR USE	0.8	0.9	1.4	0.7	0.9	0.5	1.1	1.3	1.2	0.7	0.9	1	1	0.7
Chromium (III)	5	23	46.6	589.5	3	400	329.0309	POTENTIALLY SUITABLE FOR USE	269.5	77.5	87.5	109.5	109.5	269.5	239.5	77.5	99.5	77.5	81.5	479.5	209.5	539.5
Chromium (VI)	0.5	20	0.2	1.2	0	25	0.683627	POTENTIALLY SUITABLE FOR USE	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Copper	5	23	6	49	0	135	38.32559	POTENTIALLY SUITABLE FOR USE	21	23	31	31	31	41	46	28	40	23	26	40	49	35
Nickel	5	40	29	210	31	75	126.9991	FURTHER ASSESSMENT REQUIRED	110	62	99	100	92	150	120	69	79	52	60	170	160	210
Zinc	10	23	74	970	5	300	393.701	FURTHER ASSESSMENT REQUIRED	190	110	180	140	160	300	260	110	150	100	120	340	290	380
	Mean																					
pH (su)	7.7								7.1	7.5	7.7	8.3	7.7	7.7	7.9	7.9	7.6	7.6	7.3	7.7	7.5	7.6

Risk parameter: **Plant life pH 7**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Legend: Values in blue are at or below the laboratory reporting limit (where a single value is indicated) and are considered as being at the detection limit for the purposes of statistical analysis, as a conservative estimate.
Values in red are equal to, or greater than, the generic assessment criterion (GAC).
MG denotes Made Ground
NAT denotes natural ground

Assessment of Chemicals of Potential Concern to Plant Life

All values in mg/kg unless otherwise stated								Soil Type	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT	NAT
								Location & Depth	HTP45	HTP46	TP5	TP8	TP8	TP9	HS1 TS1	HS1 TS2	HS1 SS1	HS1 SS1	HS2 TS1	HS2 TS2	HS2 SS1	HS3 TS1
Chemical of Potential Concern	**Lab. RL**	**No. Samples**	**Min. Value**	**Max. Value**	**No. Samples > or = GAC**	**GAC**	**US_{95}**	**Result of Significance Test**	**0.4**	**0.7**	**0.1**	**0.4**	**2.8**	**0.6**	**0.21**	**0.15**	**0.33**	**No depth**	**0.22**	**0.28**	**0.35**	**0.24**
Arsenic	2	40	17	230	0	250	130.0778	POTENTIALLY SUITABLE FOR USE	120	170	19	58	17	27	120	140	150	150	110	110	110	60
Boron	0.4	20	0.5	2.2	0	3	1.440611	POTENTIALLY SUITABLE FOR USE	1	1.2	1.8	1	2.2	0.7								
Chromium (III)	5	23	46.6	589.5	3	400	329.0309	POTENTIALLY SUITABLE FOR USE	189.5	589.5	55.57	109.8	53.8	46.6								
Chromium (VI)	0.5	20	0.2	1.2	0	25	0.683627	POTENTIALLY SUITABLE FOR USE	0.5	0.5	0.43	0.2	1.2	0.4								
Copper	5	23	6	49	0	135	38.32559	POTENTIALLY SUITABLE FOR USE	43	25	11	18	13	12								
Nickel	5	40	29	210	31	75	126.9991	FURTHER ASSESSMENT REQUIRED	130	180	29	57	32	43	100	100	130	150	110	110	110	75
Zinc	10	23	74	970	5	300	393.701	FURTHER ASSESSMENT REQUIRED	220	970	82	130	74	84								
	Mean																					
pH (su)	7.7								6.9	7.9	7.2	8.1	7.4	7.1	8.2	8.1	8.1		8.1	8.1	8.1	8

Risk parameter: **Plant life pH 7**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Assessment of Chemicals of Potential Concern to Plant Life

Hydrock

All values in mg/kg unless otherwise stated

Chemical of Potential Concern	Lab. RL	No. Samples	Min. Value	Max. Value	No. Samples > or = GAC	GAC	US_{95}	Result of Significance Test	NAT HS3 TS2 0.25	NAT HS3 TS2 No depth	NAT HS3SS1 0.4	NAT HS4 TS1 0.22	NAT HS4TS2 0.19	NAT HS4 SS1 0.38	NAT HS5 TS1 0.16	NAT HS5 TS1 No depth	NAT HS5TS2 0.17	NAT WAHS1 No depth	NAT WAHS2 No depth	NAT WAHS4 No depth
Arsenic	2	40	17	230	0	250	130.0778	POTENTIALLY SUITABLE FOR USE	66	86	58	79	60	70	130	110	110	150	120	69
Boron	0.4	20	0.5	2.2	0	3	1.440611	POTENTIALLY SUITABLE FOR USE												
Chromium (III)	5	23	46.6	589.5	3	400	329.0309	POTENTIALLY SUITABLE FOR USE										270	150	87
Chromium (VI)	0.5	20	0.2	1.2	0	25	0.683627	POTENTIALLY SUITABLE FOR USE												
Copper	5	23	6	49	0	135	38.32559	POTENTIALLY SUITABLE FOR USE										6	6	14
Nickel	5	40	29	210	31	75	126.9991	FURTHER ASSESSMENT REQUIRED	75	87	65	83	78	86	110	120	110	110	98	79
Zinc	10	23	74	970	5	300	393.701	FURTHER ASSESSMENT REQUIRED										310	290	170
	Mean																			
pH (su)	7.7								8		8	7.9	7.6	7.7	7.7		7.8	7.45	7.58	6.88

Risk parameter: **Plant life pH 7**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

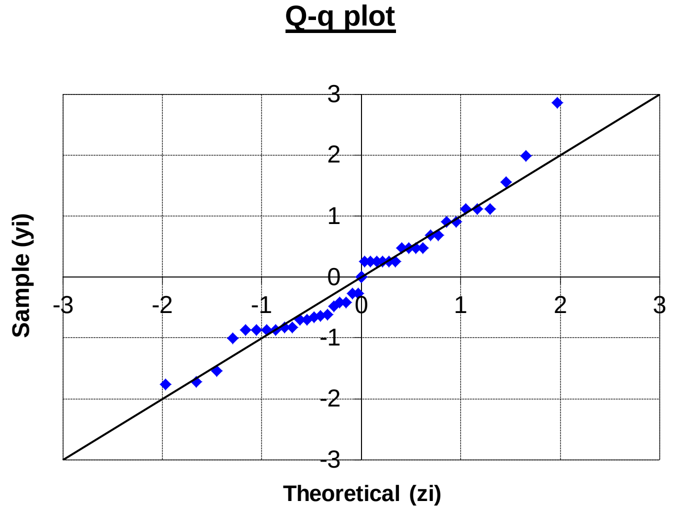
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

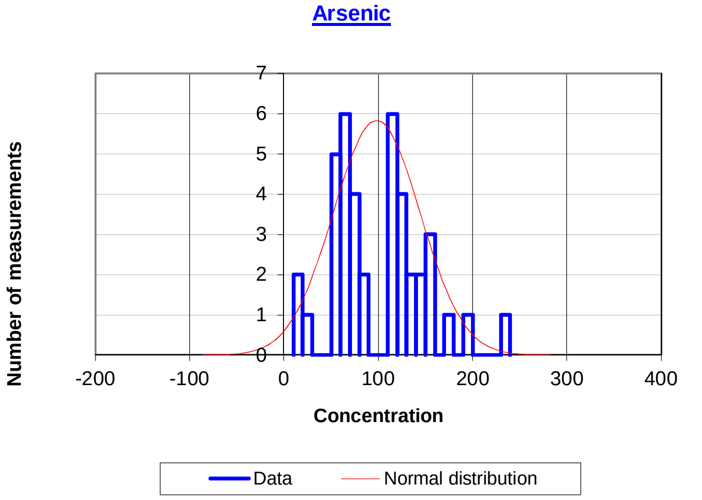
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Arsenic	Potential Outlier?	Sample
110		HTP15 @ 0.25
66		HTP17 @ 0.15
68		HTP20 @ 0.15
86		HTP22 @ 0.20
79		HTP24 @ 0.20
140		HTP25 @ 0.15
120		HTP26 @ 0.10
58		HTP29 @ 0.15
76		HTP33 @ 0.25
52		HTP39 @ 0.20
58		HTP40 @ 0.20
190		HTP41 @ 0.1
130		HTP43 @ 0.2
230		HTP44 @ 0.7
120		HTP45 @ 0.4
170		HTP46 @ 0.7
19		TP5 @ 0.1
58		TP8 @ 0.4
17		TP8 @ 2.8
27		TP9 @ 0.6
120		HS1 TS1 @ 0.21
140		HS1 TS2 @ 0.15
150		HS1 SS1 @ 0.33
150		HS1 SS1 @ No depth
110		HS2 TS1 @ 0.22
110		HS2 TS2 @ 0.28
110		HS2 SS1 @ 0.35
60		HS3 TS1 @ 0.24
66		HS3 TS2 @ 0.25
86		HS3 TS2 @ No depth
58		HS3SS1 @ 0.4
79		HS4 TS1 @ 0.22
60		HS4TS2 @ 0.19
70		HS4 SS1 @ 0.38
130		HS5 TS1 @ 0.16
110		HS5 TS1 @ No depth
110		HS5TS2 @ 0.17
150		WAHS1 @ No depth
120		WAHS2 @ No depth
69		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

32 = GAC (critical conc.) (mg/kg)

40 = no. samples
37 = no. samples > or = GAC
17 = min. value
230 = max. value
2 = laboratory reporting limit (RL)
98.3 = mean (mean>GAC)
0 = no. samples at RL
46.09644 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
9.096537 = t_0	9.096537 = k_0
1.685 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
110.5811 = 95% UCL (US_{95})	130.0778 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **normally distributed**

Therefore:

Use one-sample t-test - Ho accepted, true mean >GAC

US_{95} = 110.5811 GAC = 32 (US95 = 3.456 x GAC)

Site reference **FURTHER ASSESSMENT REQUIRED**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

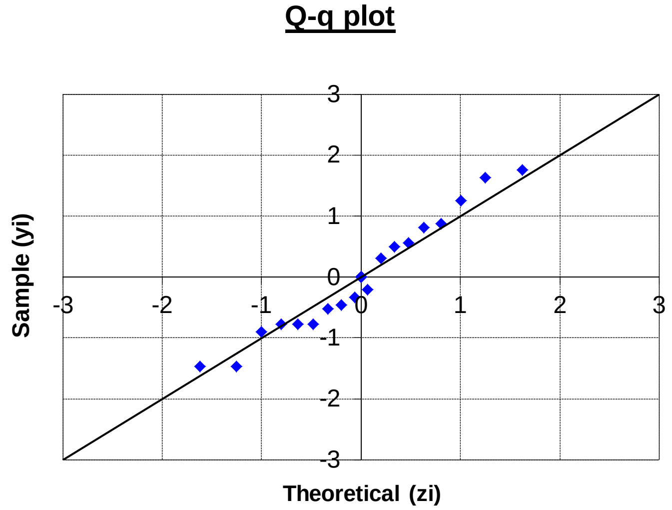
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

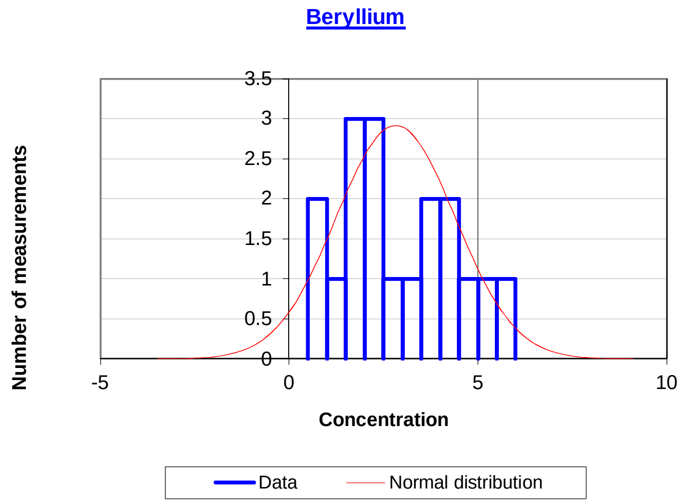
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Beryllium	Potential Outlier?	Sample
4.1		HTP15 @ 0.25
1.6		HTP17 @ 0.15
2.3		HTP20 @ 0.15
2.5		HTP22 @ 0.20
2		HTP24 @ 0.20
4.2		HTP25 @ 0.15
3.7		HTP26 @ 0.10
1.6		HTP29 @ 0.15
2.1		HTP33 @ 0.25
1.4		HTP39 @ 0.20
1.6		HTP40 @ 0.20
5.4		HTP41 @ 0.1
3.6		HTP43 @ 0.2
5.6		HTP44 @ 0.7
3.3		HTP45 @ 0.4
4.8		HTP46 @ 0.7
0.5		TP5 @ 0.1
0.5		TP8 @ 0.4

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
51 = GAC (critical conc.) (mg/kg)
18 = no. samples
0.5 = min. value
5.6 = max. value
2.822222 = mean
1.576875 = standard deviation

0 = no. samples > or = GAC
1 = laboratory reporting limit (RL)
2 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-129.6241 = t_0
0.174 = $t_{(n-1,0.95)}$
2.886893 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-129.624 = k_0
4.36 = $k_{0.05}$
4.442717 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 4.4427169 GAC = 51 (US95 = 0.087 x GAC)

Site reference
POTENTIALLY SUITABLE FOR USE

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

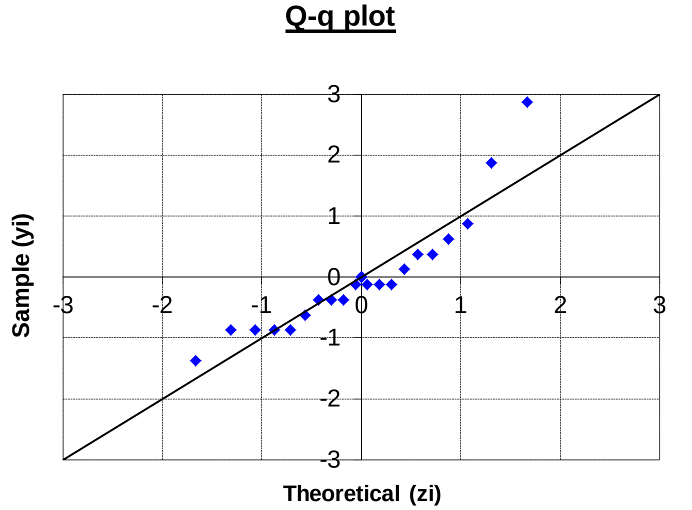
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

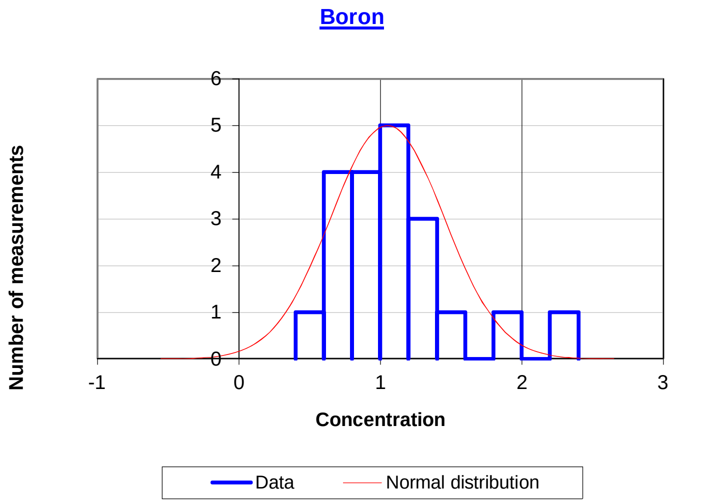
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Boron	Potential Outlier?	Sample
0.8		HTP15 @ 0.25
0.9		HTP17 @ 0.15
1.4		HTP20 @ 0.15
0.7		HTP22 @ 0.20
0.9		HTP24 @ 0.20
0.5		HTP25 @ 0.15
1.1		HTP26 @ 0.10
1.3		HTP29 @ 0.15
1.2		HTP33 @ 0.25
0.7		HTP39 @ 0.20
0.9		HTP40 @ 0.20
1		HTP41 @ 0.1
1		HTP43 @ 0.2
0.7		HTP44 @ 0.7
1		HTP45 @ 0.4
1.2		HTP46 @ 0.7
1.8		TP5 @ 0.1
1		TP8 @ 0.4
2.2	Yes	TP8 @ 2.8
0.7		TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

290 = GAC (critical conc.) (mg/kg)

20 = no. samples
0.5 = min. value
2.2 = max. value
1.05 = mean
0.400657 = standard deviation

0 = no. samples > or = GAC
0.4 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-3225.259 = t_0	-3225.26 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
1.204901 = 95% UCL (US_{95})	1.440611 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 1.4406111 GAC = 290 (US95 = 0.005 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

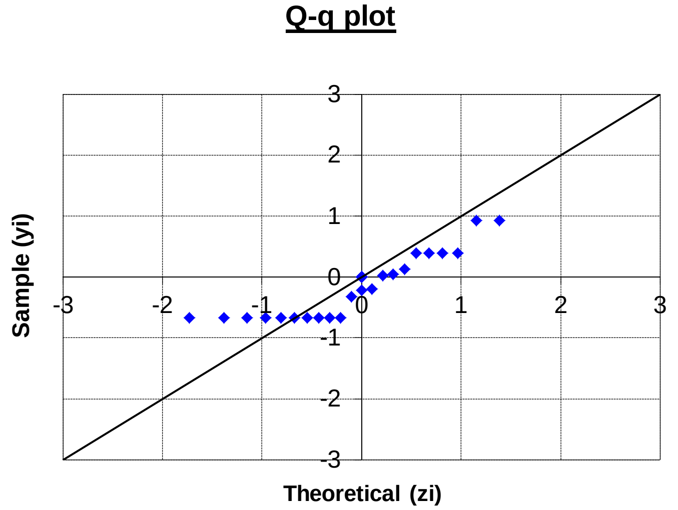
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

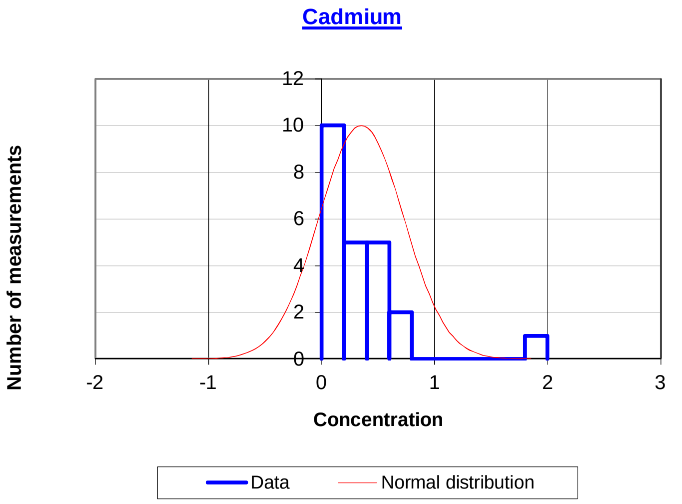
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Cadmium	**Potential Outlier?**	**Sample**
0.1		HTP15 @ 0.25
0.1		HTP17 @ 0.15
0.28		HTP20 @ 0.15
0.1		HTP22 @ 0.20
0.1		HTP24 @ 0.20
0.1		HTP25 @ 0.15
0.1		HTP26 @ 0.10
0.1		HTP29 @ 0.15
0.1		HTP33 @ 0.25
0.1		HTP39 @ 0.20
0.1		HTP40 @ 0.20
0.36		HTP41 @ 0.1
0.37		HTP43 @ 0.2
0.27		HTP44 @ 0.7
0.4		HTP45 @ 0.4
0.23		HTP46 @ 0.7
0.5		TP5 @ 0.1
0.5		TP8 @ 0.4
0.5		TP8 @ 2.8
0.5		TP9 @ 0.6
1.8	Yes	WAHS1 @ No depth
0.7		WAHS2 @ No depth
0.7		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

11 = GAC (critical conc.) (mg/kg)

23 = no. samples	0 = no. samples > or = GAC
0.1 = min. value	
1.8 = max. value	0.1 = laboratory reporting limit (RL)
0.352609 = mean	10 = no. samples at RL
0.374836 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-136.2279 = t_0	-136.228 = k_0
1.717 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.486807 = 95% UCL (US_{95})	0.693381 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.6933806 GAC = 11 (US95 = 0.063 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: MRB & WMF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

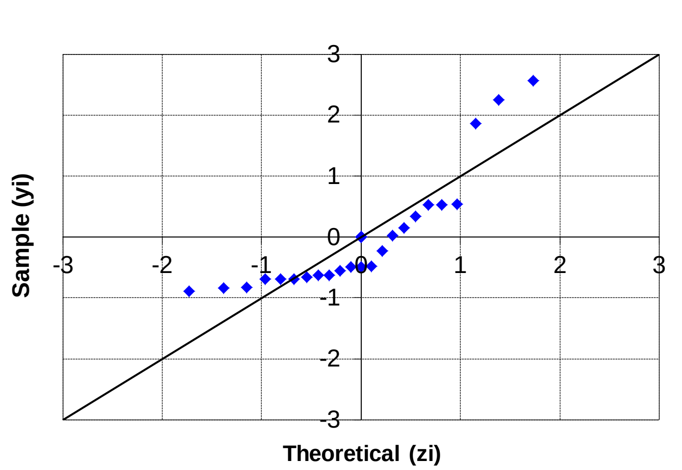
3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

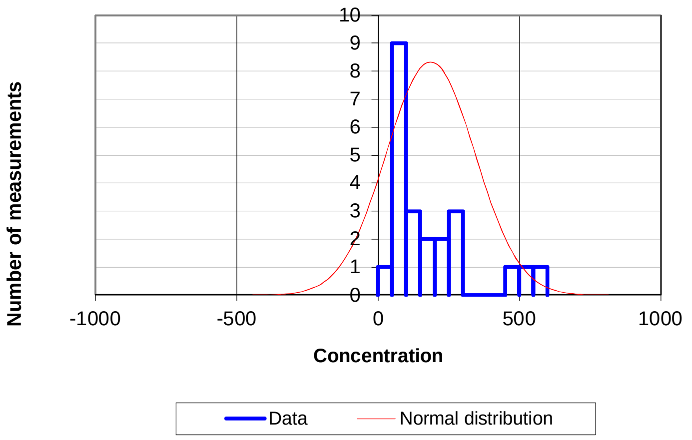
Chromium (III)	Potential Outlier?	Sample
269.5		HTP15 @ 0.25
77.5		HTP17 @ 0.15
87.5		HTP20 @ 0.15
109.5		HTP22 @ 0.20
109.5		HTP24 @ 0.20
269.5		HTP25 @ 0.15
239.5		HTP26 @ 0.10
77.5		HTP29 @ 0.15
99.5		HTP33 @ 0.25
77.5		HTP39 @ 0.20
81.5		HTP40 @ 0.20
479.5	Yes	HTP41 @ 0.1
209.5		HTP43 @ 0.2
539.5	Yes	HTP44 @ 0.7
189.5		HTP45 @ 0.4
589.5	Yes	HTP46 @ 0.7
55.57		TP5 @ 0.1
109.8		TP8 @ 0.4
53.8		TP8 @ 2.8
46.6		TP9 @ 0.6
270		WAHS1 @ No depth
150		WAHS2 @ No depth
87		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots

Q-q plot



Chromium (III)



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

630 = GAC (critical conc.) (mg/kg)

23 = no. samples	0 = no. samples > or = GAC
46.6 = min. value	
589.5 = max. value	5 = laboratory reporting limit (RL)
186.0335 = mean	0 = no. samples at RL
157.2917 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-13.53656 = t_0	-13.5366 = k_0
1.717 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
242.3469 = 95% UCL (US_{95})	329.0309 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 329.03091 GAC = 630 (US95 = 0.522 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

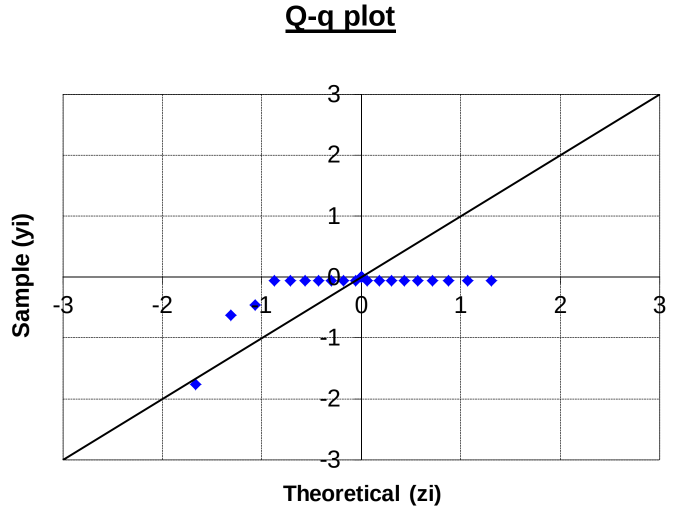
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

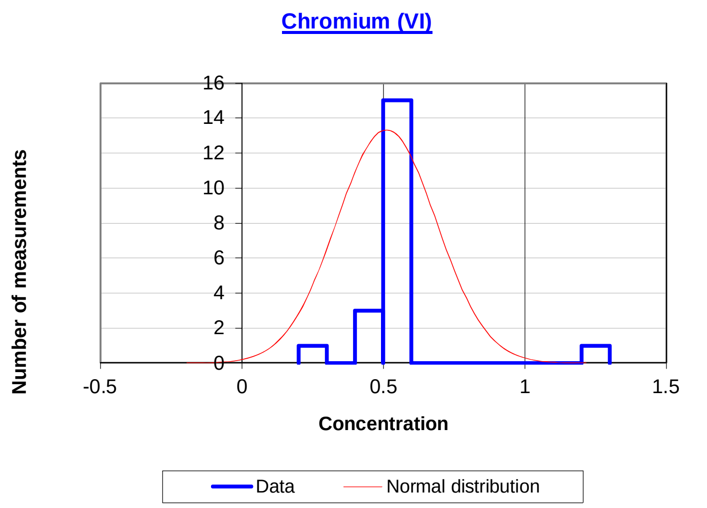
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Chromium (VI)	Potential Outlier?	Sample
0.5	n/a	HTP15 @ 0.25
0.5	n/a	HTP17 @ 0.15
0.5	n/a	HTP20 @ 0.15
0.5	n/a	HTP22 @ 0.20
0.5	n/a	HTP24 @ 0.20
0.5	n/a	HTP25 @ 0.15
0.5	n/a	HTP26 @ 0.10
0.5	n/a	HTP29 @ 0.15
0.5	n/a	HTP33 @ 0.25
0.5	n/a	HTP39 @ 0.20
0.5	n/a	HTP40 @ 0.20
0.5	n/a	HTP41 @ 0.1
0.5	n/a	HTP43 @ 0.2
0.5	n/a	HTP44 @ 0.7
0.5	n/a	HTP45 @ 0.4
0.5	n/a	HTP46 @ 0.7
0.43	n/a	TP5 @ 0.1
0.2	n/a	TP8 @ 0.4
1.2	n/a	TP8 @ 2.8
0.4	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

4.3 = GAC (critical conc.) (mg/kg)

20 = no. samples
0.2 = min. value
1.2 = max. value
0.5115 = mean
0.176554 = standard deviation

0 = no. samples > or = GAC
0.5 = laboratory reporting limit (RL)
19 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-95.9632 = t_0
1.729 = $t_{(n-1,0.95)}$
0.579759 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-95.9632 = k_0
4.36 = $k_{0.05}$
0.683627 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.683627 GAC = 4.3 (US95 = 0.159 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

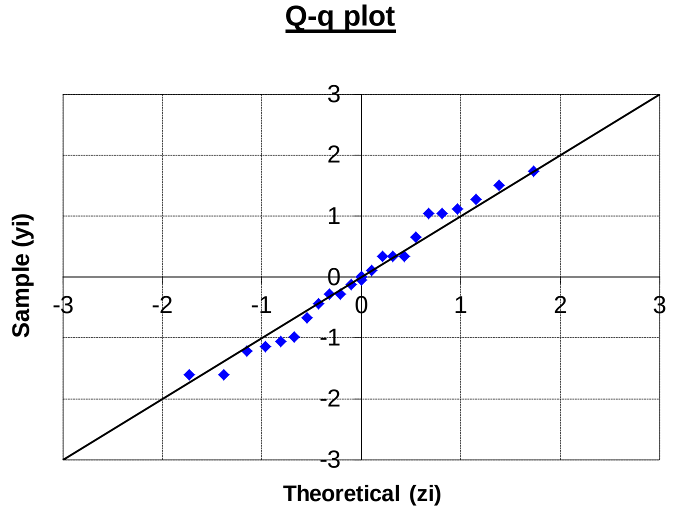
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

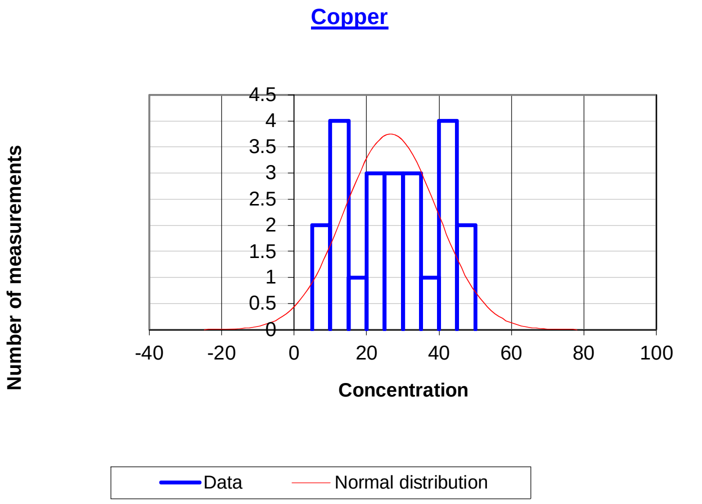
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Copper	Potential Outlier?	Sample
21		HTP15 @ 0.25
23		HTP17 @ 0.15
31		HTP20 @ 0.15
31		HTP22 @ 0.20
31		HTP24 @ 0.20
41		HTP25 @ 0.15
46		HTP26 @ 0.10
28		HTP29 @ 0.15
40		HTP33 @ 0.25
23		HTP39 @ 0.20
26		HTP40 @ 0.20
40		HTP41 @ 0.1
49		HTP43 @ 0.2
35		HTP44 @ 0.7
43		HTP45 @ 0.4
25		HTP46 @ 0.7
11		TP5 @ 0.1
18		TP8 @ 0.4
13		TP8 @ 2.8
12		TP9 @ 0.6
6		WAHS1 @ No depth
6		WAHS2 @ No depth
14		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

2300 = GAC (critical conc.) (mg/kg)

23 = no. samples
6 = min. value
49 = max. value
26.65217 = mean
12.84031 = standard deviation

0 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-849.0912 = t_0
1.717 = $t_{(n-1,0.95)}$
31.24925 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-849.091 = k_0
4.36 = $k_{0.05}$
38.32559 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 38.325592 GAC = 2300 (US95 = 0.017 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

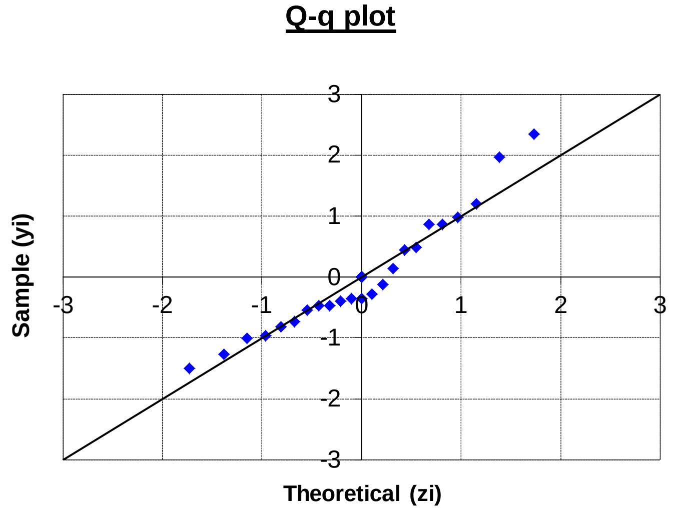
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

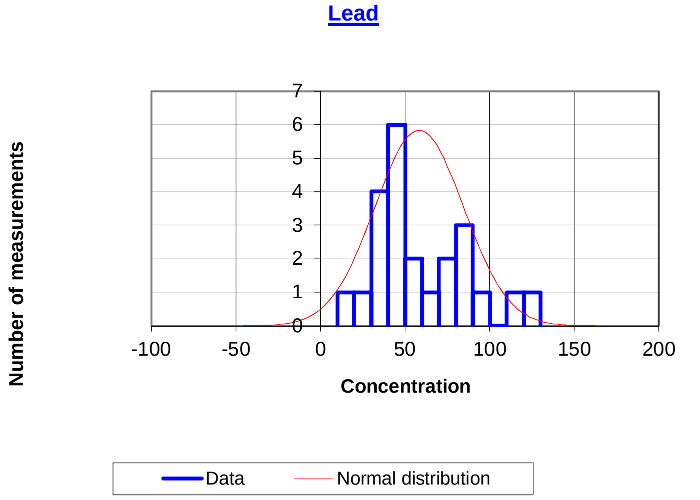
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Lead	Potential Outlier?	Sample
39		HTP15 @ 0.25
46		HTP17 @ 0.15
62		HTP20 @ 0.15
55		HTP22 @ 0.20
51		HTP24 @ 0.20
70		HTP25 @ 0.15
120		HTP26 @ 0.10
48		HTP29 @ 0.15
71		HTP33 @ 0.25
44		HTP39 @ 0.20
49		HTP40 @ 0.20
81		HTP41 @ 0.1
90		HTP43 @ 0.2
84		HTP44 @ 0.7
81		HTP45 @ 0.4
33		HTP46 @ 0.7
32		TP5 @ 0.1
37		TP8 @ 0.4
25		TP8 @ 2.8
19		TP9 @ 0.6
46		WAHS1 @ No depth
110		WAHS2 @ No depth
49		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
450 = GAC (critical conc.) (mg/kg)

23 = no. samples
19 = min. value
120 = max. value
58.34783 = mean
26.2412 = standard deviation

0 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-71.57819 = t_0
1.717 = $t_{(n-1,0.95)}$
67.74268 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-71.5782 = k_0
4.36 = $k_{0.05}$
82.2043 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 82.204304 GAC = 450 (US95 = 0.183 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

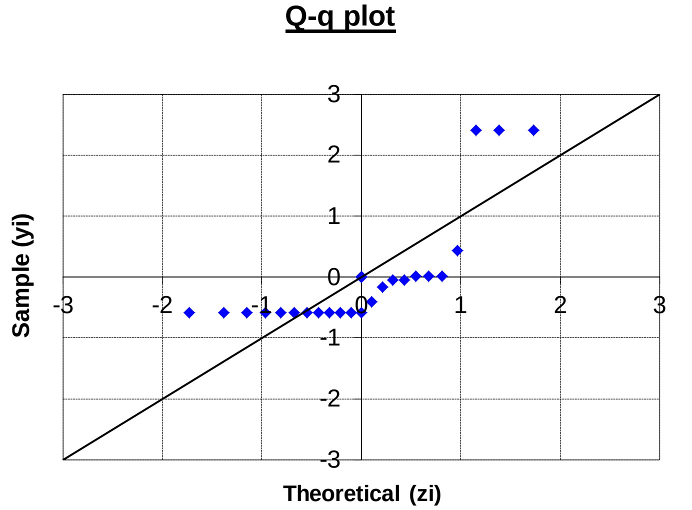
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

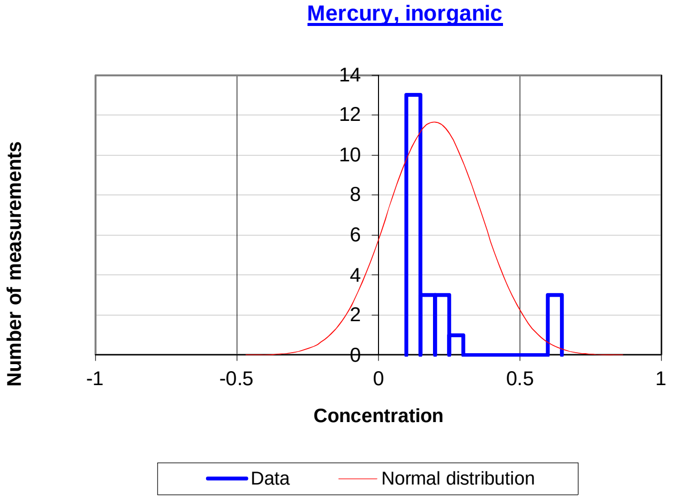
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Mercury, inorganic	Potential Outlier?	Sample
0.1	n/a	HTP15 @ 0.25
0.1	n/a	HTP17 @ 0.15
0.1	n/a	HTP20 @ 0.15
0.1	n/a	HTP22 @ 0.20
0.1	n/a	HTP24 @ 0.20
0.1	n/a	HTP25 @ 0.15
0.1	n/a	HTP26 @ 0.10
0.1	n/a	HTP29 @ 0.15
0.1	n/a	HTP33 @ 0.25
0.1	n/a	HTP39 @ 0.20
0.1	n/a	HTP40 @ 0.20
0.19	n/a	HTP41 @ 0.1
0.19	n/a	HTP43 @ 0.2
0.13	n/a	HTP44 @ 0.7
0.17	n/a	HTP45 @ 0.4
0.1	n/a	HTP46 @ 0.7
0.2	n/a	TP5 @ 0.1
0.27	n/a	TP8 @ 0.4
0.2	n/a	TP8 @ 2.8
0.2	n/a	TP9 @ 0.6
0.6	n/a	WAHS1 @ No depth
0.6	n/a	WAHS2 @ No depth
0.6	n/a	WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
170 = GAC (critical conc.) (mg/kg)
23 = no. samples
0 = no. samples > or = GAC
0.1 = min. value
0.6 = max. value
0.1 = laboratory reporting limit (RL)
0.197826 = mean
12 = no. samples at RL
0.166623 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-4887.335 = t_0	-4887.33 = k_0
1.717 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.25748 = 95% UCL (US_{95})	0.349307 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.3493069 GAC = 170 (US95 = 0.002 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

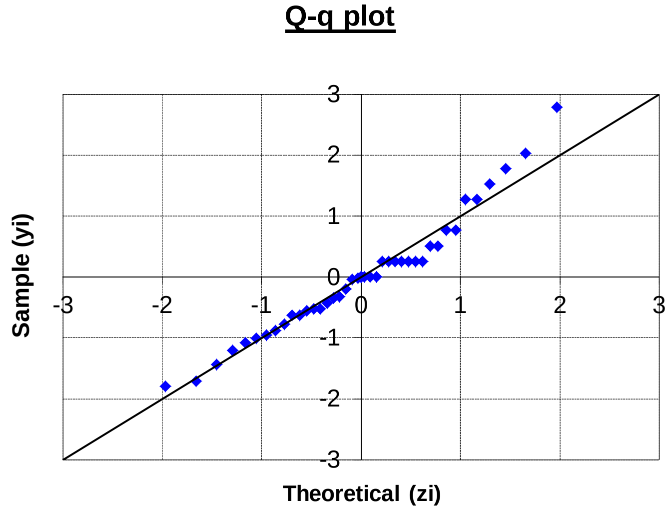
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

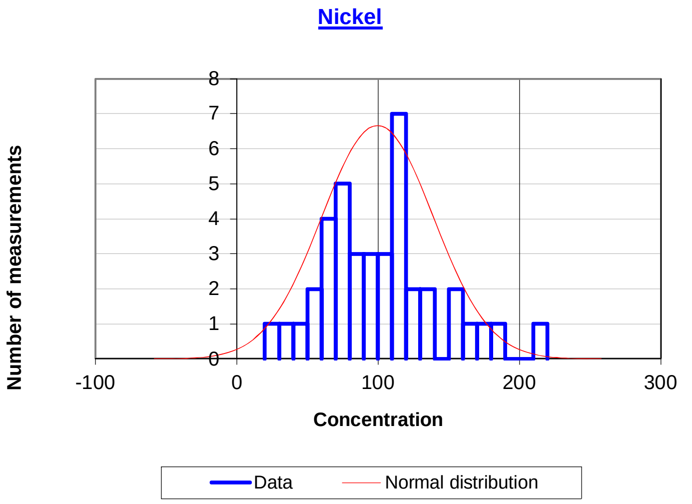
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Nickel	Potential Outlier?	Sample
110		HTP15 @ 0.25
62		HTP17 @ 0.15
99		HTP20 @ 0.15
100		HTP22 @ 0.20
92		HTP24 @ 0.20
150		HTP25 @ 0.15
120		HTP26 @ 0.10
69		HTP29 @ 0.15
79		HTP33 @ 0.25
52		HTP39 @ 0.20
60		HTP40 @ 0.20
170		HTP41 @ 0.1
160		HTP43 @ 0.2
210	Yes	HTP44 @ 0.7
130		HTP45 @ 0.4
180		HTP46 @ 0.7
29		TP5 @ 0.1
57		TP8 @ 0.4
32		TP8 @ 2.8
43		TP9 @ 0.6
100		HS1 TS1 @ 0.21
100		HS1 TS2 @ 0.15
130		HS1 SS1 @ 0.33
150		HS1 SS1 @ No depth
110		HS2 TS1 @ 0.22
110		HS2 TS2 @ 0.28
110		HS2 SS1 @ 0.35
75		HS3 TS1 @ 0.24
75		HS3 TS2 @ 0.25
87		HS3 TS2 @ No depth
65		HS3SS1 @ 0.4
83		HS4 TS1 @ 0.22
78		HS4TS2 @ 0.19
86		HS4 SS1 @ 0.38
110		HS5 TS1 @ 0.16
120		HS5 TS1 @ No depth
110		HS5TS2 @ 0.17
110		WAHS1 @ No depth
98		WAHS2 @ No depth
79		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

130 = GAC (critical conc.) (mg/kg)
40 = no. samples
29 = min. value
210 = max. value
99.75 = mean
39.52717 = standard deviation

8 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-4.840159 = t_0
1.685 = $t_{(n-1,0.95)}$
110.2809 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-4.84016 = k_0
4.36 = $k_{0.05}$
126.9991 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **normally distributed**
Therefore:
Use one-sample t-test - Ho rejected, true mean <=GAC
US_{95} = 110.2809 GAC = 130 (US95 = 0.848 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

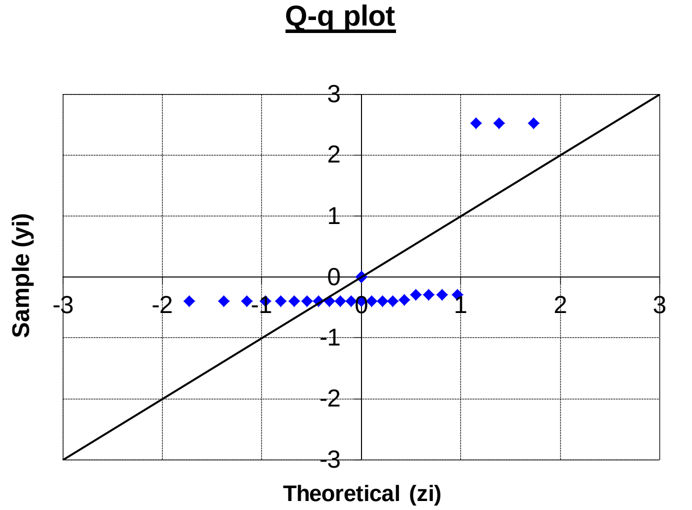
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

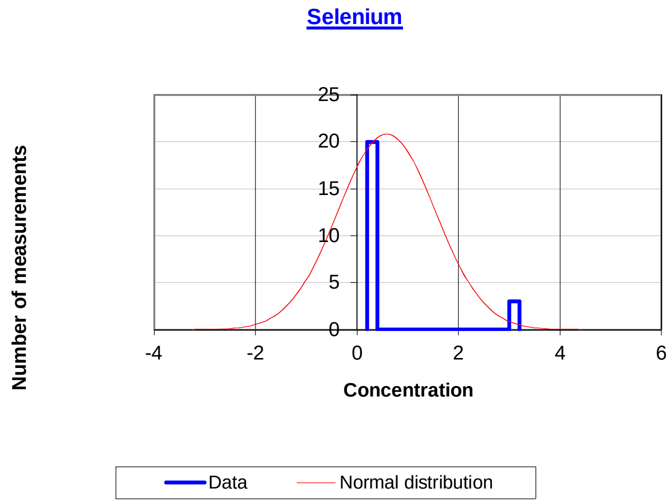
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA	
	Mean Absolute Deviation for potential outliers	
	3.5 = critical value of test statistic	Note - MAD not applicable as 50% or more of values are the same.

Selenium	Potential Outlier?	Sample
0.2	n/a	HTP15 @ 0.25
0.2	n/a	HTP17 @ 0.15
0.2	n/a	HTP20 @ 0.15
0.2	n/a	HTP22 @ 0.20
0.2	n/a	HTP24 @ 0.20
0.22	n/a	HTP25 @ 0.15
0.2	n/a	HTP26 @ 0.10
0.2	n/a	HTP29 @ 0.15
0.2	n/a	HTP33 @ 0.25
0.2	n/a	HTP39 @ 0.20
0.2	n/a	HTP40 @ 0.20
0.2	n/a	HTP41 @ 0.1
0.2	n/a	HTP43 @ 0.2
0.2	n/a	HTP44 @ 0.7
0.2	n/a	HTP45 @ 0.4
0.2	n/a	HTP46 @ 0.7
0.3	n/a	TP5 @ 0.1
0.3	n/a	TP8 @ 0.4
0.3	n/a	TP8 @ 2.8
0.3	n/a	TP9 @ 0.6
3	n/a	WAHS1 @ No depth
3	n/a	WAHS2 @ No depth
3	n/a	WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter

Human health - residential with plant uptake (2.5%SOM)

350 = GAC (critical conc.) (mg/kg)

23 = no. samples	0 = no. samples > or = GAC
0.2 = min. value	
3 = max. value	0.2 = laboratory reporting limit (RL)
0.583478 = mean	15 = no. samples at RL
0.957699 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-1749.759 = t_0	-1749.76 = k_0
1.717 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.926353 = 95% UCL (US_{95})	1.454144 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 1.4541443 GAC = 350 (US95 = 0.004 x GAC)

Site reference — **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

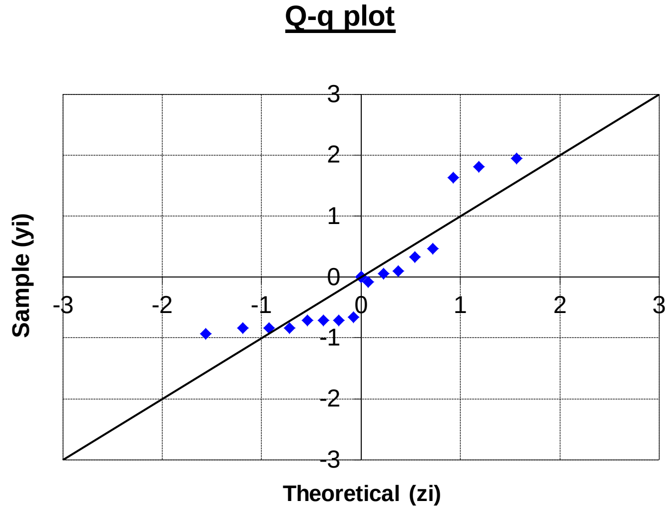
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

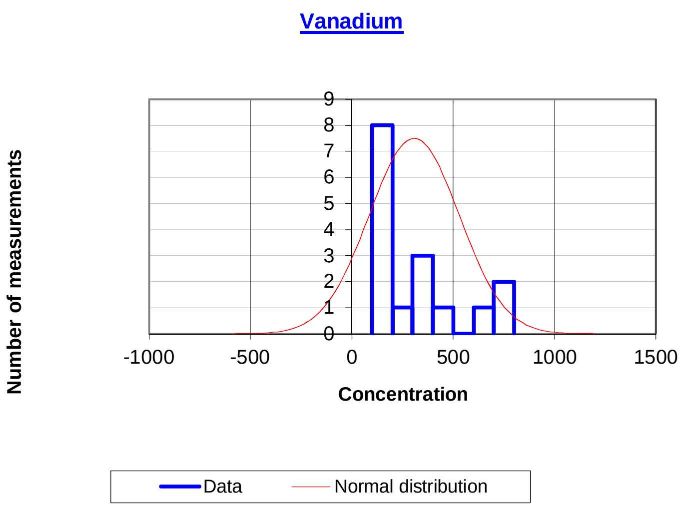
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Vanadium	Potential Outlier?	Sample
410		HTP15 @ 0.25
120		HTP17 @ 0.15
150		HTP20 @ 0.15
150		HTP22 @ 0.20
160		HTP24 @ 0.20
380		HTP25 @ 0.15
320		HTP26 @ 0.10
120		HTP29 @ 0.15
150		HTP33 @ 0.25
100		HTP39 @ 0.20
120		HTP40 @ 0.20
670		HTP41 @ 0.1
330		HTP43 @ 0.2
710		HTP44 @ 0.7
290		HTP45 @ 0.4
740		HTP46 @ 0.7

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
74 = GAC (critical conc.) (mg/kg)
16 = no. samples
16 = no. samples > or = GAC
100 = min. value
740 = max. value
5 = laboratory reporting limit (RL)
307.5 = mean (mean>GAC)
0 = no. samples at RL
222.396 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
4.199715 = t_0
1.753 = $t_{(n-1,0.95)}$
404.9651 = 95% UCL (US_{95})

One-sided Chebychev Theorem
4.199715 = k_0
4.36 = $k_{0.05}$
549.9117 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho accepted, true mean >GAC
US_{95} = 549.91169 GAC = 74 (US95 = 7.431 x GAC)

Site reference **FURTHER ASSESSMENT REQUIRED**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

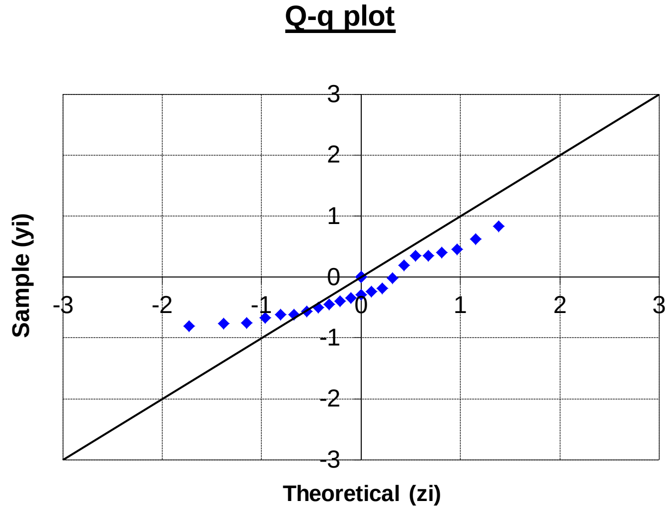
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

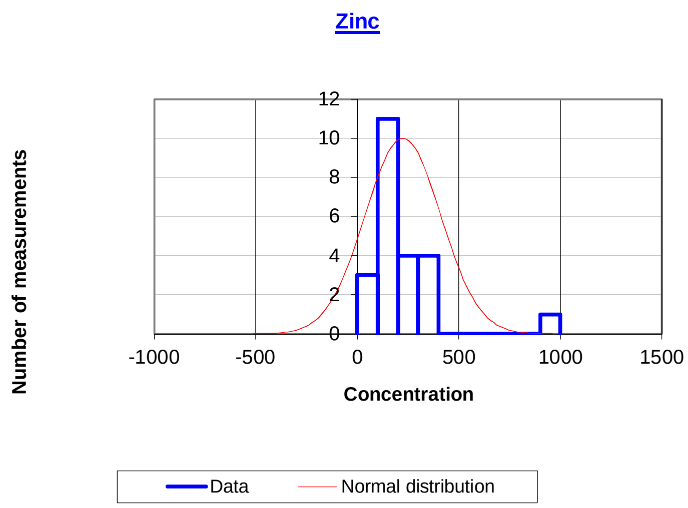
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Zinc	Potential Outlier?	Sample
190		HTP15 @ 0.25
110		HTP17 @ 0.15
180		HTP20 @ 0.15
140		HTP22 @ 0.20
160		HTP24 @ 0.20
300		HTP25 @ 0.15
260		HTP26 @ 0.10
110		HTP29 @ 0.15
150		HTP33 @ 0.25
100		HTP39 @ 0.20
120		HTP40 @ 0.20
340		HTP41 @ 0.1
290		HTP43 @ 0.2
380		HTP44 @ 0.7
220		HTP45 @ 0.4
970	Yes	HTP46 @ 0.7
82		TP5 @ 0.1
130		TP8 @ 0.4
74		TP8 @ 2.8
84		TP9 @ 0.6
310		WAHS1 @ No depth
290		WAHS2 @ No depth
170		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

3700 = GAC (critical conc.) (mg/kg)

23 = no. samples	0 = no. samples > or = GAC
74 = min. value	
970 = max. value	10 = laboratory reporting limit (RL)
224.3478 = mean	0 = no. samples at RL
186.2819 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-89.48072 = t_0	-89.4807 = k_0
1.717 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
291.0403 = 95% UCL (US_{95})	393.701 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 393.701 GAC = 3700 (US95 = 0.106 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Cyanide (free)	**Potential Outlier?**	**Sample**
0.5	n/a	HTP15 @ 0.25
0.5	n/a	HTP17 @ 0.15
0.5	n/a	HTP20 @ 0.15
0.5	n/a	HTP22 @ 0.20
0.5	n/a	HTP24 @ 0.20
0.5	n/a	HTP25 @ 0.15
0.5	n/a	HTP26 @ 0.10
0.5	n/a	HTP29 @ 0.15
0.5	n/a	HTP33 @ 0.25
0.5	n/a	HTP39 @ 0.20
0.5	n/a	HTP40 @ 0.20
0.5	n/a	HTP41 @ 0.1
0.5	n/a	HTP43 @ 0.2
0.5	n/a	HTP44 @ 0.7
0.5	n/a	HTP45 @ 0.4
0.5	n/a	HTP46 @ 0.7
5	n/a	TP5 @ 0.1
5	n/a	TP8 @ 0.4
5	n/a	TP8 @ 2.8
5	n/a	TP9 @ 0.6

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

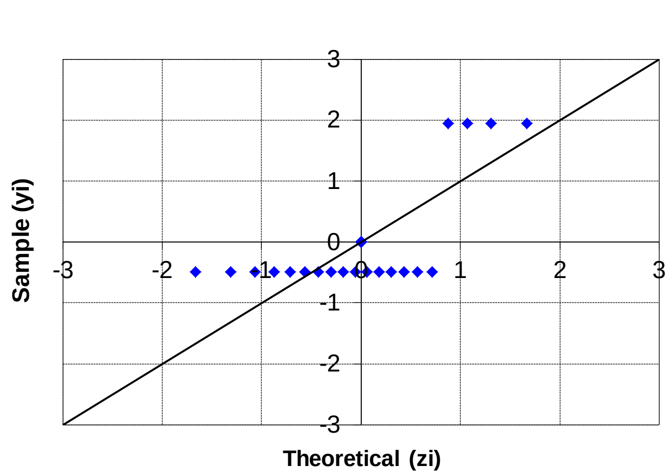
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

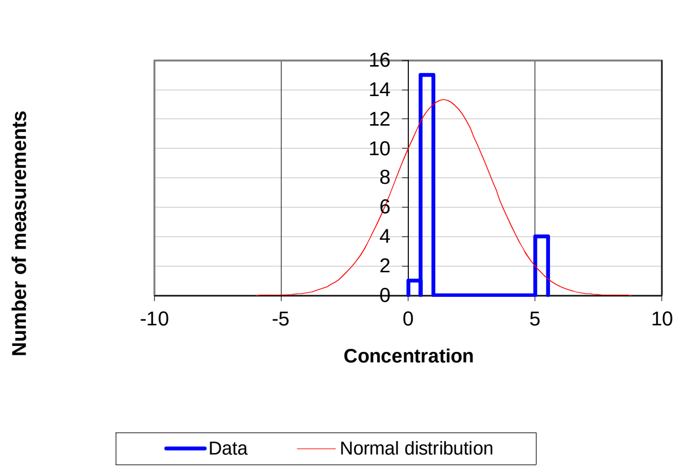
Note - MAD not applicable as 50% or more of values are the same.

Visual assessment - Q-q & histogram plots

Q-q plot



Cyanide (free)



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

750 = GAC (critical conc.) (mg/kg)

20 = no. samples	0 = no. samples > or = GAC
0.5 = min. value	
5 = max. value	0.5 = laboratory reporting limit (RL)
1.4 = mean	16 = no. samples at RL
1.846761 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-1812.818 = t_0	-1812.82 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
2.113988 = 95% UCL (US_{95})	3.200455 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 3.2004547 GAC = 750 (US95 = 0.004 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

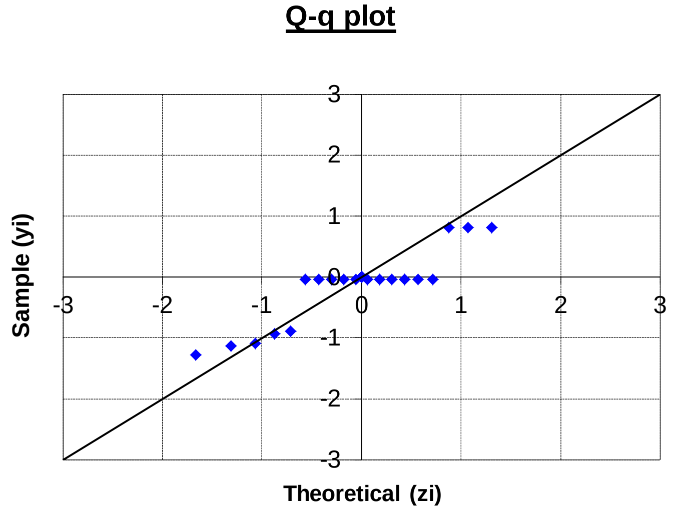
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

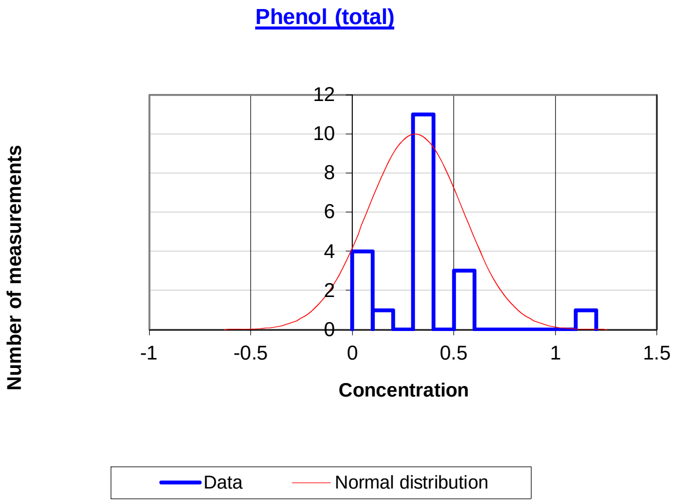
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Phenol (total)	Potential Outlier?	Sample
0.3	n/a	HTP15 @ 0.25
0.3	n/a	HTP17 @ 0.15
0.3	n/a	HTP20 @ 0.15
0.3	n/a	HTP22 @ 0.20
0.3	n/a	HTP24 @ 0.20
0.3	n/a	HTP25 @ 0.15
0.3	n/a	HTP26 @ 0.10
0.3	n/a	HTP29 @ 0.15
0.3	n/a	HTP33 @ 0.25
0.3	n/a	HTP39 @ 0.20
0.3	n/a	HTP40 @ 0.20
0.01	n/a	HTP41 @ 0.1
0.1	n/a	HTP43 @ 0.2
0.044	n/a	HTP44 @ 0.7
0.054	n/a	HTP45 @ 0.4
0.091	n/a	HTP46 @ 0.7
0.5	n/a	TP5 @ 0.1
0.5	n/a	TP8 @ 0.4
1.1	n/a	TP8 @ 2.8
0.5	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

290 = GAC (critical conc.) (mg/kg)

20 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
1.1 = max. value
0.3 = laboratory reporting limit (RL)
0.30995 = mean
16 = no. samples at RL
0.235289 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-5506.148 = t_0	-5506.15 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.400916 = 95% UCL (US_{95})	0.539339 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.5393388 GAC = 290 (US95 = 0.002 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

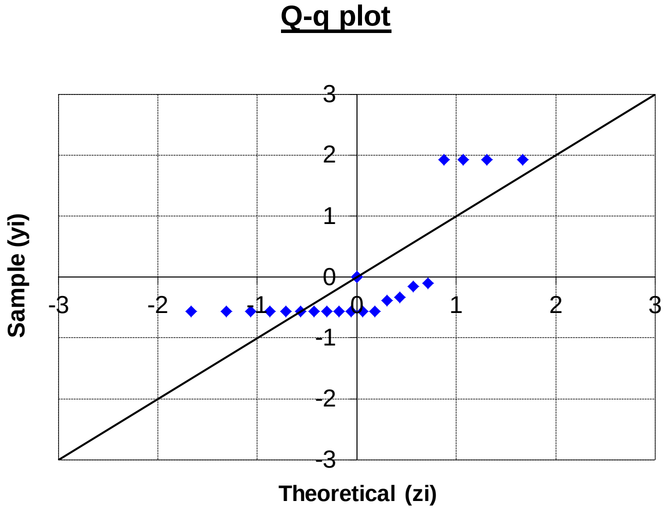
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

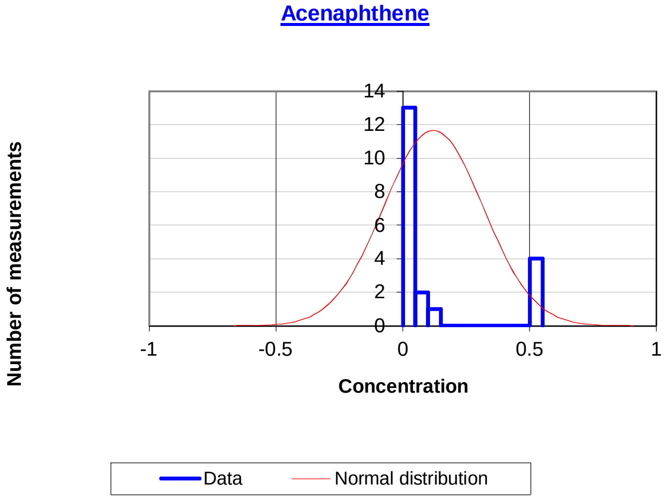
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA	
	Mean Absolute Deviation for potential outliers	
	3.5 = critical value of test statistic	Note - MAD not applicable as 50% or more of values are the same.

Acenaphthene	Potential Outlier?	Sample
0.01	n/a	HTP15 @ 0.25
0.01	n/a	HTP17 @ 0.15
0.01	n/a	HTP20 @ 0.15
0.01	n/a	HTP22 @ 0.20
0.01	n/a	HTP24 @ 0.20
0.01	n/a	HTP25 @ 0.15
0.01	n/a	HTP26 @ 0.10
0.01	n/a	HTP29 @ 0.15
0.01	n/a	HTP33 @ 0.25
0.01	n/a	HTP39 @ 0.20
0.01	n/a	HTP40 @ 0.20
0.01	n/a	HTP41 @ 0.1
0.1	n/a	HTP43 @ 0.2
0.044	n/a	HTP44 @ 0.7
0.054	n/a	HTP45 @ 0.4
0.091	n/a	HTP46 @ 0.7
0.5	n/a	TP5 @ 0.1
0.5	n/a	TP8 @ 0.4
0.5	n/a	TP8 @ 2.8
0.5	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

480 = GAC (critical conc.) (mg/kg)

20 = no. samples	0 = no. samples > or = GAC
0.01 = min. value	
0.5 = max. value	0.01 = laboratory reporting limit (RL)
0.12045 = mean	12 = no. samples at RL
0.196572 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-10917.57 = t_0	-10917.6 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.196448 = 95% UCL (US_{95})	0.312093 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.3120929 GAC = 480 (US95 = 0.001 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

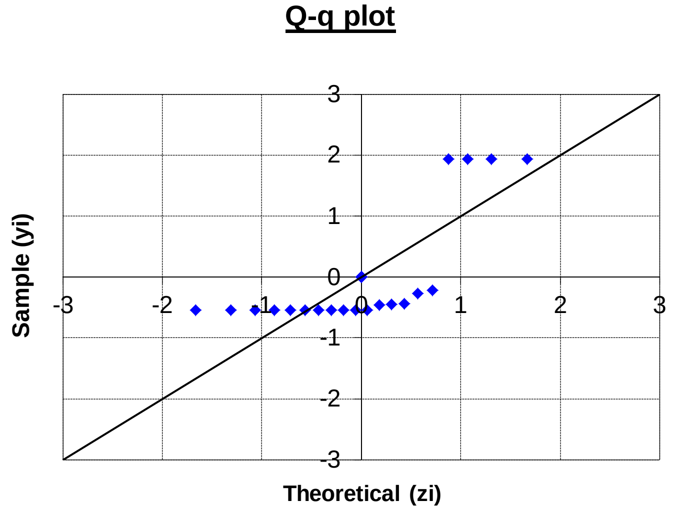
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

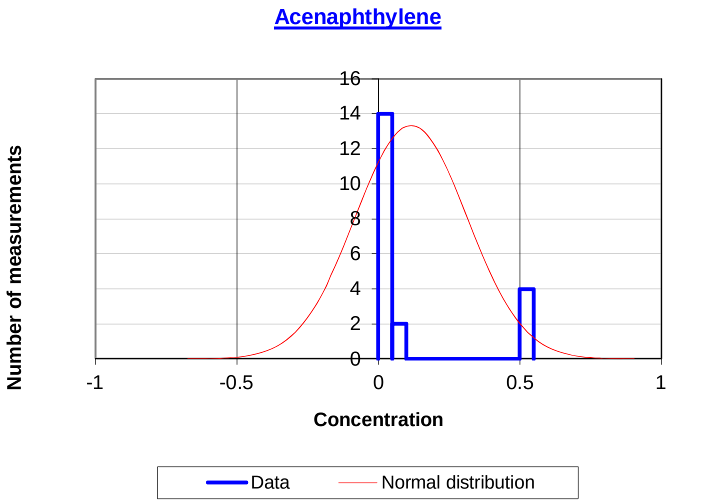
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Acenaphthylene	Potential Outlier?	Sample
0.01	n/a	HTP15 @ 0.25
0.01	n/a	HTP17 @ 0.15
0.01	n/a	HTP20 @ 0.15
0.01	n/a	HTP22 @ 0.20
0.01	n/a	HTP24 @ 0.20
0.01	n/a	HTP25 @ 0.15
0.01	n/a	HTP26 @ 0.10
0.01	n/a	HTP29 @ 0.15
0.01	n/a	HTP33 @ 0.25
0.073	n/a	HTP39 @ 0.20
0.026	n/a	HTP40 @ 0.20
0.01	n/a	HTP41 @ 0.1
0.063	n/a	HTP43 @ 0.2
0.03	n/a	HTP44 @ 0.7
0.028	n/a	HTP45 @ 0.4
0.01	n/a	HTP46 @ 0.7
0.5	n/a	TP5 @ 0.1
0.5	n/a	TP8 @ 0.4
0.5	n/a	TP8 @ 2.8
0.5	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
400 = GAC (critical conc.) (mg/kg)
20 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.5 = max. value
0.01 = laboratory reporting limit (RL)
0.1165 = mean
11 = no. samples at RL
0.197526 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-9053.666 = t_0
1.729 = $t_{(n-1,0.95)}$
0.192867 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-9053.67 = k_0
4.36 = $k_{0.05}$
0.309073 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.309073 GAC = 400 (US95 = 0.001 x GAC)

Site reference
POTENTIALLY SUITABLE FOR USE

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

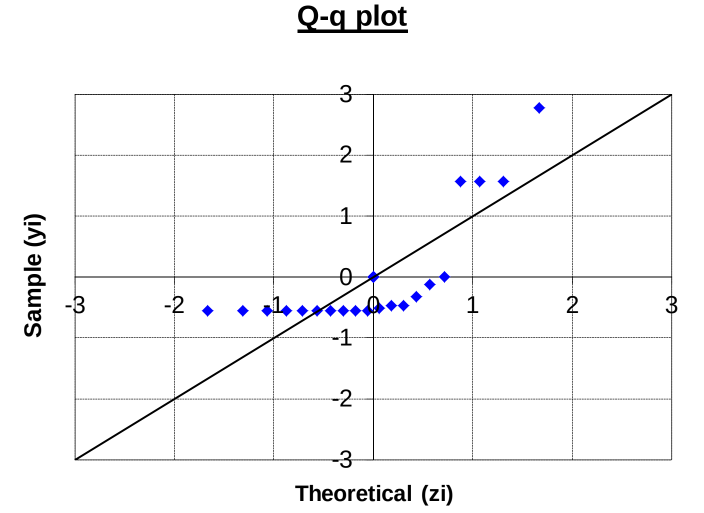
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

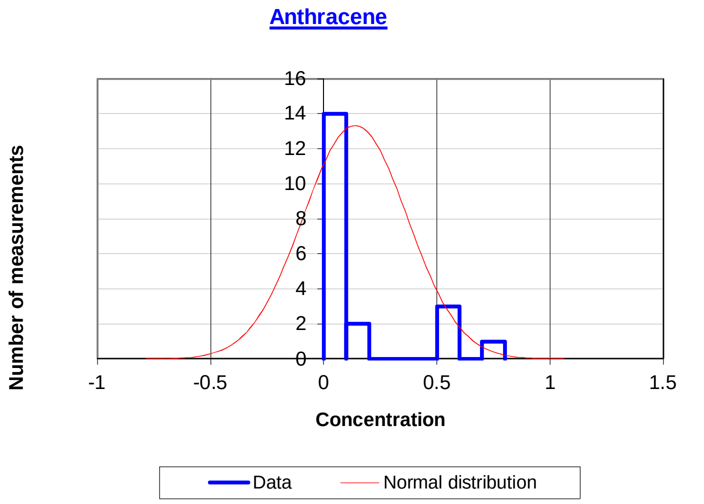
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Anthracene	Potential Outlier?	Sample
0.01		HTP15 @ 0.25
0.01		HTP17 @ 0.15
0.11	Yes	HTP20 @ 0.15
0.01		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.01		HTP25 @ 0.15
0.01		HTP26 @ 0.10
0.012		HTP29 @ 0.15
0.01		HTP33 @ 0.25
0.14	Yes	HTP39 @ 0.20
0.064	Yes	HTP40 @ 0.20
0.03		HTP41 @ 0.1
0.02		HTP43 @ 0.2
0.01		HTP44 @ 0.7
0.01		HTP45 @ 0.4
0.031		HTP46 @ 0.7
0.5	Yes	TP5 @ 0.1
0.78	Yes	TP8 @ 0.4
0.5	Yes	TP8 @ 2.8
0.5	Yes	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

4900 = GAC (critical conc.) (mg/kg)

20 = no. samples
0.01 = min. value
0.78 = max. value
0.13885 = mean
0.230778 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
9 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-94951.9 = t_0
1.729 = $t_{(n-1,0.95)}$
0.228073 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-94951.9 = k_0
4.36 = $k_{0.05}$
0.363842 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.3638418 GAC = 4900 (US95 = 0 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

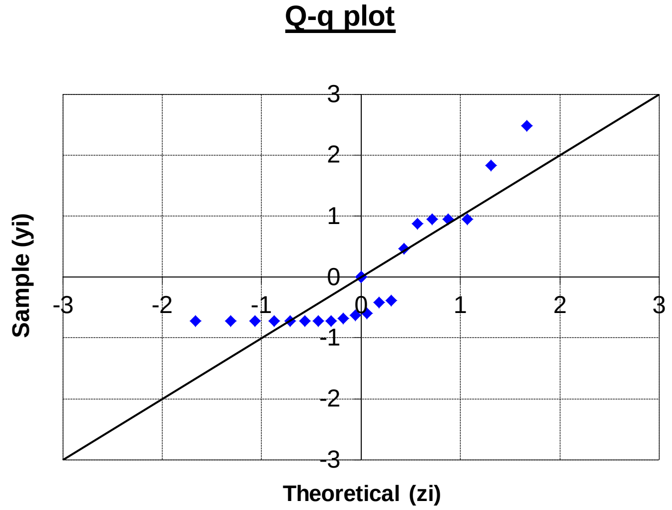
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

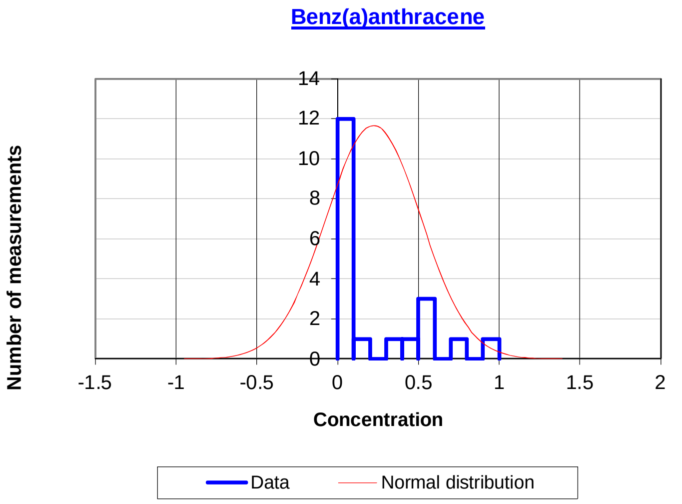
Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Benz(a)anthracene	**Potential Outlier?**	**Sample**
0.01		HTP15 @ 0.25
0.01		HTP17 @ 0.15
0.36	Yes	HTP20 @ 0.15
0.01		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.01		HTP25 @ 0.15
0.047		HTP26 @ 0.10
0.099		HTP29 @ 0.15
0.023		HTP33 @ 0.25
0.95	Yes	HTP39 @ 0.20
0.48	Yes	HTP40 @ 0.20
0.11		HTP41 @ 0.1
0.04		HTP43 @ 0.2
0.01		HTP44 @ 0.7
0.01		HTP45 @ 0.4
0.01		HTP46 @ 0.7
0.5	Yes	TP5 @ 0.1
0.76	Yes	TP8 @ 0.4
0.5	Yes	TP8 @ 2.8
0.5	Yes	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

4.7 = GAC (critical conc.) (mg/kg)

20 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.95 = max. value
0.01 = laboratory reporting limit (RL)
0.22245 = mean
8 = no. samples at RL
0.29267 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-68.41908 = t_0	-68.4191 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.335601 = 95% UCL (US_{95})	0.507781 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.5077815 GAC = 4.7 (US95 = 0.108 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

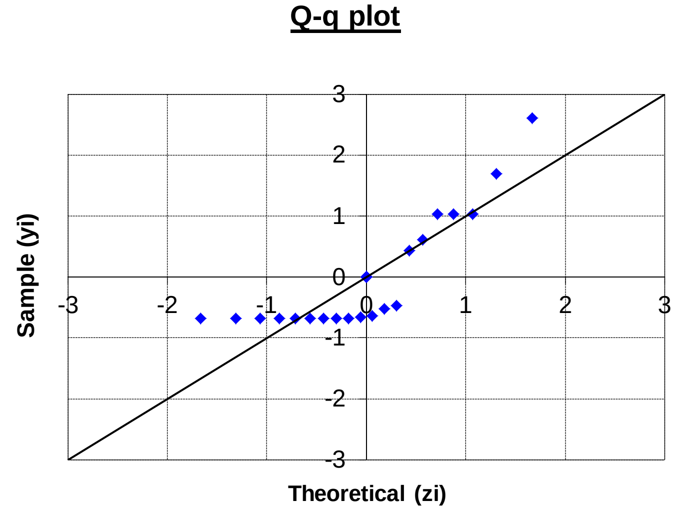
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

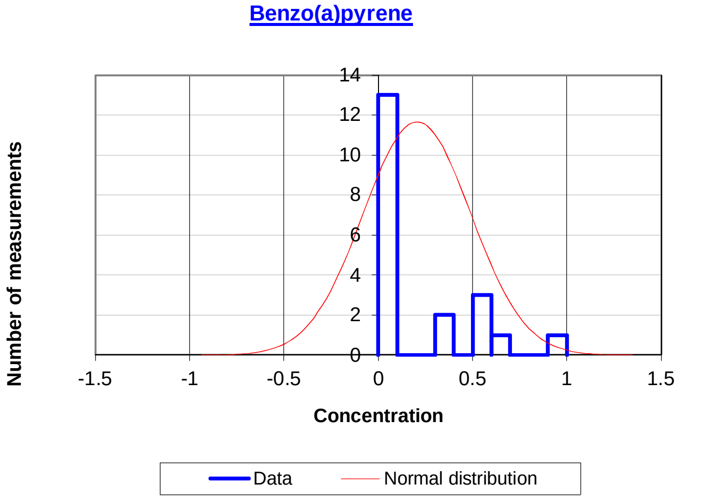
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Benzo(a)pyrene	Potential Outlier?	Sample
0.01		HTP15 @ 0.25
0.01		HTP17 @ 0.15
0.38	Yes	HTP20 @ 0.15
0.01		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.01		HTP25 @ 0.15
0.01		HTP26 @ 0.10
0.07		HTP29 @ 0.15
0.018		HTP33 @ 0.25
0.69	Yes	HTP39 @ 0.20
0.33	Yes	HTP40 @ 0.20
0.055		HTP41 @ 0.1
0.023		HTP43 @ 0.2
0.01		HTP44 @ 0.7
0.01		HTP45 @ 0.4
0.01		HTP46 @ 0.7
0.5	Yes	TP5 @ 0.1
0.95	Yes	TP8 @ 0.4
0.5	Yes	TP8 @ 2.8
0.5	Yes	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

0.94 = GAC (critical conc.) (mg/kg)

20 = no. samples	1 = no. samples > or = GAC
0.01 = min. value	
0.95 = max. value	0.01 = laboratory reporting limit (RL)
0.2053 = mean	9 = no. samples at RL
0.285493 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-11.5088 = t_0	-11.5088 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.315676 = 95% UCL (US_{95})	0.483634 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.4836342 GAC = 0.94 (US95 = 0.515 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

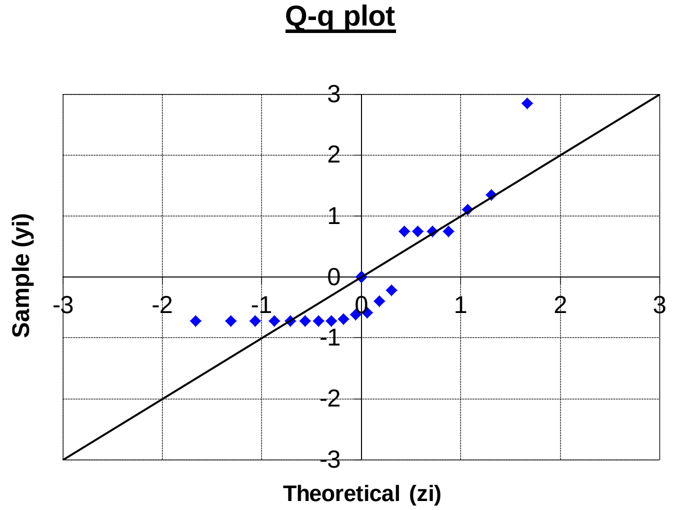
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

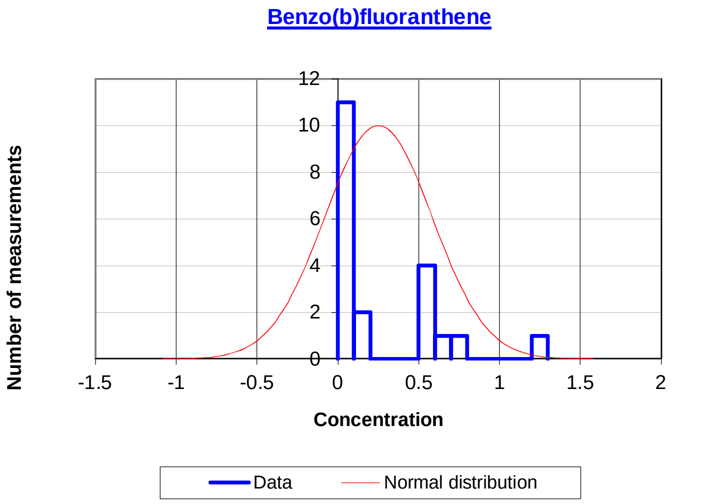
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Benzo(b)fluoranthene	Potential Outlier?	Sample
0.01		HTP15 @ 0.25
0.01		HTP17 @ 0.15
0.5	Yes	HTP20 @ 0.15
0.01		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.01		HTP25 @ 0.15
0.046		HTP26 @ 0.10
0.12		HTP29 @ 0.15
0.021		HTP33 @ 0.25
1.2	Yes	HTP39 @ 0.20
0.62	Yes	HTP40 @ 0.20
0.18		HTP41 @ 0.1
0.056		HTP43 @ 0.2
0.01		HTP44 @ 0.7
0.01		HTP45 @ 0.4
0.01		HTP46 @ 0.7
0.5	Yes	TP5 @ 0.1
0.7	Yes	TP8 @ 0.4
0.5	Yes	TP8 @ 2.8
0.5	Yes	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
6.5 = GAC (critical conc.) (mg/kg)

20 = no. samples
0.01 = min. value
1.2 = max. value
0.25115 = mean
0.332943 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
8 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-83.93547 = t_0	-83.9355 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.379871 = 95% UCL (US_{95})	0.575744 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.5757444 GAC = 6.5 (US95 = 0.089 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

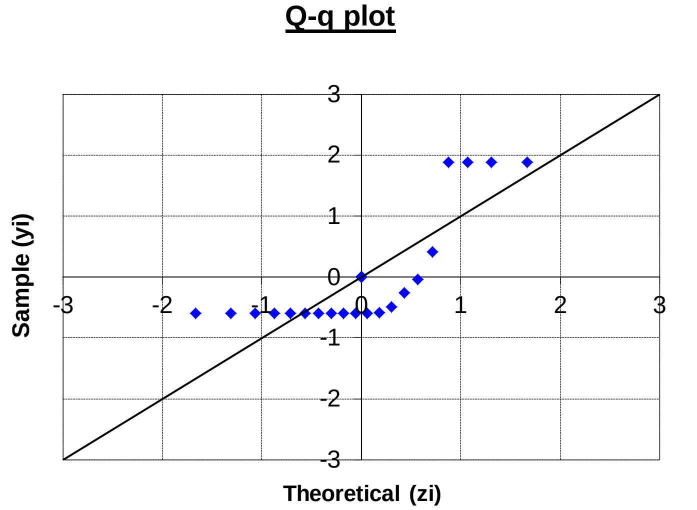
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

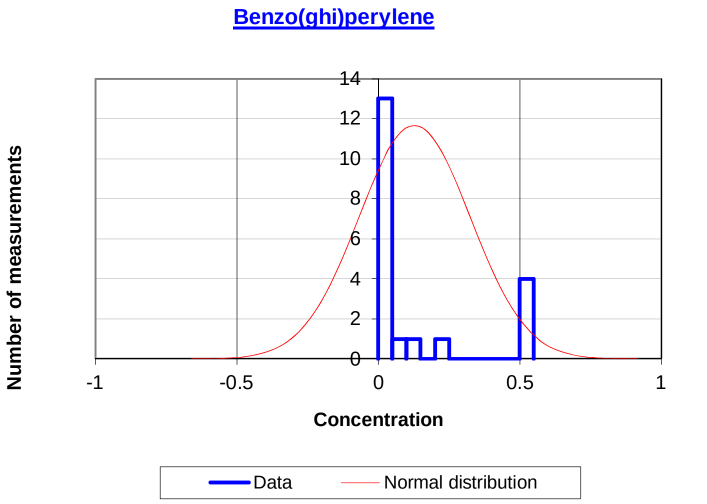
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic — Note - MAD not applicable as 50% or more of values are the same.

Benzo(ghi)perylene	Potential Outlier?	Sample
0.01	n/a	HTP15 @ 0.25
0.01	n/a	HTP17 @ 0.15
0.12	n/a	HTP20 @ 0.15
0.01	n/a	HTP22 @ 0.20
0.01	n/a	HTP24 @ 0.20
0.01	n/a	HTP25 @ 0.15
0.01	n/a	HTP26 @ 0.10
0.013	n/a	HTP29 @ 0.15
0.01	n/a	HTP33 @ 0.25
0.21	n/a	HTP39 @ 0.20
0.076	n/a	HTP40 @ 0.20
0.032	n/a	HTP41 @ 0.1
0.01	n/a	HTP43 @ 0.2
0.01	n/a	HTP44 @ 0.7
0.01	n/a	HTP45 @ 0.4
0.01	n/a	HTP46 @ 0.7
0.5	n/a	TP5 @ 0.1
0.5	n/a	TP8 @ 0.4
0.5	n/a	TP8 @ 2.8
0.5	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter
Human health - residential with plant uptake (2.5%SOM)

46 = GAC (critical conc.) (mg/kg)
20 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.5 = max. value
0.01 = laboratory reporting limit (RL)
0.12805 = mean
11 = no. samples at RL
0.197169 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-1040.458 = t_0
1.729 = $t_{(n-1,0.95)}$
0.204279 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-1040.46 = k_0
4.36 = $k_{0.05}$
0.320275 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.3202746 GAC = 46 (US95 = 0.007 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

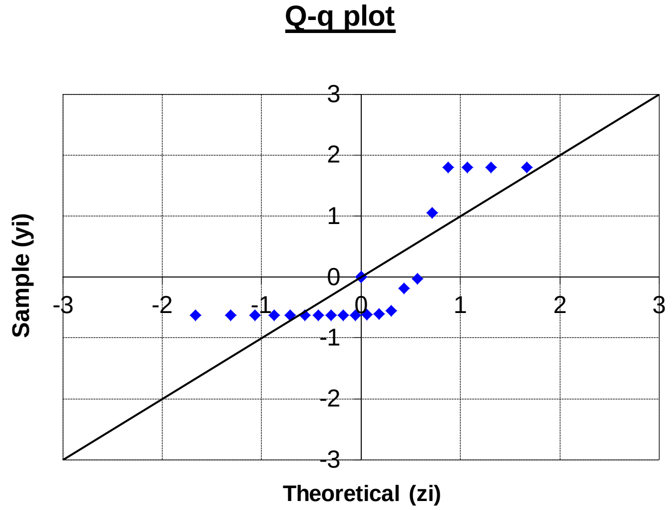
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

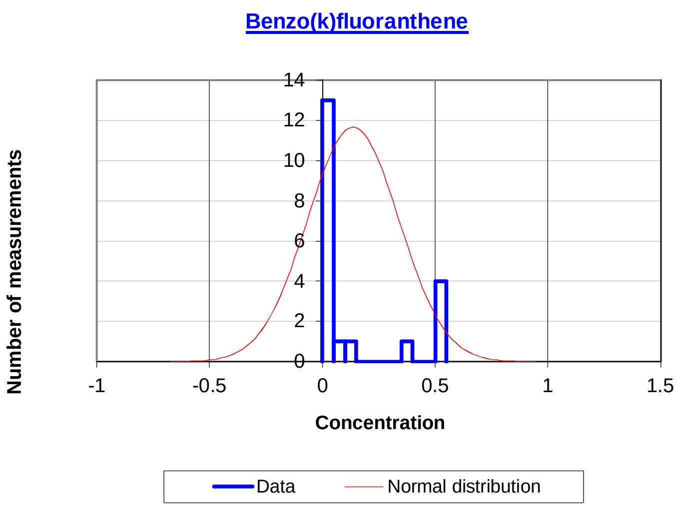
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Benzo(k)fluoranthene	Potential Outlier?	Sample
0.01		HTP15 @ 0.25
0.01		HTP17 @ 0.15
0.13	Yes	HTP20 @ 0.15
0.01		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.01		HTP25 @ 0.15
0.01		HTP26 @ 0.10
0.011		HTP29 @ 0.15
0.01		HTP33 @ 0.25
0.35	Yes	HTP39 @ 0.20
0.099	Yes	HTP40 @ 0.20
0.014	Yes	HTP41 @ 0.1
0.023	Yes	HTP43 @ 0.2
0.01		HTP44 @ 0.7
0.01		HTP45 @ 0.4
0.01		HTP46 @ 0.7
0.5	Yes	TP5 @ 0.1
0.5	Yes	TP8 @ 0.4
0.5	Yes	TP8 @ 2.8
0.5	Yes	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

9.6 = GAC (critical conc.) (mg/kg)

20 = no. samples
0.01 = min. value
0.5 = max. value
0.13635 = mean
0.202513 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
10 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-208.9875 = t_0
1.729 = $t_{(n-1,0.95)}$
0.214645 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-208.987 = k_0
4.36 = $k_{0.05}$
0.333785 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.3337853 GAC = 9.6 (US95 = 0.035 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

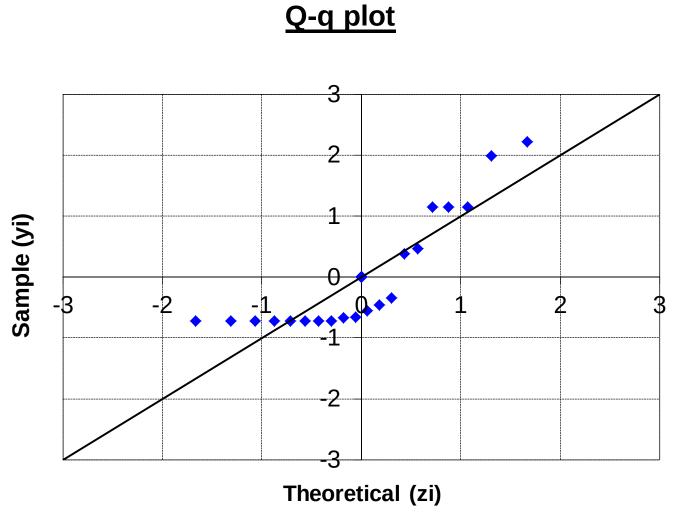
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Chrysene	**Potential Outlier?**	**Sample**
0.01		HTP15 @ 0.25
0.01		HTP17 @ 0.15
0.3	Yes	HTP20 @ 0.15
0.01		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.01		HTP25 @ 0.15
0.029		HTP26 @ 0.10
0.08		HTP29 @ 0.15
0.024		HTP33 @ 0.25
0.78	Yes	HTP39 @ 0.20
0.32	Yes	HTP40 @ 0.20
0.11		HTP41 @ 0.1
0.054		HTP43 @ 0.2
0.01		HTP44 @ 0.7
0.01		HTP45 @ 0.4
0.01		HTP46 @ 0.7
0.5	Yes	TP5 @ 0.1
0.72	Yes	TP8 @ 0.4
0.5	Yes	TP8 @ 2.8
0.5	Yes	TP9 @ 0.6

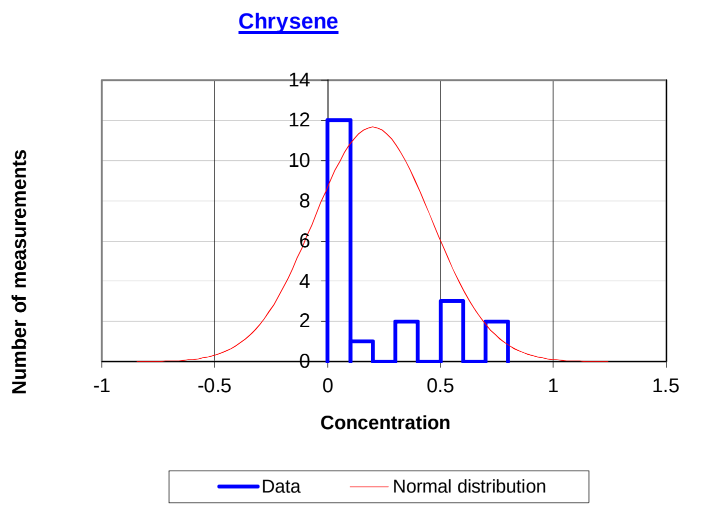
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

8 = GAC (critical conc.) (mg/kg)

20 = no. samples	0 = no. samples > or = GAC
0.01 = min. value	
0.78 = max. value	0.01 = laboratory reporting limit (RL)
0.19985 = mean	8 = no. samples at RL
0.260973 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-133.6664 = t_0	-133.666 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.300746 = 95% UCL (US_{95})	0.454279 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.4542794 GAC = 8 (US95 = 0.057 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

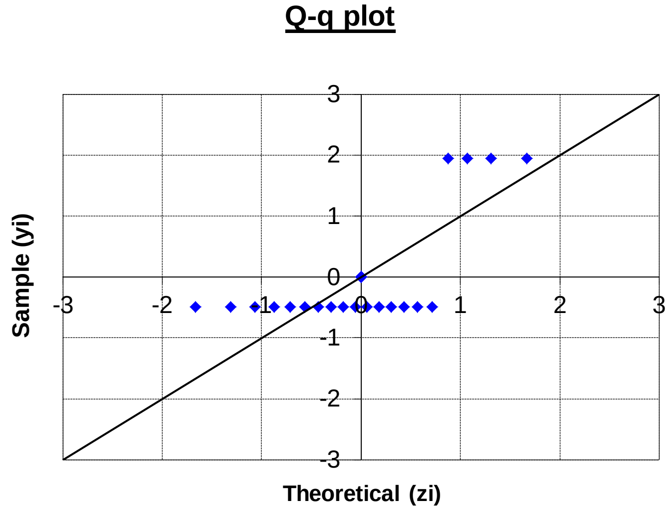
Job no: C12702

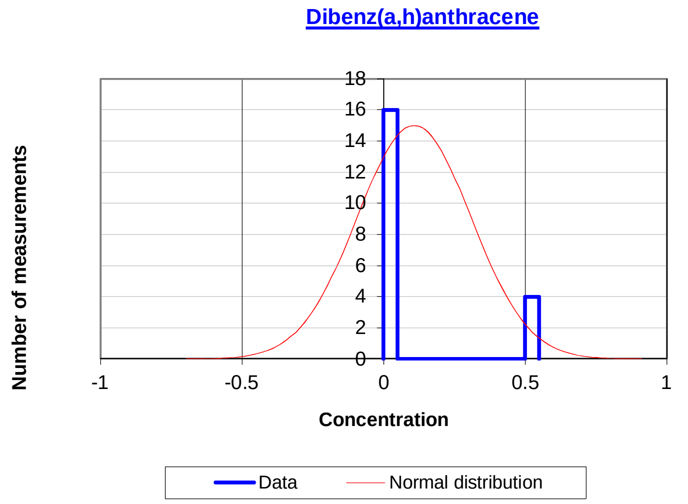
Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA	
	Mean Absolute Deviation for potential outliers	
	3.5 = critical value of test statistic	Note - MAD not applicable as 50% or more of values are the same.

Dibenz(a,h)anthracene	Potential Outlier?	Sample
0.01	n/a	HTP15 @ 0.25
0.01	n/a	HTP17 @ 0.15
0.01	n/a	HTP20 @ 0.15
0.01	n/a	HTP22 @ 0.20
0.01	n/a	HTP24 @ 0.20
0.01	n/a	HTP25 @ 0.15
0.01	n/a	HTP26 @ 0.10
0.01	n/a	HTP29 @ 0.15
0.01	n/a	HTP33 @ 0.25
0.01	n/a	HTP39 @ 0.20
0.01	n/a	HTP40 @ 0.20
0.01	n/a	HTP41 @ 0.1
0.01	n/a	HTP43 @ 0.2
0.01	n/a	HTP44 @ 0.7
0.01	n/a	HTP45 @ 0.4
0.01	n/a	HTP46 @ 0.7
0.5	n/a	TP5 @ 0.1
0.5	n/a	TP8 @ 0.4
0.5	n/a	TP8 @ 2.8
0.5	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

0.86 = GAC (critical conc.) (mg/kg)

20 = no. samples

0 = no. samples > or = GAC

0.01 = min. value

0.5 = max. value

0.01 = laboratory reporting limit (RL)

0.108 = mean

16 = no. samples at RL

0.201092 = standard deviation

RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-16.72394 = t_0	-16.7239 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.185745 = 95% UCL (US_{95})	0.30405 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.3040495 GAC = 0.86 (US95 = 0.354 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: MRB & WMF

Client: Bovis Barratt and Taylor Wimpy

Site: Land at Bankside, Banbury

Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

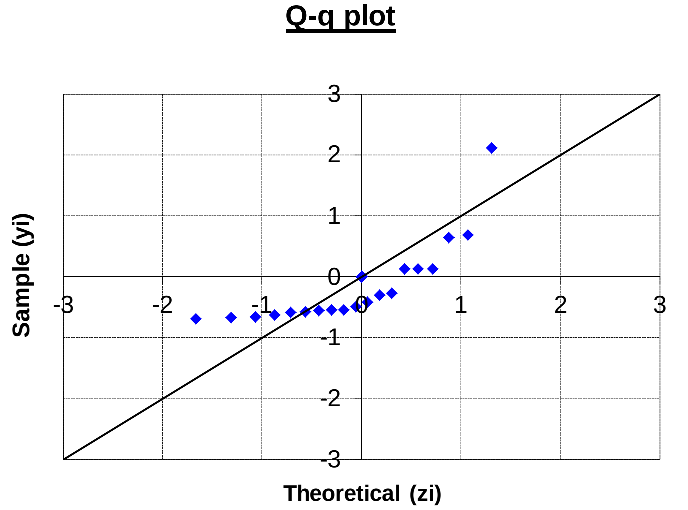
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)		
Fluoranthene	**Potential Outlier?**	**Sample**
0.096		HTP15 @ 0.25
0.019		HTP17 @ 0.15
0.81	Yes	HTP20 @ 0.15
0.043		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.028		HTP25 @ 0.15
0.13		HTP26 @ 0.10
0.26		HTP29 @ 0.15
0.076		HTP33 @ 0.25
1.7	Yes	HTP39 @ 0.20
0.84	Yes	HTP40 @ 0.20
0.24		HTP41 @ 0.1
0.17		HTP43 @ 0.2
0.091		HTP44 @ 0.7
0.071		HTP45 @ 0.4
0.096		HTP46 @ 0.7
0.5		TP5 @ 0.1
2.3	Yes	TP8 @ 0.4
0.5		TP8 @ 2.8
0.5		TP9 @ 0.6

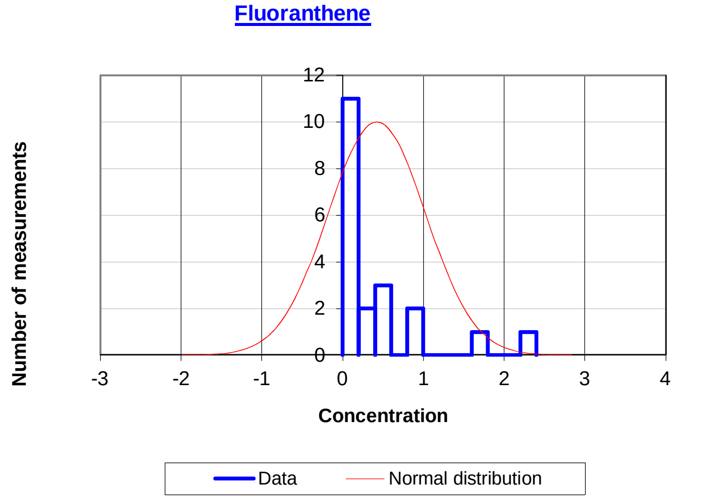
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots





Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

460 = GAC (critical conc.) (mg/kg)

20	= no. samples	0	= no. samples > or = GAC
0.01	= min. value		
2.3	= max. value	0.01	= laboratory reporting limit (RL)
0.424	= mean	1	= no. samples at RL
0.602967	= standard deviation		RL is limit of detection of the method used

Statistical tests

One-sample t-test		**One-sided Chebychev Theorem**	
-3408.624	= t_0	-3408.62	= k_0
1.729	= $t_{(n-1,0.95)}$	4.36	= $k_{0.05}$
0.657117	= 95% UCL (US_{95})	1.011848	= 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC

Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 1.0118475 GAC = 460 (US95 = 0.002 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**

Data set:	MRB & WMF
Client:	Bovis Barratt and Taylor Wimpy
Site:	Land at Bankside, Banbury
Job no:	C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

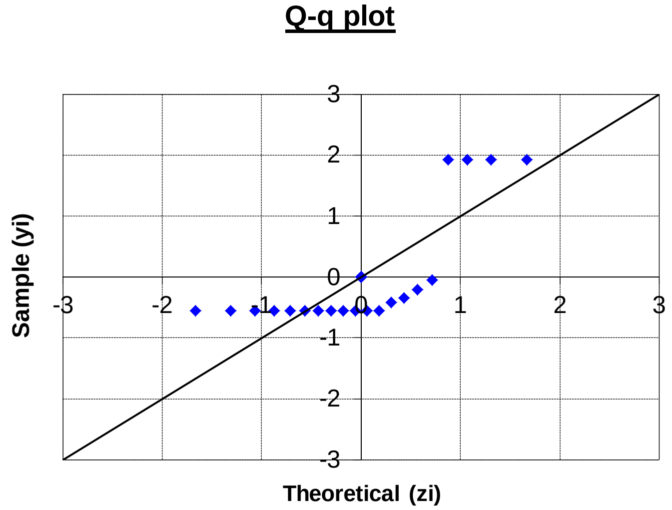
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

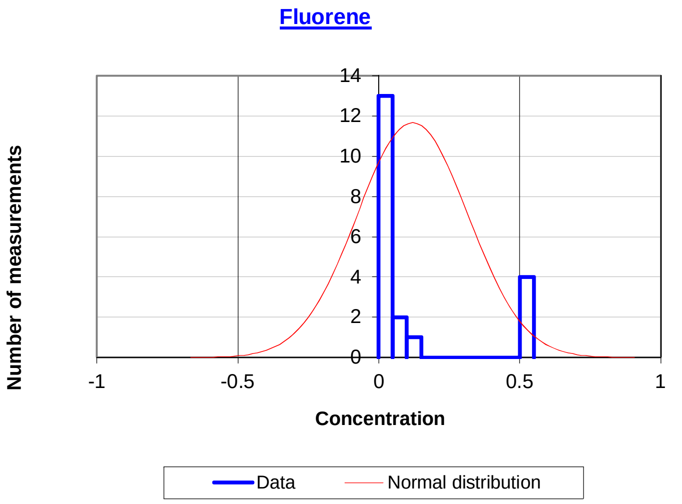
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Fluorene	Potential Outlier?	Sample
0.01	n/a	HTP15 @ 0.25
0.01	n/a	HTP17 @ 0.15
0.01	n/a	HTP20 @ 0.15
0.01	n/a	HTP22 @ 0.20
0.01	n/a	HTP24 @ 0.20
0.01	n/a	HTP25 @ 0.15
0.01	n/a	HTP26 @ 0.10
0.01	n/a	HTP29 @ 0.15
0.01	n/a	HTP33 @ 0.25
0.01	n/a	HTP39 @ 0.20
0.01	n/a	HTP40 @ 0.20
0.01	n/a	HTP41 @ 0.1
0.08	n/a	HTP43 @ 0.2
0.038	n/a	HTP44 @ 0.7
0.053	n/a	HTP45 @ 0.4
0.11	n/a	HTP46 @ 0.7
0.5	n/a	TP5 @ 0.1
0.5	n/a	TP8 @ 0.4
0.5	n/a	TP8 @ 2.8
0.5	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter

Human health - residential with plant uptake (2.5%SOM)

380 = GAC (critical conc.) (mg/kg)

20 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.5 = max. value
0.01 = laboratory reporting limit (RL)
0.12005 = mean
12 = no. samples at RL
0.196778 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-8633.442 = t_0
1.729 = $t_{(n-1,0.95)}$
0.196128 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-8633.44 = k_0
4.36 = $k_{0.05}$
0.311894 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.3118943 GAC = 380 (US95 = 0.001 x GAC)

Site reference
POTENTIALLY SUITABLE FOR USE

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

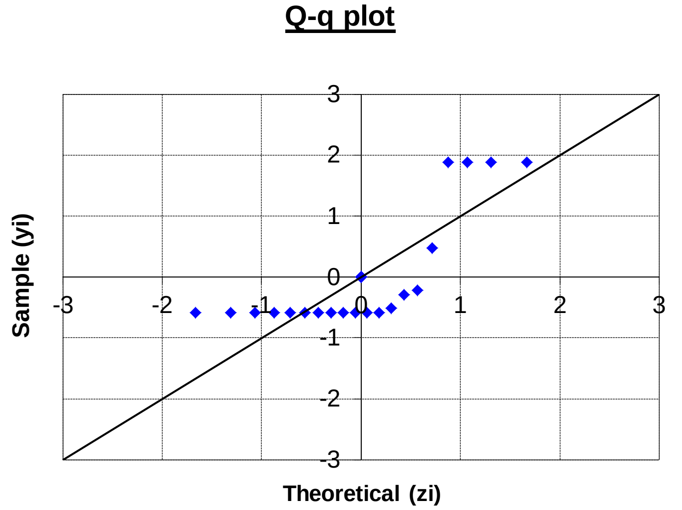
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

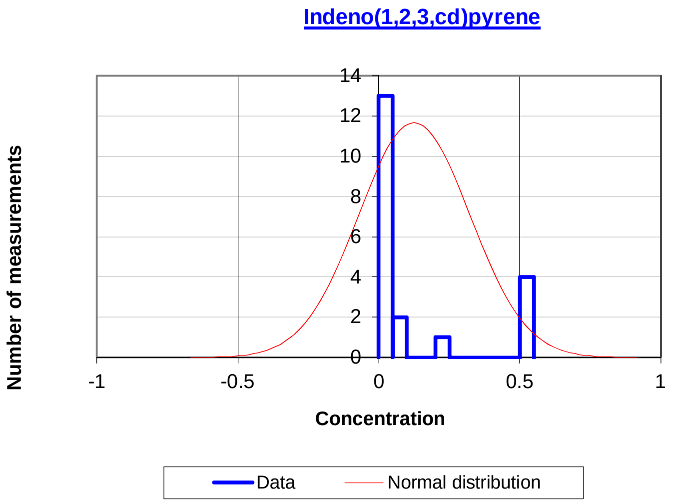
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Indeno(1,2,3,cd)pyrene	Potential Outlier?	Sample
0.01	n/a	HTP15 @ 0.25
0.01	n/a	HTP17 @ 0.15
0.083	n/a	HTP20 @ 0.15
0.01	n/a	HTP22 @ 0.20
0.01	n/a	HTP24 @ 0.20
0.01	n/a	HTP25 @ 0.15
0.01	n/a	HTP26 @ 0.10
0.01	n/a	HTP29 @ 0.15
0.01	n/a	HTP33 @ 0.25
0.22	n/a	HTP39 @ 0.20
0.069	n/a	HTP40 @ 0.20
0.025	n/a	HTP41 @ 0.1
0.01	n/a	HTP43 @ 0.2
0.01	n/a	HTP44 @ 0.7
0.01	n/a	HTP45 @ 0.4
0.01	n/a	HTP46 @ 0.7
0.5	n/a	TP5 @ 0.1
0.5	n/a	TP8 @ 0.4
0.5	n/a	TP8 @ 2.8
0.5	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data Risk parameter
Human health - residential with plant uptake (2.5%SOM)
3.9 = GAC (critical conc.) (mg/kg)
20 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
0.5 = max. value
0.01 = laboratory reporting limit (RL)
0.12585 = mean
12 = no. samples at RL
0.198031 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-85.23159 = t_0	-85.2316 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.202412 = 95% UCL (US_{95})	0.318916 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.3189157 GAC = 3.9 (US95 = 0.082 x GAC)

Site reference **POTENTIALLY SUITABLE FOR USE**
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

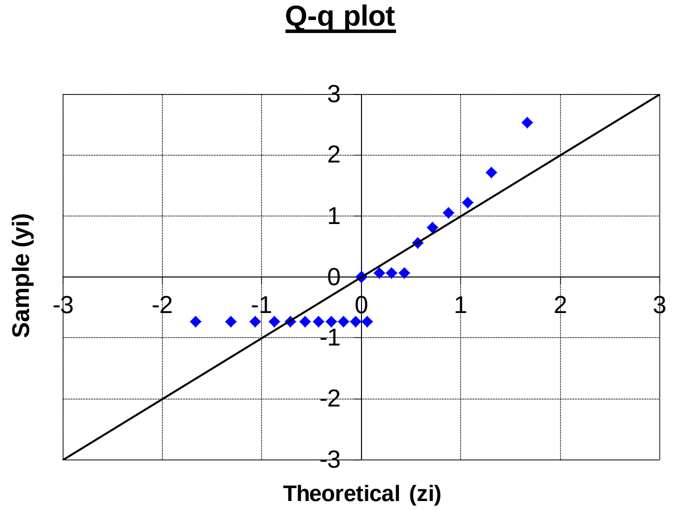
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

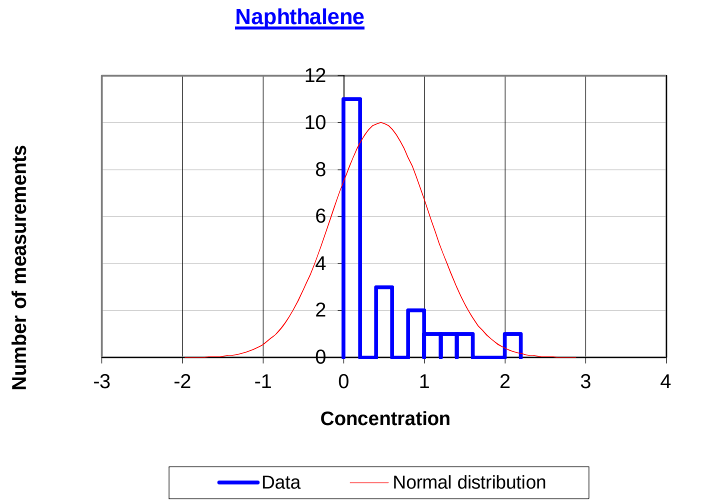
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Naphthalene	Potential Outlier?	Sample
0.01	n/a	HTP15 @ 0.25
0.01	n/a	HTP17 @ 0.15
0.01	n/a	HTP20 @ 0.15
0.01	n/a	HTP22 @ 0.20
0.01	n/a	HTP24 @ 0.20
0.01	n/a	HTP25 @ 0.15
0.01	n/a	HTP26 @ 0.10
0.01	n/a	HTP29 @ 0.15
0.01	n/a	HTP33 @ 0.25
0.01	n/a	HTP39 @ 0.20
0.01	n/a	HTP40 @ 0.20
0.8	n/a	HTP41 @ 0.1
1.5	n/a	HTP43 @ 0.2
0.95	n/a	HTP44 @ 0.7
1.2	n/a	HTP45 @ 0.4
2	n/a	HTP46 @ 0.7
0.5	n/a	TP5 @ 0.1
1.1	n/a	TP8 @ 0.4
0.5	n/a	TP8 @ 2.8
0.5	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter
Human health - residential with plant uptake (2.5%SOM)

3.7 = GAC (critical conc.) (mg/kg)

20 = no. samples
0 = no. samples > or = GAC
0.01 = min. value
2 = max. value
0.01 = laboratory reporting limit (RL)
0.458 = mean
11 = no. samples at RL
0.606904 = standard deviation
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-23.88955 = t_0	-23.8895 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.692639 = 95% UCL (US_{95})	1.049686 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 1.0496864 GAC = 3.7 (US95 = 0.284 x GAC)

Site reference — **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	Potential Outlier?	Sample
Phenanthrene		
0.039		HTP15 @ 0.25
0.01		HTP17 @ 0.15
0.39		HTP20 @ 0.15
0.01		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.01		HTP25 @ 0.15
0.043		HTP26 @ 0.10
0.059		HTP29 @ 0.15
0.029		HTP33 @ 0.25
0.28		HTP39 @ 0.20
0.17		HTP40 @ 0.20
0.22		HTP41 @ 0.1
0.17		HTP43 @ 0.2
0.1		HTP44 @ 0.7
0.08		HTP45 @ 0.4
0.24		HTP46 @ 0.7
0.5		TP5 @ 0.1
2.1	Yes	TP8 @ 0.4
0.5		TP8 @ 2.8
0.5		TP9 @ 0.6

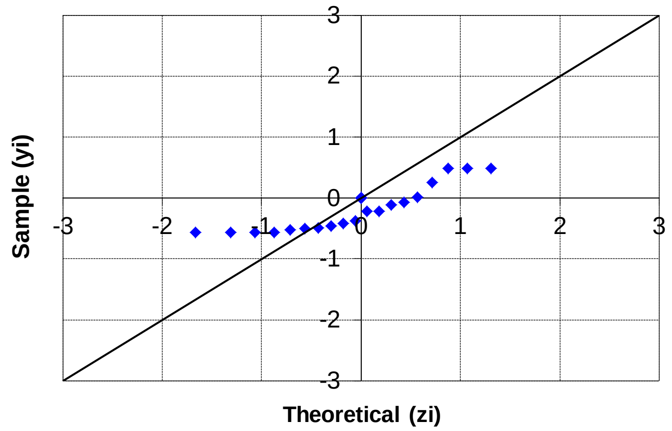
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

Mean Absolute Deviation for potential outliers

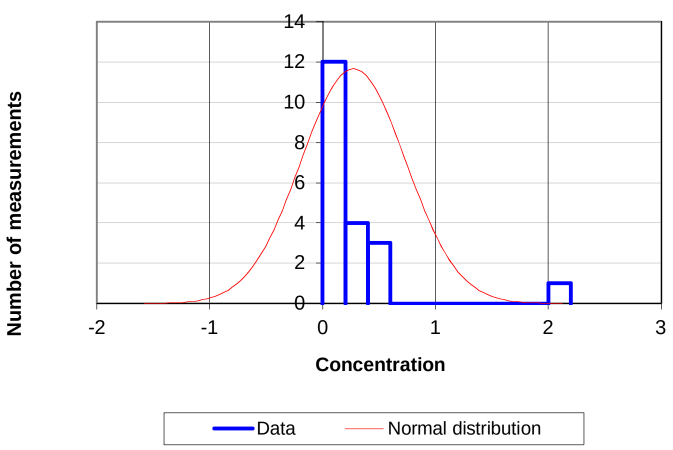
3.5 = critical value of test statistic

Visual assessment - Q-q & histogram plots

Q-q plot



Phenanthrene



Basic data Risk parameter

Human health - residential with plant uptake (2.5%SOM)

200 = GAC (critical conc.) (mg/kg)

20 = no. samples
0.01 = min. value
2.1 = max. value
0.273 = mean
0.463863 = standard deviation

0 = no. samples > or = GAC
0.01 = laboratory reporting limit (RL)
4 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test

-1925.581 = t_0
1.729 = $t_{(n-1,0.95)}$
0.452337 = 95% UCL (US_{95})

One-sided Chebychev Theorem

-1925.58 = k_0
4.36 = $k_{0.05}$
0.725232 = 95% UCL (US_{95})

Results of significance test at 95% confidence level

Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC

Data set treated as **non-normally distributed**

Therefore:

Use Chebychev Theorem - Ho rejected, true mean <=GAC

US_{95} = 0.7252321 GAC = 200 (US95 = 0.004 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

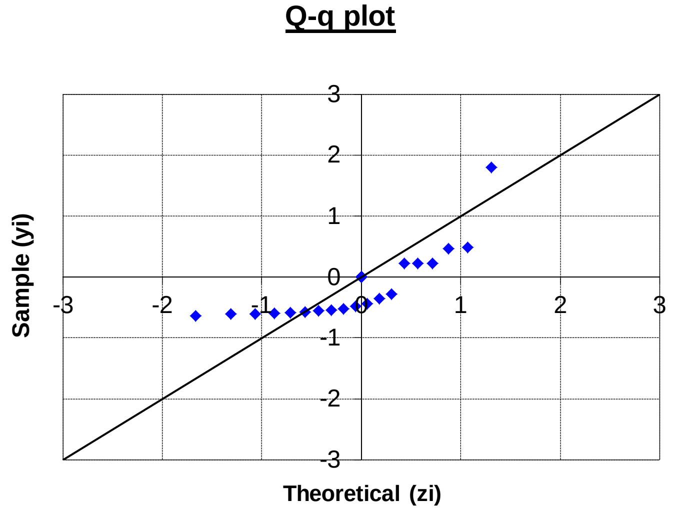
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

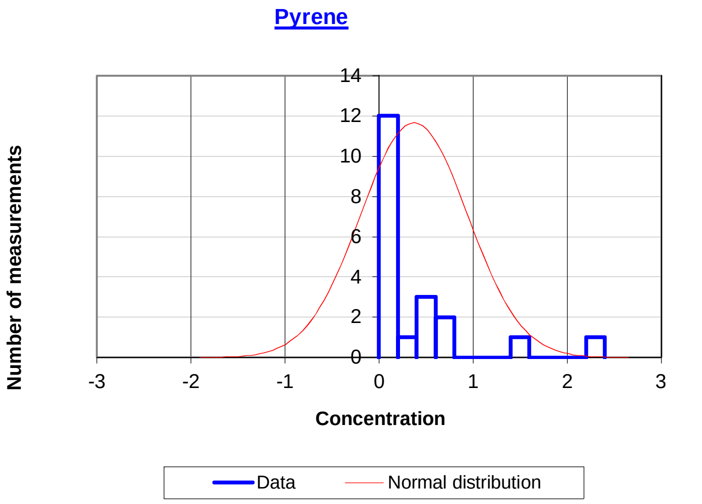
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Pyrene	Potential Outlier?	Sample
0.037		HTP15 @ 0.25
0.028		HTP17 @ 0.15
0.64	Yes	HTP20 @ 0.15
0.03		HTP22 @ 0.20
0.01		HTP24 @ 0.20
0.024		HTP25 @ 0.15
0.1		HTP26 @ 0.10
0.21		HTP29 @ 0.15
0.056		HTP33 @ 0.25
1.4	Yes	HTP39 @ 0.20
0.65	Yes	HTP40 @ 0.20
0.17		HTP41 @ 0.1
0.12		HTP43 @ 0.2
0.072		HTP44 @ 0.7
0.045		HTP45 @ 0.4
0.063		HTP46 @ 0.7
0.5		TP5 @ 0.1
2.3	Yes	TP8 @ 0.4
0.5		TP8 @ 2.8
0.5		TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter
Human health - residential with plant uptake (2.5%SOM)
1000 = GAC (critical conc.) (mg/kg)

20 = no. samples	0 = no. samples > or = GAC
0.01 = min. value	
2.3 = max. value	0.01 = laboratory reporting limit (RL)
0.37275 = mean	1 = no. samples at RL
0.569796 = standard deviation	RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-7845.73 = t_0	-7845.73 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.593043 = 95% UCL (US_{95})	0.928259 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.9282592 GAC = 1000 (US95 = 0.001 x GAC)

Site reference — **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

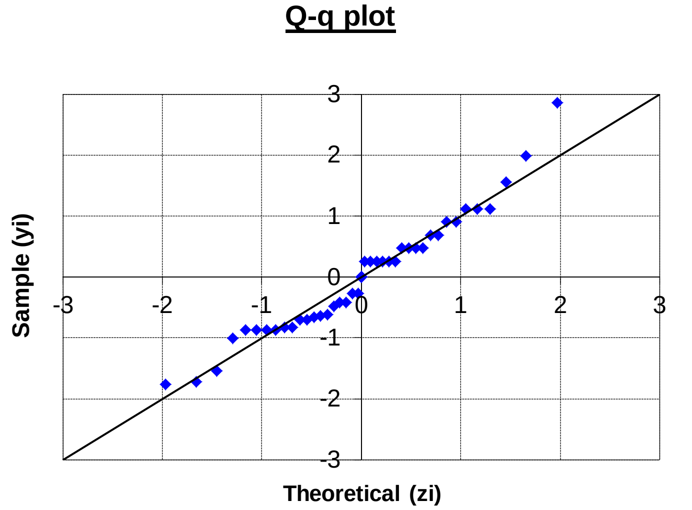
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

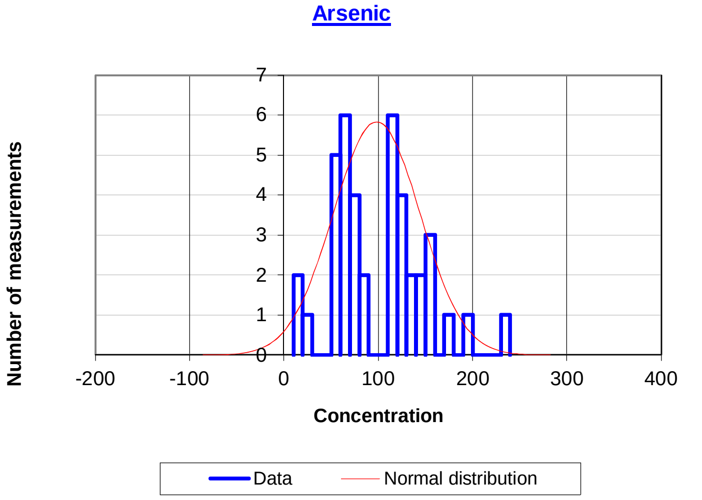
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

Arsenic	Potential Outlier?	Sample
110		HTP15 @ 0.25
66		HTP17 @ 0.15
68		HTP20 @ 0.15
86		HTP22 @ 0.20
79		HTP24 @ 0.20
140		HTP25 @ 0.15
120		HTP26 @ 0.10
58		HTP29 @ 0.15
76		HTP33 @ 0.25
52		HTP39 @ 0.20
58		HTP40 @ 0.20
190		HTP41 @ 0.1
130		HTP43 @ 0.2
230		HTP44 @ 0.7
120		HTP45 @ 0.4
170		HTP46 @ 0.7
19		TP5 @ 0.1
58		TP8 @ 0.4
17		TP8 @ 2.8
27		TP9 @ 0.6
120		HS1 TS1 @ 0.21
140		HS1 TS2 @ 0.15
150		HS1 SS1 @ 0.33
150		HS1 SS1 @ No depth
110		HS2 TS1 @ 0.22
110		HS2 TS2 @ 0.28
110		HS2 SS1 @ 0.35
60		HS3 TS1 @ 0.24
66		HS3 TS2 @ 0.25
86		HS3 TS2 @ No depth
58		HS3SS1 @ 0.4
79		HS4 TS1 @ 0.22
60		HS4TS2 @ 0.19
70		HS4 SS1 @ 0.38
130		HS5 TS1 @ 0.16
110		HS5 TS1 @ No depth
110		HS5TS2 @ 0.17
150		WAHS1 @ No depth
120		WAHS2 @ No depth
69		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter
Plant life pH 7

250 = GAC (critical conc.) (mg/kg)
40 = no. samples
17 = min. value
230 = max. value
98.3 = mean
46.09644 = standard deviation

0 = no. samples > or = GAC
2 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-20.81365 = t_0
1.685 = $t_{(n-1,0.95)}$
110.5811 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-20.8136 = k_0
4.36 = $k_{0.05}$
130.0778 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 130.07781 GAC = 250 (US95 = 0.52 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

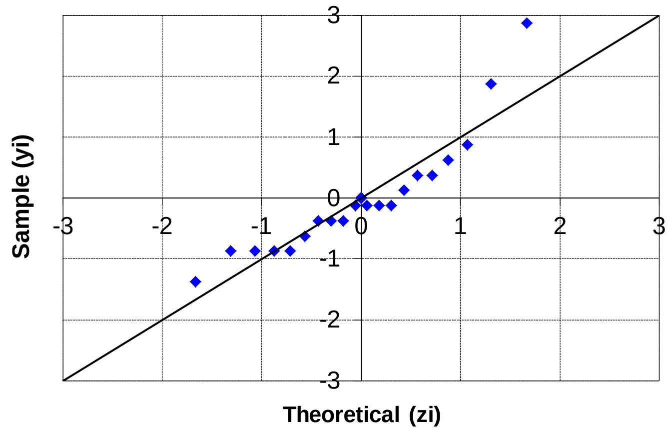
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic

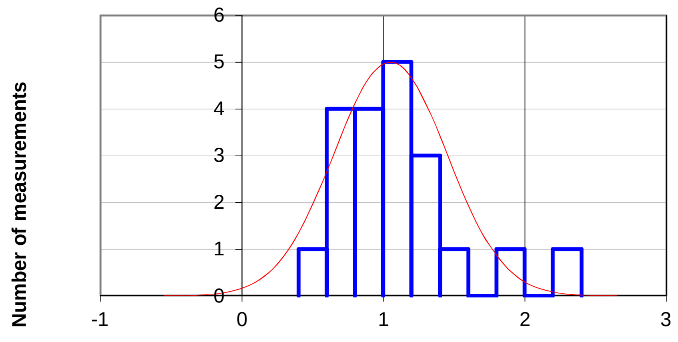
Boron	Potential Outlier?	Sample
0.8		HTP15 @ 0.25
0.9		HTP17 @ 0.15
1.4		HTP20 @ 0.15
0.7		HTP22 @ 0.20
0.9		HTP24 @ 0.20
0.5		HTP25 @ 0.15
1.1		HTP26 @ 0.10
1.3		HTP29 @ 0.15
1.2		HTP33 @ 0.25
0.7		HTP39 @ 0.20
0.9		HTP40 @ 0.20
1		HTP41 @ 0.1
1		HTP43 @ 0.2
0.7		HTP44 @ 0.7
1		HTP45 @ 0.4
1.2		HTP46 @ 0.7
1.8		TP5 @ 0.1
1		TP8 @ 0.4
2.2	Yes	TP8 @ 2.8
0.7		TP9 @ 0.6

Visual assessment - Q-q & histogram plots

Q-q plot



Boron



Basic data

Risk parameter
Plant life pH 7

3 = GAC (critical conc.) (mg/kg)
20 = no. samples
0.5 = min. value
2.2 = max. value
1.05 = mean
0.400657 = standard deviation

0 = no. samples > or = GAC
0.4 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test	**One-sided Chebychev Theorem**
-21.76589 = t_0	-21.7659 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
1.204901 = 95% UCL (US_{95})	1.440611 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 1.4406111 GAC = 3 (US95 = 0.48 x GAC)

POTENTIALLY SUITABLE FOR USE

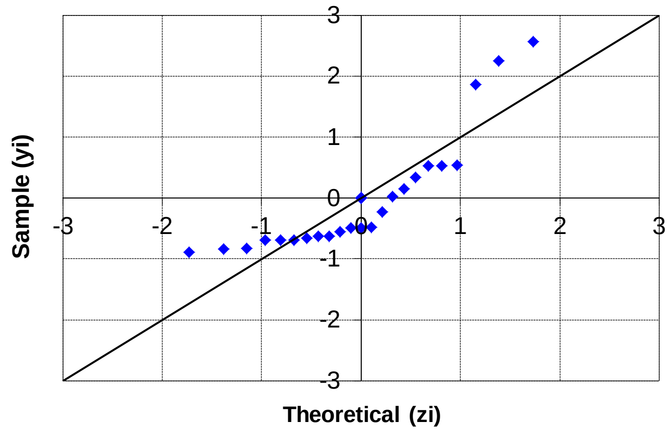
Site reference
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

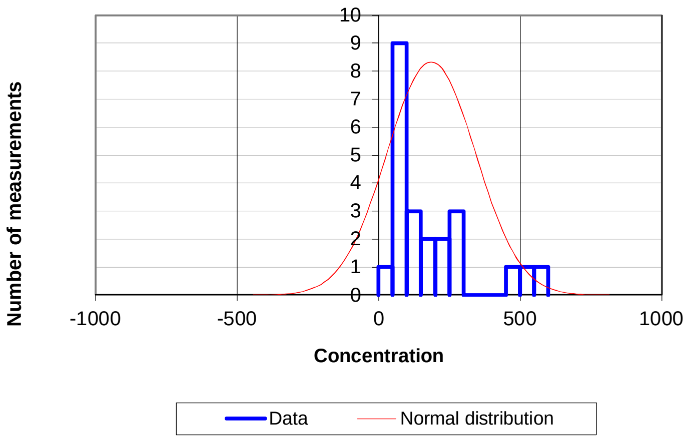
Chemical and data (mg/kg) (blue denotes <= RL) (red denotes >= GAC)	STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA	
	Mean Absolute Deviation for potential outliers	
	3.5 = critical value of test statistic	
Chromium (III)	**Potential Outlier?**	**Sample**
269.5		HTP15 @ 0.25
77.5		HTP17 @ 0.15
87.5		HTP20 @ 0.15
109.5		HTP22 @ 0.20
109.5		HTP24 @ 0.20
269.5		HTP25 @ 0.15
239.5		HTP26 @ 0.10
77.5		HTP29 @ 0.15
99.5		HTP33 @ 0.25
77.5		HTP39 @ 0.20
81.5		HTP40 @ 0.20
479.5	Yes	HTP41 @ 0.1
209.5		HTP43 @ 0.2
539.5	Yes	HTP44 @ 0.7
189.5		HTP45 @ 0.4
589.5	Yes	HTP46 @ 0.7
55.57		TP5 @ 0.1
109.8		TP8 @ 0.4
53.8		TP8 @ 2.8
46.6		TP9 @ 0.6
270		WAHS1 @ No depth
150		WAHS2 @ No depth
87		WAHS4 @ No depth

Visual assessment - Q-q & histogram plots

Q-q plot



Chromium (III)



Basic data — Risk parameter
Plant life pH 7

400 = GAC (critical conc.) (mg/kg)
23 = no. samples
46.6 = min. value
589.5 = max. value
186.0335 = mean
157.2917 = standard deviation

3 = no. samples > or = GAC
5 = laboratory reporting limit (RL)
0 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test
-6.523852 = t_0
1.717 = $t_{(n-1,0.95)}$
242.3469 = 95% UCL (US_{95})

One-sided Chebychev Theorem
-6.52385 = k_0
4.36 = $k_{0.05}$
329.0309 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 329.03091 GAC = 400 (US95 = 0.823 x GAC)

POTENTIALLY SUITABLE FOR USE

Site reference
Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

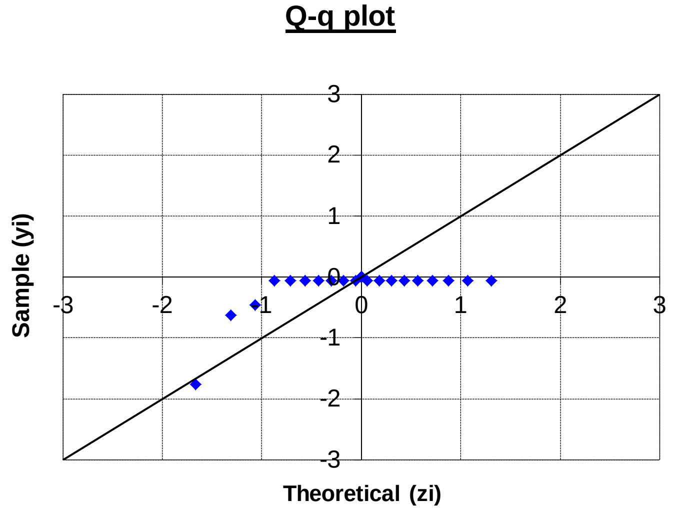
STATISTICAL ASSESSMENT OF GEO-ENVIRONMENTAL SOIL DATA

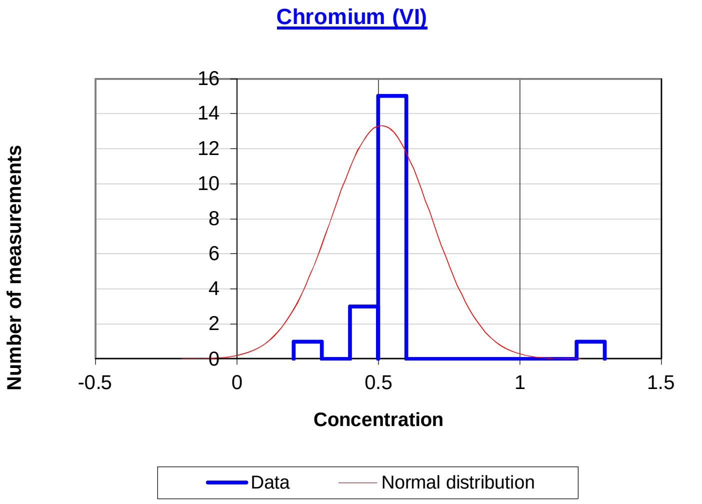
Chemical and data (mg/kg)
(blue denotes <= RL)
(red denotes >= GAC)

Mean Absolute Deviation for potential outliers
3.5 = critical value of test statistic
Note - MAD not applicable as 50% or more of values are the same.

Chromium (VI)	Potential Outlier?	Sample
0.5	n/a	HTP15 @ 0.25
0.5	n/a	HTP17 @ 0.15
0.5	n/a	HTP20 @ 0.15
0.5	n/a	HTP22 @ 0.20
0.5	n/a	HTP24 @ 0.20
0.5	n/a	HTP25 @ 0.15
0.5	n/a	HTP26 @ 0.10
0.5	n/a	HTP29 @ 0.15
0.5	n/a	HTP33 @ 0.25
0.5	n/a	HTP39 @ 0.20
0.5	n/a	HTP40 @ 0.20
0.5	n/a	HTP41 @ 0.1
0.5	n/a	HTP43 @ 0.2
0.5	n/a	HTP44 @ 0.7
0.5	n/a	HTP45 @ 0.4
0.5	n/a	HTP46 @ 0.7
0.43	n/a	TP5 @ 0.1
0.2	n/a	TP8 @ 0.4
1.2	n/a	TP8 @ 2.8
0.4	n/a	TP9 @ 0.6

Visual assessment - Q-q & histogram plots





Basic data — Risk parameter
Plant life pH 7

25 = GAC (critical conc.) (mg/kg)
20 = no. samples
0.2 = min. value
1.2 = max. value
0.5115 = mean
0.176554 = standard deviation

0 = no. samples > or = GAC
0.5 = laboratory reporting limit (RL)
19 = no. samples at RL
RL is limit of detection of the method used

Statistical tests

One-sample t-test	One-sided Chebychev Theorem
-620.2969 = t_0	-620.297 = k_0
1.729 = $t_{(n-1,0.95)}$	4.36 = $k_{0.05}$
0.579759 = 95% UCL (US_{95})	0.683627 = 95% UCL (US_{95})

Results of significance test at 95% confidence level
Null hypothesis (H_0) = level of contamination is the same as, or higher than, the GAC
Alternative hypotheses (H_1) = level of contamination is lower than the GAC
Data set treated as **non-normally distributed**
Therefore:
Use Chebychev Theorem - Ho rejected, true mean <=GAC
US_{95} = 0.683627 GAC = 25 (US95 = 0.027 x GAC)

Site reference — **POTENTIALLY SUITABLE FOR USE**

Data set: MRB & WMF
Client: Bovis Barratt and Taylor Wimpy
Site: Land at Bankside, Banbury
Job no: C12702

Reference: CL:AIRE & CIEH. May 2008.Guidance on comparing soil contamination with a critical concentration.

Summary of Remedial Targets Methodology

RTM Level 1 - Soil Zone Assessment - leachate samples

Water body receptor(s): Surface water
Secondary receptor(s): Aquatic ecosystem
Data set: Tip Area
Client: Bovis, Barratt and Taylor Wimpey Homes
Site: Land at Bankside, Banbury
Job no: C12702

Chemicals of Potential Concern (concentrations in µg/l)	Summary of Sample Data					Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red Text)		No. Samples Exceeding Water Quality Target		Notes
	No. of Samples	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value		Inland Waters EQS		Inland Waters EQS		
Hardness as mg/l CaCO3	-	-	61	-	-	-	-				Used with some EQS.
Ag (dissolved)	2	0.5	0.5	0.5	0.5	0.5	0.05		2		EQS > LoD.
As (dissolved)	2	1	1	1.6	1.57	1.6	50		0		
B (dissolved)	2	20	20	20	20	20	2000		0		
Cd (dissolved)	2	0.08	0.08	0.08	0.08	0.08	0.09		0		
Co (dissolved)	2	1	1	1	1	1	3		0		
Cr (VI) (dissolved)	2	1	1	1	1	1	3.4		0		
Cr (III) (dissolved)	2	1	1	1	1	1	4.7		0		
Cu (dissolved)	2	1	1	6.3	6.035	6.3	6		1		
Fe (dissolved)	2	20	100	590	565.5	590	1000		0		
Hg (dissolved)	2	0.01	0.01	0.022	0.0214	0.022	0.05		0		
Ni (dissolved)	2	1	1	1	1	1	20		0		
Pb (dissolved)	2	1	1	2	1.95	2	7.2		0		
Sn (dissolved)	2	1	1	2.2	2.14	2.2	25		0		
V (dissolved)	2	1	1	2.6	2.52	2.6	20		0		
Zn (total)	2	1	3.5	3.8	3.785	3.8	50		0		
Cyanide (free)	2	5	5	5	5	5	1		2		EQS > LoD.
Chloride (Cl-)	2	1000	2500	2700	2690	2700	250000		0		
Fluoride (F-)	2	50	160	250	245.5	250	5000		0		
Sulfate (SO42-)	2	1000	3600	6800	6640	6800	400000		0		
pH (min.) (su)	2	0.1	8.2	8	8.19	8	6		0		Max & Min interchanged to compare min. value.
pH (max.) (su)	2	0.1	8	8.2	8.19	8.2	8.5		0		
Anthracene	2	0.01	0.01	0.01	0.01	0.01	0.1		0		
Benzo(a)pyrene	2	0.01	6.7	8.9	8.79	8.9	0.05		2		
PAH sum of benzo(b)fluoranthene benzo(k)fluoranthene	2	0.02	0.02	1.21	1.1505	1.21	0.03		1		
PAH sum of benzo(ghi)perylene indeno(1,2,3-cd)pyrene	2	0.02	0.02	0.02	0.02	0.02	0.002		2		EQS > LoD.
Fluoranthene	2	0.01	0.01	0.6	0.5705	0.6	0.1		1		
Naphthalene	2	0.01	2.6	3.3	3.265	3.3	2.4		2		
Phenol	2	0.2	0.2	0.2	0.2	0.2	7.7		0		
2,4,6-Trichlorophenol	2	0.2	0.2	0.2	0.2	0.2			0		
2-Chlorophenol	2	0.2	0.2	0.2	0.2	0.2	50		0		
2,4-Dichlorophenol	2	0.2	0.2	0.2	0.2	0.2	20		0		
4-Chloro, 3-methylphenol	2	0.2	0.2	0.2	0.2	0.2	40		0		

Summary of Remedial Targets Methodology

Hydrock

RTM Level 1 - Soil Zone Assessment - leachate samples

Water body receptor(s): Surface water
Secondary receptor(s): Aquatic ecosystem
Data set: Tip Area
Client: Bovis, Barratt and Taylor Wimpey Homes
Site: Land at Bankside, Banbury
Job no: C12702

Chemicals of Potential Concern (concentrations in µg/l)	Summary of Sample Data					Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red Text)		No. Samples Exceeding Water Quality Target		Notes
	No. of Samples	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value		Inland Waters EQS		Inland Waters EQS		
Pentachlorophenol	2	0.2	0.2	0.2	0.2	0.2	0.4		0		

Summary of Remedial Targets Methodology

RTM Level 1 - Soil Zone Assessment - leachate samples

Water body receptor(s): Groundwater and surface water
Secondary receptor(s): Aquatic ecosystem
Data set: Wider site area (combined)
Client: Bovis, Barratt and Taylor Wimpey Homes
Site: Land at Bankside, Banbury
Job no: C12702

Chemicals of Potential Concern (concentrations in µg/l)	Summary of Sample Data					Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red Text)		No. Samples Exceeding Water Quality Target		Notes General comment: where more than one LoD applies because several labs are involved, the highest is quoted.
	No. of Samples	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value		Inland Waters EQS		Inland Waters EQS		
Ag (dissolved)	2	0.5	0.5	0.5	0.5	0.5	0.05		2		EQS < LoD.
As (dissolved)	21	1	1	4	3	4	50		0		
B (dissolved)	21	50	10	66	65	66	2000		0		
Cd (dissolved)	21	0.5	0.08	0.5	0.5	0.5	0.08		19		EQS < higher LoD.
Co (dissolved)	2	1	1	1	1	1	3		0		
Cr (VI) (dissolved)	12	2	1	2	2	2	3.4		0		
Cr (III) (dissolved)	15	2	1	8	5.9	8	4.7		2		
Cu (dissolved)	21	5	1	100	28	100	1		20		EQS < higher LoD, but some values are > EQS.
Fe (dissolved)	21	20	1	1200	220	1200	1000		1		
Hg (dissolved)	20	0.2	0.01	0.2	0.2	0.2	0.05		16		EQS <higher LoD.
Ni (dissolved)	21	2	1	20	3.2	20	20		0		
Pb (dissolved)	2	1	1	1	1	1	7.2		0		
Sn (dissolved)	2	1	1	1	1	1	25		0		
V (dissolved)	2	1	1	1.8	1.76	1.8	20		0		
Zn (total)	21	5	1	27	10	27	8		4		
Cyanide (free)	12	5	5	5	5	5	1		12		EQS < LoD.
Chloride (Cl-)	2	1000	1400	2900	2825	2900	250000		0		
Fluoride (F-)	2	50	340	620	606	620	1000		0		
Sulfate (SO42-)	2	1000	1600	6700	6445	6700	400000		0		
pH (min.) (su)	12	0.1	8.5	7.1	8.28	7.1	6		0		Max & Min interchanged to compare min. value.
pH (max.) (su)	12	0.1	7.1	8.5	8.28	8.5	8.5		0		
Anthracene	12	0.01	0.01	0.036	0.02995	0.036	0.1		0		
Benzo(a)pyrene	12	0.01	0.02	7.1	6.055	7.1	0.05		2		
PAH sum of benzo(b)fluoranthene benzo(k)fluoranthene	12	0.04	0.02	0.04	0.04	0.04	0.03		10		EQS < higher LoD.
PAH sum of benzo(ghi)perylene indeno(1,2,3-cd)pyrene	12	0.04	0.02	0.04	0.04	0.04	0.002		12		EQS < LoD.
Fluoranthene	12	0.02	0.01	1	0.4951	1	0.1		1		
Naphthalene	12	0.02	0.01	2.2	1.0835	2.2	2.4		0		
Phenol	12	0.5	0.2	0.5	0.5	0.5	7.7		0		

Summary of Remedial Targets Methodology

Notes to Remedial Targets Methodology Table(s)

1 Data from the Environment Agency Chemical Standards web site at http://87.84.223.229/ChemicalStandards/Home.aspx
2 Substances in **bold** are defined in 2008/105/EC Annex II as priority substances in the field of water policy and those in ***bold italic*** as priority hazardous substances.
3 EQS for inland waters applies to freshwater rivers, lakes etc. EQS for other waters refers to marine and transitional (eg estuarine) waters.
4 Inland waters EQS for Cd, Cu and Zn depend on water hardness (mg/l as $CaCO_3$). Where applicable, water hardness is measured, otherwise it has been estimated by reference to the map at http://dwi.defra.gov.uk/consumers/advice-leaflets/hardness_map.pdf. If hardness cannot be determined, a worst case is assumed by setting it to 10mg/l.

Appendix F

WASTE MANAGEMENT

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Establishing if Substances are Wastes

Any material excavated on site may be classified as waste and it is the responsibility of the holder of a material to form their own view on whether or not it is waste. This includes determining when waste that has been treated in some way can cease to be classed as waste for a particular purpose.

One of the ways this can be achieved is set out in the Development Industry Code of Practice (CoP) (CL:AIRE, March 2011). This builds on the Environment Agency guidance document *Definition of waste: developing greenfield and brownfield sites* (2006).

The handling, re-use or disposal of waste is regulated by the Agency. The Agency will take into account the use of the CoP in deciding whether to regulate materials as waste. If materials are dealt with in accordance with the CoP, the Agency considers that those materials are unlikely to be waste at the point when they are to be used for the purpose of land development. This may be because the materials were never discarded in the first place, or because they have been submitted to a recovery operation and have been completely recovered so that they have ceased to be waste.

Good practice has three basic elements:

1. Ensuring that an adequate Materials Management Plan (MMP) is in place, covering the use of materials on a specific site.

2. Ensuring that the MMP is based on an appropriate risk assessment, that underpins the Remediation Strategy or Design Statement, concluding that the objectives of preventing harm to human health and pollution of the environment will be met if materials are used in the proposed manner.

3. Ensuring that materials are actually treated and used as set out in the MMP and that this is subsequently demonstrated in a Verification Report.

To confirm that Steps 1 and 2 have been taken, a Qualified Person must review the relevant documents and provide a Declaration before excavation work commences on a particular site. When the Declaration is provided to the Agency, demonstrating that the materials are to be dealt within accordance with the MMP and risk assessment, the Agency will take the view that the materials on the site where they are to be used will not be waste.

However, if it turns out that materials were not used in accordance with the MMP and risk assessment, or if it is discovered that materials are not suitable for use, are used or planned to be used in excessive quantities, or are likely to cause harm to human health or pollution of the environment, the Agency may conclude that those materials have been discarded and are waste. In order to show how materials have been treated and used, a Verification Report must be prepared at the conclusion of works and, if requested, provided to the Agency. Completion of a Verification Report will not prevent consideration of the above matters by the Agency.

The CoP applies to both uncontaminated and contaminated material from anthropogenic and natural sources excavated:

- for use on the site from which it has been excavated, either without treatment or after on-site treatment, as part of the development of that land (Site of Origin scenario);
- for use directly without treatment at another development site subject to the material meeting certain requirements (Direct Transfer scenario);
- for use in the development of land other than the site from which the material has been excavated, following treatment at an authorised Hub site including a fixed Soil Treatment Facility (Cluster Project scenario); or
- a combination of the above.

The need to distinguish between “contaminated” and “uncontaminated” soils is no longer considered necessary. The Agency accepts that these are self-defining terms on a site specific basis having regard to the risk assessment (e.g. some soil may not be considered contaminated for a given land use, but would be for a more sensitive land use, on the same site).

The fact that the material has to be treated indicates that it is a waste, i.e. it is not suitable for use until it is treated.

“Development” also includes redevelopment, remediation and regrading of a site. The CoP therefore applies not only to development carried out under the development control regime, but also to remediation activities which may occur outside of that regime, e.g. remediation as a direct result of a spillage or leak on an industrial site or at the surrender stage of a permit. Land development or remediation does not include landfilling of waste or other waste disposal operations.

There is no single factor that can be used to determine if something is a waste or when it ceases to be waste. However, in the context of excavated materials used on sites undergoing development, the following factors are considered to be of particular relevance.

- *Factor 1: protection of human health and the environment -* Compliance with the Water Framework Directive. If the use of the material will create unacceptable risk, it is likely to be waste.
- *Factor 2: suitability for use, without any further treatment -* Suitability for use means that a material must be suitable for its intended purpose in all respects. In particular, both its chemical and geotechnical properties have to be demonstrated to be suitable, and the relevant specification for its use must be met. Suitability of use also includes consideration of the effect that the material may have on the environment.

  Certain excavated materials may be suitable for their intended use in the proposed development without any treatment at all. If they are used in that way those materials are unlikely to be waste. For example some materials may be assessed as being suitable for direct use, e.g. engineered backfill beneath cover layers, capping layers, buildings and hard standing or for site regrading. Use for the purposes of reclamation, restoration, landscaping or improvement of land may fall within this category. Landfilling or disposal does not.

Other materials may not have the required characteristics for use without first being treated. If treatment is needed in order to make the material ready for use the materials will be waste, but may cease to be waste once treated so as to be suitable for use. This treatment may be biological, chemical, physical or any combination of these and will need to be carried out under an appropriate authorisation.

Some materials, although they do not require treatment to make them suitable for use, may nonetheless be regraded or compacted before or during their use as part of the development of a site. This regrading or compacting does not prevent the material being regarded as a non-waste.

- *Factor 3: certainty of use* - The holder of the material must be able to demonstrate that the material will actually be used and that the use is not just a probability, but a certainty. For example, if materials are stockpiled with no pre-defined destination and use, they will be waste.

  In the process of site development surplus material may be generated that cannot be used either directly or after treatment. For example, the material may not conform to the required specification following treatment and in such a case the material would remain a waste.

  There may be unexpected arisings on a development site that were not picked up within the site investigation works. Any out of specification materials will be waste and will need to be disposed of or recovered in the proper manner and in accordance with waste legislation.

- *Factor 4: quantity of material* - Materials should be used in the quantities necessary for that use, and no more. The use of an excessive amount of material will indicate that it is being disposed of and is waste.

The production of a MMP will help to ensure that the above matters are considered and a correct determination is made in relation to the nature of the materials.

In order to demonstrate that the factors described above have been satisfied, an MMP has to be produced relating to the use of the materials, which includes a tracking system and contingency arrangements. The MMP accompanies the Remediation Strategy or Design Statement, which has been derived using risk assessment. A Verification Plan also needs to form a part of the MMP.

Upon completion of these documents, a Qualified Person needs to sign a Declaration. Once the development has been completed in accordance with the MMP, a Verification Report must be completed that demonstrates that the materials have been located in the correct place within the development or dealt with appropriately.

Further details can be found in the CoP.

Key Legal Requirements

If the material is considered to be waste then the legislation will apply up to the point that it ceases to be waste.

Duty of Care: It is necessary to ensure all waste is handled, recovered and disposed of responsibly, and that the waste is only handled by individuals, companies or groups that are authorised to deal with it. For example, waste can only be collected by registered carriers or transporters. Regular checks must be made on the destination of all wastes leaving site to ensure they are only being taken to an appropriately authorised waste management facility. Records (Waste Transfer Notes) must be kept of all wastes received or transferred.

Characteristics of waste received from a third party must be checked its to ensure that companies are licensed or have an exemption under which they can receive it and that it complies with the classification set out in the Waste Transfer Notes.

Waste Carrier or Transporter: Registration is require to transport waste.

Environmental Permits: It is normally an offence to undertake waste disposal or recovery operations, which are regulated by the Agency, without being in possession of an appropriate Environmental Permit, unless it is material that is “uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated”, which is excluded from waste regulation by the Waste Framework Directive.

As an alternative to using the Industry CoP in excavating and re-using materials there are a number of options:

- Waste Exemption - mainly for small volumes of non-hazardous waste, recovery only;
- Standard Rules Environmental Permit – which replaces the traditionally used Waste Exemptions Paragraphs 9 and 19, but can take several months to obtain;
- Bespoke Environmental Permit – applicable to greater volumes and more waste streams than Standard Rules, but can take several months to obtain; or
- WRAP Aggregates Quality Protocol – allows for inert aggregate waste to be recovered and used at any site subject to meeting set standards.

Waste Classification

With respect to the possible waste streams from a site, it is recommended that a phased approach is implemented. In the first instance, the groundwork’s contractor or specialist remediation contractor appointed by the developer should approach the landfill site with the available chemical data and seek a waste characterisation. Should the waste be classified as hazardous, it would be necessary to undertake the Waste Acceptance Criteria (WAC) testing to determine whether the receiving landfill could accept the hazardous waste. This would require additional soil sampling and chemical testing.

The two stages are explained below.

Waste Characterisation

All wastes going to landfill must be classified as ‘inert’, ‘non-hazardous’ or ‘hazardous’. There is a sub-category of hazardous waste known as ‘stable non-reactive hazardous waste'. Individual landfill sites have permits to take these classes of waste. Hazardous and non-hazardous wastes cannot be disposed of at the same site, apart from stable non-reactive hazardous waste which can go to specially constructed cells in certain non-hazardous landfill sites.

Contaminated soil is a 'mirror entry' in the Consolidated European Waste Catalogue, and is not necessarily a hazardous waste. It is only classified as hazardous if it contains dangerous substances above certain threshold concentrations. The Environment Agency Briefing Note on Hazardous Waste and Contaminated Soil (V.1 July 2004) suggests that waste holders should use the information collected as part of the contaminated land risk assessment to inform decisions as to the concentrations that might reasonably be expected to be present in the contaminated soil, given the past and current uses of the site.

The waste must be assessed against all the appropriate hazards in accordance with the Environment Agency Technical Guidance WM2. This makes certain worst case assumptions about the chemical composition if specific compounds are not analysed for.

Waste Acceptance Criteria

Waste classified as hazardous must be subject to WAC testing to determine if it can go to a hazardous landfill site. The WAC are a list of limit values for certain parameters obtained from standard leaching tests and total content tests. If the limit values are exceeded, the waste is not suitable for disposal at that class of landfill site and alternative disposal methods have to be found. Maximum permissible limit values are determined by the EU (part of what is known as 'full waste acceptance criteria') but individual landfills may have more stringent values to take into account the environmental setting, liner system or additional nature of specific waste streams.

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