



Remedial Methodology

Battle Hospital, Portman Way, Reading, RG30 1AN

For:

Bellway Homes Limited (Thames Valley)



Contact Details:

Enzygo Geoenvironmental Ltd.
The Byre
Woodend Lane
Cromhall
Gloucestershire
GL12 8AA

tel: 01454 269237
fax: 01454 269760
email: steve.rhodes@enzygo.com
www: enzygo.com

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Enzygo Limited Registered in England No. 6525159

Registered Office Stag House The Chipping Wotton-Under-Edge Gloucestershire GL12 7AD

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1.0 INTRODUCTION

Background

- 1.1 Enzygo Geoenvironmental Limited has been commissioned by Bellway Homes Limited (Thames Valley) to prepare a Remedial Methodology for the proposed re-development of a former hospital site for residential use comprising a mixture of apartments with communal open space and residential houses with domestic gardens. The scheme also includes areas of public open space.
- 1.2 The proposed end use is as residential housing and the development layout is shown on Drawing 031610-BEL-TV-01 prepared by DHA Architect Ltd. The proposed layout has been incorporated in to Drawing CRM.1265.007.GE.D.001

Existing Investigation

- 1.3 Previous Phase I Desk Study and subsequent Phase II Intrusive Ground Investigations were undertaken at the site by RSK which identified contamination requiring remediation.

Detailed Quantitative Risk Assessment

- 1.4 Utilising information obtained from the previous ground investigations a Detailed Quantitative Risk Assessment (DQRA) has been prepared during July 2018 (ref CRM.1265.007.GE.R.001).
- 1.5 The DQRA was used to derive risk based remedial targets to protect controlled waters resources. General Acceptance Criteria (GAC) values being used to assess remedial requirements for risk to future site users.

Objectives

- 1.6 The objectives of this document are to provide details of the proposed remediation scheme to allow safe development of the site.
- 1.7 This Remediation Methodology has been prepared to formulate an approach to remediation, verification and validation of the site. Remedial targets included within this report are to be used for remediating areas of contamination identified from the site investigation but will also be used should unforeseen contamination be encountered.

1.8 By obtaining prior approval to the proposed remedial approach it is considered that delays associated with the remediation and development works will be minimised. This Remedial Methodology will address the following:

- Prepare a remedial scheme based on the existing desk study and site investigation report carried out by Enzygo Geoenvironmental Limited to address significant risks to receptors and allow development of the proposed scheme;
- Identify relevant management processes for the remedial works;
- Details of any specialist procedures identified;
- Emergency Procedures considered appropriate;
- Procedures to address any unexpected areas of contamination;
- Identify requirements for verification works and validation reporting required; and
- Provide a programme for the proposed works.

2.0 SUMMARY OF GROUND INVESTIGATION

General

- 2.1 The site has been subject to multiple phases on investigation comprising a Phase I Desk Study and subsequent Phase II intrusive ground investigations by RSK. The investigation works were initially undertaken on behalf of the Royal Berkshire NHS Trust and then for Bellway Homes (Thames Valley) Ltd.
- 2.2 Details of the various investigations are included in the Geoenvironmental site Assessment Report (ref. 28916-R01(0)) prepared by RSK and dated March 2017. Details of the investigations are provided below:

Desk Study

- 2.3 The northern area of the site was formerly the Battle Hospital, which included ambulance storage, workshops, offices, laundry and incinerator. Underground and above ground storage tanks were noted by RSK.
- 2.4 The south eastern area of the site was used for residential apartment blocks with associated soft landscaping.
- 2.5 Historic site use comprised marshland prior to development of the hospital. An infilled gravel pit was identified 200m south-east of the site.
- 2.6 Published geology comprises Alluvium over Taplow Gravels and Chalk. Taplow Gravels are designated as a Secondary A Aquifer and the Chalk is a Principal Aquifer.

Ground Investigation

- 2.7 The ground investigation works were undertaken by RSK over several phases and comprised:
 - Twenty two shallow window sampler boreholes;
 - Six deeper cable percussive boreholes;
 - Monitoring Wells; and
 - Ground gas and groundwater monitoring.
- 2.8 Samples of soil and groundwater were tested for the CLEA metal suite, pH, sulphate, cyanide, phenols, speciated Polycyclic Aromatic Hydrocarbons (PAH), organic carbon Petroleum Hydrocarbon (TPH) Volatile Organic Compounds (VOC) and asbestos screen.

Summary of Ground and Groundwater Conditions

- 2.9 The desk study and site investigation were undertaken by RSK which confirmed the ground conditions as comprising between 0.8m and 5m of Made Ground over Alluvium, Taplow Gravels and Chalk.
- 2.10 Groundwater was encountered within the superficial deposits and the Chalk.

Contamination

- 2.11 Visual and olfactory evidence of contamination by hydrocarbons, solvents and a sulphurous odour were noted during the site investigation. Assessment of the risks to human health has been undertaken by comparing the soil quality data from the chemical analysis with reference values obtained from the Contaminated Land Exposure Assessment (CLEA), Soil Guideline Values (SGV) and General Acceptance Criteria (GAC) published by LQM/CIEH. The soil quality shows exceedance of the reference values for Lead, Polycyclic Aromatic Hydrocarbons (PAH) Hydrocarbons within Made Ground.
- 2.12 Asbestos fibres were also detected.
- 2.13 Exceedances were noted for hydrocarbons in groundwater. In addition, concentrations of TPH and PAH were recorded in groundwater exceeding Environmental Quality Standards (EQS).

Ground Gas

- 2.14 Enzygo Geoenvironmental Ltd have re-assessed the ground gas and flow rates reported by RSK and confirm that the central and northern areas of the site falls within Characteristic Situation 2 of CIRIA C665. Elevated methane was measured in Borehole PH3, which is likely to be associated with hydrocarbons rather than putrescible materials.
- 2.15 The south eastern area of the site falls within Characteristic Situation 1 of CIRIA C665.

Remediation

- 2.16 It is considered that hardstanding to pavement areas and buildings will provide a suitable barrier to prevent potential risk to end users. Within areas of the soft landscaping it is proposed that remediation is undertaken using cover soils. This is detailed in Section 3.
- 2.17 Existing tanks are to be emptied, made safe and then removed from site. Hydrocarbon impacted soils below tanks and also encountered elsewhere on site are to be excavated and any soils showing exceedance of the Remedial Criteria are removed off site as discussed in Section 3.

- 2.18 Gas protection measures will be incorporated in to future structures within the central and northern area. The extent of the site where gas protective measures are proposed is shown on Drawing CRM.1265.007.GE.D.002.
- 2.19 On completion of the site works a Verification Report will be prepared and submitted for approval to the Local Planning Authority. This is detailed in Section 3.
- 2.20 If unforeseen contamination is encountered during construction works such as localised spillage outside the areas investigated an Environmental Consultant will be available on a 'call out' basis to undertake an assessment of risk. If 'unforeseen contamination' is encountered the discovery strategy will be to remove the source as it is likely to be very limited in extent and the Local Planning Authority advised. The remedial criteria given in Section 4 will be used.

Supplementary Monitoring

- 2.21 In order to assist with the DQRA a monitoring visit was undertaken by Enzygo Geoenvironmental Ltd to measure depth to groundwater from existing wells and also to undertake two falling head tests from which soil permeability could be calculated.

3.0 PROPOSED REMEDIAL WORKS

General

- 3.1 Gross contamination was not encountered at the site and the remedial works proposed are limited to:
- Removal of existing tanks and hydrocarbon impacted soils;
 - Hardstanding will encapsulate the built site;
 - Use of gas membrane to ground floor slabs within the northern and central areas of the site;
 - Use of clean cover soil to landscape areas;
 - Use of barrier pipes for potable water supply;
 - Discovery strategy to address unforeseen contamination encountered during site development works.
- 3.2 Any area of hydrocarbons identified on site will be de-lineated and any exceedance of the Remedial Targets for controlled waters will be removed.
- 3.3 Details of the relevant components of the remedial works proposed are outlined below:

Buildings and Pavement Areas

- 3.4 Excavation below proposed buildings and pavement areas will excavate Made Ground thereby removing potential contaminant sources as part of the sub-structure works. This source removal should provide positive environmental betterment.
- 3.5 It is considered that the use of floor slabs to buildings, hardstanding, terraced and other pavement areas will act as a barrier between future site users and any residual contamination at sub formation level. This will break the pollutant linkage. Risk from ground gas and potential vapour ingress will be addressed within the gas protection measures discussed later in this section.

Landscape Areas

- 3.6 Existing buildings are to be demolished and hardstanding removed. Where necessary existing Made Ground will be removed to an appropriate sub-formation level based on final site levels. Soil to landscaping areas will be placed above this.
- 3.7 The area of proposed soft landscaping is shown on the proposed development plan which has been incorporated in to Drawing CRM.1265.007.GE.D.001. The drawing shows areas of communal open space and domestic gardens which are coloured in different shades of green to differentiate them.
- 3.8 Areas of soft landscaping will be covered with clean cover soils which will break any residual pollutant linkage. It is proposed that a 600mm thickness of cover soils will be provided for the private garden areas and 400mm for the communal gardens and open space areas. A geotextile separator (Terram 1000 or similar) will be placed at the base of the cover soils and above the sub-formation. Where appropriate cover soil thicknesses will be increased to accommodate deeper planting in accordance with the requirements of the Landscape Architect.
- 3.9 These cover soils will need to be confirmed as clean and pass the chemical requirements given below. These are based on the GAC values for residential use with plant uptake within domestic garden areas and GAC values for residential use without plant uptake in areas of communal open space.
- 3.10 The works would involve the following:
- Excavation to sub-formation level, as required;
 - Additional excavations may be undertaken to accommodate tree planting pits as required by the landscape architect;
 - Inspection of the exposed sub-formation to validate that areas of unforeseen contamination are not present;
 - Placement of a geotextile no dig barrier which will also act as a separator between the topsoil/subsoil to prevent mixing with underlying sub-formation. It is proposed that the geotextile will comprise Terram 1000 or similar material. This will be placed across the formation and wrapped around the sides and base of any tree planting pits;
 - The geotextile will be placed and overlapped in accordance with the supplier's requirements;

- Imported cover soils will be placed across the soft landscape areas, taking care not to damage the geotextile.

3.11 It is proposed that the cover soils are placed on to the geotextile and that care is taken to prevent damage to the geotextile.

3.12 The cover soils will comprise at least 150mm of imported Topsoil, certified in accordance with British Standards BS3882: Specification for Topsoil. This will be underlain by clean sub soil.

Specification of Cover Soils

3.13 Topsoil is to be General Purpose Topsoil and shall be tested to confirm that it meets the requirements of British Standards BS3882, Specification for Topsoil. Imported Topsoil is to be inspected by the Contractor who will ensure that it is free from any foreign matter, including but not limited to:

- Fragments and roots of aggressive weeds;
- Sticks and straws,
- Sub-soil;
- Fragments of brick, concrete, glass, wire, timber, large lumps of clay or vegetation.

3.14 Imported soils showing evidence of foreign inclusions will be rejected. If foreign material is encountered once the Topsoil has been placed these will be removed by the Contractor.

3.15 Where compost is to be added to imported soils this shall meet the requirements of PAS 100 and shall comprise sanitized and stabilised compost. Peat or peat products are not to be used without prior approval of the Landscape Architect.

3.16 Subsoil will comprise clean natural soils which meet the GAC values identified above. In addition, the Subsoil shall be free from any foreign matter, including but not limited to:

- Fragments and roots of aggressive weeds;
- Sticks and straws,
- Fragments of brick, concrete, glass, wire, or vegetation.

3.17 Topsoil certificate will be obtained from each supplier of Topsoil to confirm that it meets the requirements of British Standards BS3882: Specification for Topsoil and also the remedial requirements identified above.

Methodology For Handling of Cover Soils

- 3.18 Importation, stockpiling and placement of cover soils will be in accordance with British Standards BS3882: Specification for Topsoil.
- 3.19 Topsoil is not to be stockpiled on site unless absolutely necessary in order to minimise multiple handling.
- 3.20 Topsoil and Subsoil are not to be mixed. Furthermore, care must be taken to prevent contamination of the Topsoil or Subsoil with stones, hard-core, rubbish or materials from demolition works.
- 3.21 Topsoil is not to be handled during driest conditions possible and is not to be handled during or after heavy rainfall or when wetter than the plastic limit as defined by BS3882, Annex N2.
- 3.22 Plant used for the placement and spreading of Topsoil and also Subsoil is to be selected based on minimising disturbance, trafficking and compaction. In order to retain a friable texture Topsoil is not to be compacted but shall be gently firmed.
- 3.23 Topsoil is to be tipped and graded to approximate levels in one operation with minimum of trafficking by plant.

Verification of Cover Soils

- 3.24 Given the proposed plan and the landscaping requirements across the site it is recommended that the thickness of the imported materials together with the geotextile separator is verified. The proposed locations are shown on Drawing CRM.1265.007.GE.D.001.
- 3.25 Verification will comprise the excavation of hand pits within the soft landscaping area to confirm the thickness of cover soils and the presence of a geotextile separator. This will be undertaken by an experienced Environmental Consultant and will involve:
 - Excavation of pits by hand, locations of which are shown on Drawing CRM.1265.0071.GE.D.001. It is proposed that 9 pits (HP1 to HP9) are excavated within areas of communal open space and twelve pits (HPA to HPL) are excavated in areas of proposed domestic gardens. The number of pits and samples is based on current NHBC guidance, which was developed in conjunction with the Environment Agency;
 - Measure the thickness of the cover soils; and

- Photograph each pit with a measuring tape of staff used to show the thickness of the cover soils.
- 3.26 Soil samples will be collected from each pit from within the cover soils in appropriate containers provided by the analytical laboratory. Samples will be stored in cool boxes prior to dispatch to the laboratory for analysis. All samples will be collected using appropriate sampling equipment that is cleaned at each sampling location.
- 3.27 Samples will be analysed at a laboratories Ltd which is UKAS and MCERTS accredited. Samples were tested for the CLEA metal suite, pH, sulphate, cyanide, phenols, speciated Polycyclic Aromatic Hydrocarbons (PAH), organic carbon, Speciated Total Petroleum Hydrocarbon (TPH) and asbestos screen.
- 3.28 Should soils fail the GAC values these will be excavated and discarded off-site. Additional testing will be undertaken around the excavation to confirm that the adjacent soils are clean. Fresh soils will be imported and used to re-construct the cover soils.

Tanks and Hydrocarbon Impacted Soils

- 3.29 Several tanks have been identified at the site and their locations are discussed in the RSK report. Detailed methodology for the tank removal will be prepared by the specialist contractor taking due account of the health and safety requirements set out in the Construction Stage Health and Safety Plan as required under the Construction, Design and Management (CDM) Regulations. The proposed outline methodology is set out below:
- Where required the tank will be emptied, cleaned, de-gassed and made safe by the specialist contractor in accordance with their detailed Method Statement and Construction Stage Health and Safety Plan. The tank will be tested to ensure that there are no residual vapours present. Where possible cleaning and de-gassing will be undertaken in situ to minimise health and safety risks and control potential spillage from the tank.
 - The tank will be removed.
 - Existing areas of hardstanding will be broken out to reveal any associated pipework.
 - Pipework will be disconnected from the tank and will be drained of any fuel or liquids contained within.
 - Should any liquid be present in the base of the excavation this will be pumped out from a shallow sump formed at the base of the excavation and will either be

pumped in to a tanker for off-site disposal or discharged to sewer via an oil/water separator under a Trade Effluent Discharge Consent.

- 3.30 Once the tanks have been removed it will either be crushed and cut up on site or taken off site for processing. Where required, the tank will be foam filled, although it is not anticipated that this will be required once they have been cleaned and de-gassed.
- 3.31 All remedial works are to be undertaken in a safe and appropriate manner by a competent contractor.
- 3.32 Soils showing visual and olfactory evidence of gross contamination will be removed. Following removal of any gross hydrocarbon impacted soils the exposed formation will be inspected by a suitably qualified environmental consultant. Visual and olfactory evidence will be used to assess the extent of excavation. Following excavation soil samples will be collected from the base and sides which will be submitted for analysis at an accredited laboratory for validation. Risk based remedial targets for validation of hydrocarbon remediation are discussed in Section 4.
- 3.33 As a minimum one sample will be collected from each side and the base of the hotspot excavation. In the unlikely event that contamination is more extensive samples will be recovered as detailed below:
 - One sample per 30 linear metres of the side.
 - One sample per 30m by 30m area of the base.

- 3.34 Should contamination be particularly variable then additional samples may be recovered.

Backfilling

- 3.35 Once the laboratory analysis of the validation samples has confirmed that the soils comply with the site remedial targets given in Section 4 the excavation will be available for backfilling. The voids will be backfilled with chemically and geotechnical suitable fill material placed and compacted in accordance with the relevant specifications where required. As a minimum the materials used should meet the risk based remedial values given in Section 4.

Stockpiled Materials

- 3.36 When material is not removed directly from site then clearly defined and labelled stockpile areas will be set up for material storage. Materials will be sorted and stockpiled based on its contamination status. The material requiring stockpiling will be underlain by plastic sheeting or placed on hardstanding and covered by plastic sheeting to minimise the production of

leachate and or dust. It may be necessary for the material to be damped down to further minimise the production of dust.

- 3.37 Where appropriate, stockpiles of the excavated Made Ground will be tested to determine their waste classification. If the materials meet the acceptability criteria for re-use then they may be retained on site.
- 3.38 Soils arising from excavations which are to be re-used as sub soil will be stockpiled and tested to confirm their acceptability.

Treatment of Contaminated Material

- 3.39 An assessment of remedial options for hydrocarbon impacted soils has been undertaken.
- 3.40 It is considered that in-situ treatment is not viable. Therefore, it is proposed to excavate any unforeseen contamination and remove the spoil to an offsite landfill or waste treatment centre. This is considered an economically viable option for sites where there is a limited and un-quantified volume of soil.
- 3.41 All material removed from the site will be disposed of at a suitable licensed facility in accordance with the Duty of Care Waste Management Legislation. Prior to soil removal, all material will have been classified under the Landfill Directive as either inert, non-hazardous, stable non-reactive hazardous waste or hazardous waste based on the level of contamination. Where required, further analysis of the materials will be undertaken, to provide data for waste classification purposes by the Contractor.

Site Won Materials

- 3.42 Any material that is considered to be suitable for site use including excavated soils will be stockpiled separately from material requiring removal from site. The stockpiles will be based on material type and visual or olfactory indications of contamination. All soils will be sampled and tested to demonstrate compliance with the remedial targets prior to re-use.

Unforeseen Contamination

- 3.43 If unforeseen contamination is encountered during construction works such as localised spillage outside the areas investigated an Environmental consultant will be available on a 'call out' basis to undertake an assessment of risk. If 'unforeseen contamination' is encountered the discovery strategy will be to remove the source as it is likely to be very limited in extent and the Local Planning Authority advised.

3.44 Based on the findings of the ground investigation, including the desk study, it is considered that any unforeseen contamination will be localised. The proposed remedial approach is therefore:

- Excavate material showing visual or olfactory evidence of gross contamination;
- Stockpile the material prior to testing;
- Sample and test the exposed formation and the stockpiled material;
- Undertake an assessment of the risk associated with the soil concentrations measured:
and
- Either remove the stockpiled material for off-site disposal or re-use if acceptable.

3.45 As a minimum one sample will be collected from each side and the base of the hotspot excavation. In the unlikely event that contamination is more extensive samples will be recovered.

Utilities

3.46 Results of the chemical analysis will be provided to the water authority and any requirements in relation to protecting potable waste supply pipes will be incorporated into the scheme. It is anticipated that barrier pipes will be used.

Gas Membrane

3.47 Due to the presence of elevated ground gas within the northern and central areas of the site it is recommended that gas protection measures are included within ground floor slabs. The locations of buildings where gas protective measures are proposed are shown on Drawing CRM.1265.007.GE.D.002. Gas protective measures are to provide a minimum score of 3.5 in accordance with British Standards BS8485:2015. This will include:

- Use of a jointed vapour and gas membrane in place of a DPM, sealed to service entries and the cavity tray; and
- Ventilated underfloor void.

3.48 It is proposed that a membrane which provides protection against both hydrocarbons and ground gas issued.

3.49 Installation of the gas membrane will be in accordance with British Standards BS8485:2015.

Verification Report

3.50 A remediation verification report will be prepared based on the inspections which will include:

- Details of the cover soils placed, including photographs;
- Chemical results from the cover soil validation;
- The site observations and notes of any agreed changes to the remedial methodology;
- Details of tank removal;
- Details of the hydrocarbon de-lineation and remediation works undertaken;
- Any areas of un-known contamination encountered and the remedial measures undertaken;
- Details of gas membrane installations, including photographs;
- Waste disposal notes where appropriate.
- Confirmation that the works observed complied with the remedial methodology.
- Details of site won materials re-used on site together with the results of any chemical analysis.

4.0 DERIVATION OF REMEDIAL TARGETS

General

- 4.1 The risk of significant contamination across the site has been discounted, and the likely risks are associated with PAH, Lead and asbestos together with localised hydrocarbon contamination associated with former tanks.
- 4.2 In order to have remedial threshold levels against which to compare soil quality values remedial targets have been developed for both human health and controlled water receptors.

Human Health

- 4.3 Assessment of the risks to human health has been undertaken by comparing the soil quality data with reference values obtained from the Contaminated Land Exposure Assessment (CLEA), Soil Guideline Values (SGV) and General Acceptance Criteria (GAC) published by LQM/CIEH. The LQM/CIEH S4ULs values are used and summary tables of the reference values are included in Appendix A. The proposed development is for residential use, with associated gardens and landscaping. Based on the nature of the development and the proposed masterplan layout it is considered that the GAC values for Residential Use (with plant uptake) are applicable within areas of domestic gardens and GAC values for Residential Use (without plant uptake) are applicable within areas of communal open space.

Controlled Water

- 4.4 The risk to controlled water receptors has been assessed using a Detailed Quantitative Risk Assessment a copy of the risk assessment is included in the Detailed Quantitative Risk Assessment Report dated July 2018 (ref CRM.1265.007.GE.R.001).

Remedial Target Values

- 4.5 As site wide remediation is being undertaken the Human Health GAC values are only used to assess cover soils to soft landscape areas.
- 4.6 Risk based remedial validation targets have been prepared based on the DQRA derived controlled waters values which will be used for validating remediation of hydrocarbons in soils. The remedial target values derived are summarised below:

Contaminant	Remedial Target	
	Within Soils (mg/kg)	Within Groundwater (mg/l)
C ₈ -C ₁₀ Aliphatic	1650	770
C ₈ -C ₁₀ Aromatic	3320	1.76E ⁷
C ₁₀ -C ₁₂ Aliphatic	8800	17.3
C ₁₀ -C ₁₂ Aromatic	84.6	9.9E ⁴
C ₁₂ -C ₁₆ Aliphatic	1.76E ⁶	17.3
C ₁₂ -C ₁₆ Aromatic	300	4.27E ⁶
C ₁₆ -C ₂₁ Aliphatic	2.21E ⁷	17.3
C ₁₆ -C ₂₁ Aromatic	3880	355
C ₂₁ -C ₃₅ Aliphatic	2.22E ⁷	17.3
C ₂₁ -C ₃₅ Aromatic	2460	231
Benzo(a)Pyrene	1.75E ¹⁴⁷	No Impact

- 4.7 None of the concentrations measured in groundwater exceed the risk based remedial target values and therefore no groundwater remediation is considered necessary.

5.0 GENERAL LEGISLATIVE COMPLIANCE MEASURES

General

- 5.1 Prior to the commencement of the remedial works a Designers Risk Assessment and Pre-Tender Health and Safety Plan will be prepared outlining the Health and Safety issues.
- 5.2 The appointed Contractor for the works will be required to provide a Construction Stage Health and Safety Plan and comprehensive supporting Method Statement for the works.
- 5.3 As a general measure all working areas at the site will require fencing and appropriate signs to prevent access by unauthorised persons during the progression of deeper excavations or demolition works. Notwithstanding the above, the following health and safety measures are proposed to mitigate risks to construction workers and the general public, together with nuisance issues, during the remedial works.

Dust and Noise

- 5.4 All site works are to be carried out under the following measures to monitor and control potential impacts on the offsite receptors. These measures are to include:
 - Sheeting of vehicles to mitigate the risks from contaminated waste transportation.
 - Covering, and where necessary wetting down, of formation and stockpiles to mitigate dust generation.
 - Limitations on appropriate working hours and noise levels.
- 5.5 During progression of the works dust monitoring apparatus will be utilised in order to demonstrate that the works are not posing an unacceptable risk to offsite receptors.

Odour

- 5.6 During the progression of the site remedial works the contractor will be responsible for ensuring that odours generated for the excavation of contaminated arisings are minimised. Where it is considered that odours are liable to pose a nuisance to surrounding landowners the contractor will employ suitable control measures in order to suppress and control the odour.

Protective Equipment and Mitigation

- 5.7 The following protective equipment is to be used, which will be supplemented by PPE as necessary:
 - Separation of the remedial area from the site offices and mess facilities;

- Use of wetting down equipment, where necessary to reduce dust.
- Provision of impermeable plastic sheeting to underlay and cover stockpiles to reduce dust and leachate generation.
- Sheeting of Lorries to reduce dust.
- Reversing sirens used on plant.
- Provision of appropriate welfare facilities for site staff to utilise during the remedial works.
- The following Personnel Protective Equipment (PPE) is to be used, which will be replaced as necessary.
- Use of disposable overalls and gloves.
- Hard hats, ear defenders, boots, gloves and high visibility vests to be used.
- Use of dust masks for all site operatives coming in to contact with contaminated material. Vapour masks will be available should they be required.
- Wheel washing facilities and site fencing.

5.8 Asbestos contaminated material has been identified during the ground investigation and it is possible that further material could be encountered during construction works. Measures should to be incorporated in to the Contractors Construction Stage Health and Safety Plan as required under the Construction Design and Management (CDM) Regulations to mitigate risk to construction works. Measures may include:

- Designing temporary works to minimise disturbance of the Back fill material;
- Separating material and disposal of soils containing asbestos;
- Wetting down during excavation;
- Sheeting of stockpiles where asbestos is suspected;
- Testing of soils and off-site disposal of any soils found or suspected of containing asbestos;
- Preventing access to the construction site by members of the public;
- Use of good hygiene measures, including washing down of plant; and
- Use of appropriate PPE, including face masks.

Emergency Procedures

5.9 Measures to address environmental and health and safety issues will be provided by the Contractor as part of the Construction Stage Health and Safety Plan and should include the following:

- Spill response kits are to be available on site in the event that fuel or oil is spilt from the tank during the remedial works.
- Where excavations are to remain open awaiting laboratory, analysis results any water showing signs of significant contamination, such as free product, is to be removed. Where appropriate sheeting over the excavation may be considered to reduce de-watering requirements.
- Should significantly contaminated soil be stockpiled with the result that hydrocarbon contaminated leachate is being mobilised, then an impermeable bund shall be constructed around the stock pile to collect the leachate and allow it to be pumped off.
- Contaminated materials shall not be stockpiled adjacent to any water course or surface water drain not protected by an interceptor.

Human Health Assessment Reference Values

Determinant	Units	GAC Value Residential					
		With Plant Uptake			Without Plant Uptake		
Arsenic	mg/kg	37			40		
Cadmium	mg/kg	11			85		
Chromium	mg/kg	910			910		
Chromium VI	mg/kg	6			6		
Lead	mg/kg	200			310		
Mercury	mg/kg	40			56		
Nickel	mg/kg	180			180		
Selenium	mg/kg	250			430		
Copper	mg/kg	2400			7100		
Zinc	mg/kg	3700			40000		
Cyanide	mg/kg	791			800		
SOM	%	1	2.5	6	1	2.5	6
Phenol	mg/kg	280	550	1100	750	1300	2300
Napthalene	mg/kg	2.3	5.6	13	2.3	5.6	13
Acenaphtylene	mg/kg	170	420	920	2900	4600	6000
Acenaphthene	mg/kg	210	510	1100	3000	4700	6000
Flourene	mg/kg	170	400	860	2800	3800	4500
Phenanthrene	mg/kg	95	220	440	1300	1500	1500
Anthracene	mg/kg	2400	5400	11000	31000	35000	37000
Fluoranthene	mg/kg	280	560	890	1500	1600	1600
Pyrene	mg/kg	620	1200	2000	3700	3800	3800
Benzo(a)Anthracene	mg/kg	7.2	11	13	11	14	15
Chrysene	mg/kg	15	22	27	30	31	32
Benzo(b)Flouranthene	mg/kg	2.6	3.3	3.7	3.9	4.0	4.0
Benzo(k)Flouranthene	mg/kg	77	93	100	110	110	110
Benzo(a)Pyrene	mg/kg	2.2	2.7	3.0	3.2	3.2	3.2
Indeno(123-cd)Pyrene	mg/kg	27	36	41	45	46	46
Dibenzo(a,h)Anthracene	mg/kg	0.24	0.28	0.3	0.31	0.32	0.32
Benzo(ghi)Perylene	mg/kg	320	340	350	360	360	360
TPH C ₅ -C ₆ Aliphatic	mg/kg	42	78	160	42	78	160
TPH C ₆ -C ₈ Aliphatic	mg/kg	100	230	530	100	230	530
TPH C ₈ -C ₁₀ Aliphatic	mg/kg	27	65	150	27	65	150
TPH C ₁₀ -C ₁₂ Aliphatic	mg/kg	130	330	760	130	330	770
TPH C ₁₂ -C ₁₆ Aliphatic	mg/kg	1100	2400	4300	1100	2400	4400
TPH C ₁₆ -C ₃₅ Aliphatic	mg/kg	65000	92000	110000	65000	92000	110000
TPH C ₃₅ -C ₄₄ Aliphatic	mg/kg	65000	92000	110000	65000	92000	110000
TPH C ₅ -C ₇ Aromatic	mg/kg	70	140	300	370	690	1400
TPH C ₇ -C ₈ Aromatic	mg/kg	130	290	660	860	1800	3900
TPH C ₈ -C ₁₀ Aromatic	mg/kg	34	83	190	47	110	270
TPH C ₁₀ -C ₁₂ Aromatic	mg/kg	74	180	380	250	590	1200
TPH C ₁₂ -C ₁₆ Aromatic	mg/kg	140	330	660	1800	2300	2500
TPH C ₁₆ -C ₂₁ Aromatic	mg/kg	260	540	930	1900	1900	1900
TPH C ₂₁ -C ₃₅ Aromatic	mg/kg	1100	1500	1700	1900	1900	1900
TPH C ₃₅ -C ₄₄ Aromatic	mg/kg	1100	1500	1700	1900	1900	1900
Benzene	mg/kg	0.087	0.17	0.37	0.38	0.70	1.4
Toluene	mg/kg	130	290	660	880	1900	3900
Ethylbenzene	mg/kg	47	110	260	83	190	440
Xylene	mg/kg	56	130	310	79	180	430

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Determinant	Units	GAC Value					
		Residential POS			Commercial		
Arsenic	mg/kg	79			640		
Cadmium	mg/kg	120			190		
Chromium	mg/kg	1500			8600		
Chromium VI	mg/kg	7.7			33		
Lead	mg/kg	630			2330		
Mercury	mg/kg	120			1100		
Nickel	mg/kg	230			980		
Selenium	mg/kg	1100			12000		
Copper	mg/kg	12000			68000		
Zinc	mg/kg	81000			730000		
Cyanide	mg/kg	N/A			16200		
SOM	%	1	2.5	6	1	2.5	6
Phenol	mg/kg	760	1500	3200	760	1500	3200
Napthalene	mg/kg	4900	4900	4900	190	460	1100
Acenaphtylene	mg/kg	15000	15000	15000	83000	97000	100000
Acenaphthene	mg/kg	15000	15000	15000	84000	97000	100000
Flourene	mg/kg	9900	9900	9900	63000	68000	71000
Phenanthrene	mg/kg	3100	3100	3100	22000	22000	23000
Anthracene	mg/kg	74000	74000	74000	520000	540000	540000
Fluoranthene	mg/kg	3100	3100	3100	23000	23000	23000
Pyrene	mg/kg	7400	7400	7400	54000	54000	54000
Benzo(a)Anthracene	mg/kg	29	29	29	170	170	180
Chrysene	mg/kg	57	57	57	350	350	350
Benzo(b)Flouranthene	mg/kg	7.1	7.2	7.2	44	44	45
Benzo(k)Flouranthene	mg/kg	190	190	190	1200	1200	1200
Benzo(a)Pyrene	mg/kg	5.7	5.7	5.7	35	35	36
Indeno(123-cd)Pyrene	mg/kg	82	82	82	500	510	510
Dibenzo(a,h)Anthracene	mg/kg	0.57	0.57	0.58	3.5	3.6	3.6
Benzo(ghi)Perylene	mg/kg	640	640	640	3900	4000	4000
TPH C ₅ -C ₆ Aliphatic	mg/kg	570000	590000	600000	3200	5900	12000
TPH C ₆ -C ₈ Aliphatic	mg/kg	600000	610000	620000	7800	17000	40000
TPH C ₈ -C ₁₀ Aliphatic	mg/kg	13000	13000	13000	2000	4800	11000
TPH C ₁₀ -C ₁₂ Aliphatic	mg/kg	13000	13000	13000	9700	23000	47000
TPH C ₁₂ -C ₁₆ Aliphatic	mg/kg	13000	13000	13000	59000	82000	90000
TPH C ₁₆ -C ₃₅ Aliphatic	mg/kg	250000	250000	250000	1600000	1700000	1800000
TPH C ₃₅ -C ₄₄ Aliphatic	mg/kg	250000	250000	250000	1600000	1700000	1800000
TPH C ₅ -C ₇ Aromatic	mg/kg	56000	56000	56000	26000	46000	86000
TPH C ₇ -C ₈ Aromatic	mg/kg	56000	56000	56000	56000	110000	180000
TPH C ₈ -C ₁₀ Aromatic	mg/kg	5000	5000	5000	3500	8100	17000
TPH C ₁₀ -C ₁₂ Aromatic	mg/kg	5000	5000	5000	16000	28000	34000
TPH C ₁₂ -C ₁₆ Aromatic	mg/kg	5100	5100	5000	36000	37000	38000
TPH C ₁₆ -C ₂₁ Aromatic	mg/kg	3800	3800	3800	28000	28000	28000
TPH C ₂₁ -C ₃₅ Aromatic	mg/kg	3800	3800	3800	28000	28000	28000
TPH C ₃₅ -C ₄₄ Aromatic	mg/kg	3800	3800	3800	28000	28000	28000
Benzene	mg/kg	72	72	73	27	47	90
Toluene	mg/kg	56000	56000	56000	56000	110000	180000
Ethylebenzene	mg/kg	24000	24000	25000	5700	13000	27000
Xylene	mg/kg	41000	42000	43000	5900	14000	30000

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Determinant	Units	GAC Value					
		Park POS			Allotments		
Arsenic	mg/kg	170			43		
Cadmium	mg/kg	532			1.9		
Chromium	mg/kg	33000			18000		
Chromium VI	mg/kg	220			1.8		
Lead	mg/kg	1300			80		
Mercury	mg/kg	240			19		
Nickel	mg/kg	3400			230		
Selenium	mg/kg	1800			88		
Copper	mg/kg	44000			520		
Zinc	mg/kg	170000			620		
Cyanide	mg/kg						
SOM	%	1	2.5	6	1	2.5	6
Phenol	mg/kg	760	1500	3200	66	140	280
Napthalene	mg/kg	1200	1900	3000	4.1	10	24
Acenaphtylene	mg/kg	29000	30000	30000	28	69	160
Acenaphthene	mg/kg	29000	30000	30000	34	85	200
Flourene	mg/kg	20000	20000	20000	27	67	160
Phenanthrene	mg/kg	6200	6200	6300	15	38	90
Anthracene	mg/kg	150000	150000	150000	380	950	2200
Fluoranthene	mg/kg	6300	6300	6400	52	130	290
Pyrene	mg/kg	15000	15000	15000	110	270	620
Benzo(a)Anthracene	mg/kg	49	56	62	2.9	6.5	13
Chrysene	mg/kg	93	110	120	4.1	9.4	19
Benzo(b)Flouranthene	mg/kg	13	15	16	0.99	2.1	3.9
Benzo(k)Flouranthene	mg/kg	370	410	440	37	75	130
Benzo(a)Pyrene	mg/kg	11	12	13	0.97	2.0	3.5
Indeno(123-cd)Pyrene	mg/kg	150	170	180	9.5	21	39
Dibenzo(a,h)Anthracene	mg/kg	1.1	1.3	1.4	0.14	0.27	0.43
Benzo(ghi)Perylene	mg/kg	1400	1500	1600	290	470	640
TPH C ₅ -C ₆ Aliphatic	mg/kg	95000	130000	180000	730	1700	3900
TPH C ₆ -C ₈ Aliphatic	mg/kg	150000	220000	320000	2300	5600	13000
TPH C ₈ -C ₁₀ Aliphatic	mg/kg	14000	18000	21000	320	770	1700
TPH C ₁₀ -C ₁₂ Aliphatic	mg/kg	21000	23000	24000	2200	4400	7300
TPH C ₁₂ -C ₁₆ Aliphatic	mg/kg	25000	25000	26000	11000	13000	13000
TPH C ₁₆ -C ₃₅ Aliphatic	mg/kg	450000	480000	490000	260000	270000	270000
TPH C ₃₅ -C ₄₄ Aliphatic	mg/kg	450000	480000	490000	260000	270000	270000
TPH C ₅ -C ₇ Aromatic	mg/kg	76000	84000	92000	13	27	57
TPH C ₇ -C ₈ Aromatic	mg/kg	87000	95000	100000	22	51	120
TPH C ₈ -C ₁₀ Aromatic	mg/kg	7200	8500	9300	8.6	21	51
TPH C ₁₀ -C ₁₂ Aromatic	mg/kg	9200	9700	10000	13	31	74
TPH C ₁₂ -C ₁₆ Aromatic	mg/kg	10000	10000	10000	23	57	130
TPH C ₁₆ -C ₂₁ Aromatic	mg/kg	7600	7700	7800	46	110	260
TPH C ₂₁ -C ₃₅ Aromatic	mg/kg	7800	7800	7900	370	820	1600
TPH C ₃₅ -C ₄₄ Aromatic	mg/kg	7800	7800	7900	370	820	1600
Benzene	mg/kg	90	100	110	0.017	0.034	0.075
Toluene	mg/kg	87000	95000	100000	22	51	120
Ethylbenzene	mg/kg	17000	22000	27000	16	39	91
Xylene	mg/kg	17000	23000	31000	28	67	160

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