Report Title: # Remediation Strategy

Project Name: # Red Mile Nursery, Pinchbeck



Report Reference: **BRD3760-OR3-A**

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# REPORT CONTROL SHEET

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| **REPORT TITLE** | **REMEDIATION STRATEGY** |
| **PROJECT** | **RED MILE NURSERY, PINCHBECK** |
| **CLIENT** | **BELLWAY HOMES** |

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## BRD Environmental Limited

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# REPORT LAYOUT

This report is divided into the following three sections: Technical Report, Supporting Information and Appendices.

## TECHNICAL REPORT

The main report section is intended to provide the technical detail of the investigation and is intended to provide the level of information required by current guidance documents and practice. The Technical Report is written in a language that, in part, assumes knowledge of subject matter so that it can be written in as concise a form as possible. Its intended audience is peers, regulators and other professionals in related disciplines.


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**REFERENCES**

**SUPPORTING INFORMATION**

This section of the report provides background details of a generic nature together with specific technical approaches adopted by BRD and details of the guidance documents that are commonly referenced in the report. The section also includes explanations of technical terms to assist non-specialist readers in understanding the Technical Report. It should be noted that not all the information within this section is necessarily applicable to this specific report.

**APPENDICES**

The final section of the report presents the factual data collected and employed as part of the investigation.

**APPENDIX 1 SITE PLANS**

| | |
|---|---|
| Site Location Plan | Ref. BRD3760-OP3-A |
| Revised Conceptual Site Model | Ref. BRD3760-OP6-C |
| Proposed Development Layout | "Planning Site Layout", LMC – Architect Limited, ref. 487-SK-01, rev. F, dated 01/12/21. |
| Remediation Plan | Ref. BRD3760-OD2-A |
| Potable Water Design Plan | Ref. Independent Water Networks Potable Water Desgin plan, drawing ref. NGE21-4444-001 Rev C, dated 10/11/21. |

# 1. INTRODUCTION TO TECHNICAL REPORT

## 1.1. CONTRACT DETAILS

| | |
|---|---|
| **CLIENT** | Bellway Homes Ltd trading as Bellway Homes. |
| **SITE** | Land situated off Wardentree Lane in the village of Pinchbeck. |
| **CLIENT'S ADVISORS** | BRD Environmental Limited (BRD) has been commissioned directly by the Client. |
| **REPORT CONTEXT** | It is understood that the Client intends to develop the site for residential housing. |
| **REPORT TYPE** | Remediation Strategy. |
| **REPORT OBJECTIVES** | The site has been subject to previous site investigations by both Ground Engineering and BRD, referenced as follows:<br>• "Site Investigation Report – Land off Wardentree Lane, Spalding, Lincolnshire", Ground Engineering, report ref. C14985, dated April 2020.<br>• "Geo-Environmental Site Investigation – Red Mile Nursery, Pinchbeck", BRD Environmental Ltd, ref. BRD3760-OR2-C, dated September 2021.<br>The initial Ground Engineering contamination assessment was relatively preliminary and therefore the subsequent BRD investigation looked to increase the sampling points across the site, and in particular within the former nursery within the western half of the site. The updated contamination assessment presented within the BRD report makes a recommendation for a remediation strategy to be developed to address all of the identified risks.<br>The purpose of the report is to produce a remediation strategy to be set out a clear methodology for addressing the identified contamination risks and then verifying their remediation. |

## 1.2. SCOPE OF WORKS

The agreed scope of works was:

- Review of existing reports and update of remediation plans to reflect approved development plans. Provision of a Remediation Strategy, including details on the proposed Verification Plan.

## 1.3. REPORT LIMITATIONS

Any site boundary lines depicted on plans included within this report are approximate only and do not imply legal ownership of land. Any observations of tree species, asbestos containing materials within structures or invasive weeds, does not constitute a formal survey of such features. The identification of such features is therefore tentative only. In the case of Japanese Knotweed, BRD can undertake separate surveys for this plant undertaken by a Property Care Association qualified surveyor.

The recommendations, interpretations and conclusions of this report are based solely on the ground conditions found at the exploratory holes. Due to the variability in the nature of ground, conditions between exploratory holes can only be interpreted and not defined. The description of the site and the ground conditions is accurate only for the dates of the field works. In particular, groundwater levels can vary due to seasonal and other effects.

The assessment and interpretation of contamination risks is based on the scope of works agreed with the Client together with the budgetary and programme constraints imposed. Further investigation, analysis and assessment of contamination may be required by regulators or other third parties with an interest in the site. An ecological risk assessment of contaminated soils is beyond the scope of this report. This report is concerned with assessing those contamination risks which apply to the future use of the site through the proposed development as part of the planning regime. The assessment does not consider the risk to current site users or continued future use of the site in its current state. If development of the site should occur that differs from that proposed, then the findings of the contamination assessment would need to be re-evaluated.

This report is restricted to a contamination assessment only and does not include any form of geotechnical advice.

# 2. SITE CHARACTERISTICS

## 2.1. SITE SETTING

| | |
|---|---|
| **SITE ADDRESS AND POST CODE** | Red Mile Nursery, Pinchbeck, Spalding, Lincolnshire, PE11 3UF. |
| **NATIONAL GRID REFERENCE** | 524647E, 325086N |

## 2.2. SITE DESCRIPTION

| SUBJECT | COMMENTS |
|---|---|
| **CURRENT SITE DESCRIPTION** | The site is split into two halves. The eastern half of the site is an open field, which at the time of the BRD investigation in 2021 was overgrown with grasses and weeds. The western half, which used to be a nursery, is an open area of disturbed ground surrounded by former access tracks. The disturbed ground is from the demolition of the former nursery buildings.<br>The site was bound by Heras style temporary fencing and secured with a gate and padlock. Along the western boundary of the site were locked site cabins and a public footpath, which was separated from the main site with Heras style fencing. |
| **SURROUNDING LAND USE** | The site is in a mixed residential and agricultural area. To the north and east of the site is arable land. To the south and west of the site are residential properties. |
| **PROPOSED DEVELOPMENT** | It is proposed that the site will be developed with residential housing with private gardens.<br>A high pressure gas main bisects the site from north to south, within the western section of the agricultural field. The development takes this into account and a natural open space break separates the two halves of the proposed development. |
| **HISTORICAL SUMMARY** | Historical maps are presented within the previous report already completed for the site. Below is a brief summary of the site history obtained from a review of the previous site investigation report.<br>The first available map from 1886 shows the site as an open field with a footpath crossing from the north west corner to the south east corner. The site is surrounded by arable land. By 1938, four buildings labelled as a nursery are constructed in the west of the site. The 1967 map edition shows the building configuration to have changed, but the site remains as a nursery now called “Redmile Nurseries”.<br>From 1986 onwards, nursery buildings appear and disappear, but all remain in the western half of the site. Google Earth Imagery from 1999 shows that most of these buildings on site are greenhouses and the eastern half of the site is agricultural land. Imagery from 2016 to 2020 shows some of the greenhouses have been demolished. The eastern half remains as agricultural land. |

| SUBJECT | COMMENTS |
|---|---|
| **PUBLISHED GEOLOGY** | The site is shown to be underlain by Tidal Flat Deposits. These superficial deposits typically consist of soft silty clay with layers of sand, gravel and peat. The shallowest bedrock is indicated to be the Oxford Clay Formation, which typically comprises silicate-mudstone with sporadic beds of argillaceous limestone nodules.<br>Nearby BGS borehole logs indicate the presence of "Boulder Clay" (glacial Till) between the Tidal Flat Deposits and the Oxford Clay Formation. One log from the "A16 Trunk Road" describes it as "grey silty CLAY with numerous medium to fine subrounded gravel sized erratics, mainly chalk with some flint". Another also includes mudstone gravel. |
| **ACTUAL GROUND CONDITIONS** | The investigation has proved Tidal Flat Deposits composed of soft clays, silts and sands down to around 10m bgl overlying Glacial Till composed of a stiff, gravelly, silty clay, proven down to at least 25m bgl. |
| **RADON** | Radon protection measures are not required. |
| **HYDROGEOLOGY** | The site is situated upon unproductive strata.<br>The site is not located within a groundwater Source Protection Zone. |
| **HYDROLOGY** | The closest water feature to the site is Blue Gowt Drain, which runs along the northern boundary. A small, unnamed drain also runs along the eastern boundary and joins up with the Blue Gowt Drain adjacent to the north east corner of site. Blue Gowt Drain joins up with the River Glen approximately 5km north west of site, which in turn runs to the River Welland around 5.6km to the north east.<br>The site is in a Zone 3 area and is likely to be affected by flooding. |

## 2.3. PREVIOUS INVESTIGATIONS

The site has been the subject of the following investigation, with reports referenced as follows:

- "Site Investigation Report – Land off Wardentree Lane, Spalding, Lincolnshire", Ground Engineering, report ref. C14985, dated April 2020.
- "Geo-Environmental Site Investigation – Red Mile Nursery, Pinchbeck", BRD Environmental Ltd, ref. BRD3760-OR2-C, dated September 2021.

The BRD report in particular presents an updated contamination risk assessment based on both phases of investigation. This assessment is summarised below.

### 2.3.1. Summary of Contamination Risk Assessment

From the investigations, the contamination risks on site are associated with the following:

- The surface Made Ground within the access tracks around the nursery contains elevated concentrations of Polycyclic Aromatic Hydrocarbons (PAH), which presents a risk to the human health of the future residents if left in-situ within future garden and landscaping areas. The Made Ground typically extends to between 0.2m and 0.4m in thickness.

- The surface Made Ground in the immediate vicinity of trial pit TP107 is contaminated with asbestos fibres. This contamination is very localised but does present a risk to human health if left in-situ.

- The naturally organic soils are producing elevated concentrations of methane and carbon dioxide, which presents a soil gas risk to the future residents. Appropriate landfill gas protection measures will therefore be required for all plots at this development.

- Due to the elevated PAH in the access track and also within the wider surface Made Ground (but not at concentrations that present a human health risk), it is considered likely that 'barrier' pipes incorporating an aluminium foil layer or plastic wrapped metal pipes will be required for new water supplies within the western former nursery area of the site. Conventional polythene pipework is appropriate for the eastern field area, but this is subject to approval by the local water supply company.

The Revised Conceptual Model Plan summarising all these risks is included in Appendix 1. The remediation strategy presented in the following sections provides a clear methodology for mitigating these risks as part of the proposed development.

# 3. DEVELOPMENT OF THE REMEDIATION STRATEGY

## 3.1. INTRODUCTION

The overall aim of a remediation strategy is to design the remediation works necessary to mitigate the potentially unacceptable contamination risks identified through the various desk study and investigation reports. The remediation process begins with development of the remediation objectives and the options appraisal process, although the appraisal process must be proportionate to the degree and extent of remediation required. A verification plan will need to be documented that can be implemented as the remediation works are completed.

The processes of remediation design, implementation and verification comprise:

- Definition of remediation objectives.
- Appraisal of the options for remediation and selection of a preferred strategy.
- Planning and implementation of the preferred strategy.
- Long term monitoring and maintenance.
- Preparation of a verification report.

The previous assessments have identified all of the unacceptable contamination risks. The remediation strategy must present a clear methodology for managing the risks associated with each pollutant linkage that has been identified.

## 3.2. IDENTIFIED CONTAMINATION RISKS

From the previous contamination assessments, the following pollutant linkages have been identified:

- Elevated PAH has been identified in the nursery access tracks and is not suitable to remain in future garden areas of the proposed residential development. It is likely that the concentrations relate to the presence of older tarmac fragments and/or charcoal within the Made Ground.
- Asbestos bundles have also been identified in the Made Ground in trial pit TP107 alongside the elevated PAH.
- The underlying organic soils across the site require the installation of Characteristic Situation 2 gas protection measures will be required for all plots.
- The elevated PAH within the Made Ground beneath the access tracks and within the general Made Ground to the former nursery buildings dictates that 'barrier' pipes will be required for new water supplies within the western former nursery area of the site

The Revised Conceptual Site Model that illustrates the location of these pollutant linkages is included in Appendix 1.

## 3.3. OBJECTIVES

On some sites a range of objectives may be established in response to the different nature of the risks associated with different pollutant linkages. These fall into the following three categories:

- Contamination remediation objectives must be based on the conceptual model for the site and must define the desired end condition. They can be qualitative or quantitative but must always relate to the risk assessment. Contamination related objectives are the most important of the three types of objectives and wherever possible, should drive the selection of a remediation option.

- Engineering related objectives considerer the need for improvement, maintenance or modification of the engineering properties of the physical ground conditions on a site. Improvements in stability of the site or changes in ground levels may be required in order to construct the proposed development.

- Management related objectives often relate to the aspects of the remediation process itself, but also to the site after remediation has been completed. For example, the costs of a particular remediation option may exceed the budget making the project not financially viable. Programme constraints may conflict with the use of particular remediation technology. On sites where there are existing buildings or structures to be retained, remediation activities will have to be designed and carried out to avoid unnecessary disruption.

Accordingly, all three categories of objectives need to be considered in developing the strategy.

The remediation objectives for this project are as follows:

- To ensure that future residents do not come into contact with the PAH and Asbestos contaminated soils.

- To ensure that there is no build-up of hazardous ground gases in the proposed buildings.

- That the water supply pipes will not be adversely affected by any contamination.

- To complete the remediation works in a timely cost effective manner.

- To conform with current guidance regarding contamination remediation and gain regulatory approval.

## 3.4. REMEDIATION OPTIONS APPRAISAL

### 3.4.1. Introduction

Having identified the remediation objectives an appraisal of potentially suitable remediation options must be carried out. Conceptually, remediation action will involve breaking the pollutant linkage or linkages by use of one or more of the following methods:

- Source control: technical action to either, remove or in some way modify the source(s) of the contamination for example excavation or bioremediation.

- Pathway control: technical action to reduce the ability of the contaminant source to pose a threat to receptors by inhibiting or controlling the pathway for example cover systems or gas membranes.

- Receptor control: non-technical actions or controls that alter the likely likelihood of receptors coming into contact with the contaminants, for example altering the site layout.

A wide range of different techniques can be used individually or in combination in order to break a pollutant linkage. The options appraisal will consider a technique's effectiveness in dealing with the contaminants of concern but will also give consideration of the wider circumstances of the site.

### 3.4.2. Mitigation options for risk to Human Health

The contaminated Made Ground in the nursery area forming the access track could either be excavated and removed from site in its entirety or alternatively partially removed enough so that a 'clean' soil capping layer of 0.60m thick can be placed in the garden and landscaping areas in order to prevent contact with the underlying contaminated soils. After consulting with the Client, it was agreed that removing the Made Ground in its entirety is considered the more appropriate method due to the limited thickness of the soil and by removing it, it will avoid any ongoing management issues in connection with the contaminated soils.

In terms of the Made Ground contaminated with PAH and asbestos in the vicinity of TP107, it also is considered that removing the material in its entirety is the more appropriate method, especially given its limited extent.

On the basis of the gas risk assessment presented in the BRD investigation report, gas protection measures complying with those for Characteristic Situation 2 (CS2) are required across the entire site. As the natural organic soils themselves are the source of the gas and therefore this source cannot be removed, then fitting appropriate protection measures is the only viable option to consider.

### 3.4.3. Mitigation options for risk to Building Materials and Services

With regards to the risk to water supply pipes from the elevated concentrations of Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) recorded in the Made Ground, the risk can easily be addressed by the use of specialist foil lined 'barrier' pipework. The requirement for such pipework will be dictated by the local water supply company and therefore there is no requirement to consider any other remediation options.

# 4. REMEDIATION WORKS

## 4.1. OVERVIEW

It is considered that the remediation works will be split into two phases of work, namely those initial works to be undertaken before construction begins (e.g. the contaminated soil excavation and disposal), and then those works to be undertaken as part of the construction phase process (e.g. the fitting of gas protection measures and barrier water pipes).

If there is not enough topsoil on site, there may need be a need to confirm the suitability of any such soils imported on to the development. However, given the volume of uncontaminated Topsoil to be generated from the scrape of the eastern agricultural field, it is considered that there will be more than enough site-won Topsoil to complete the development.

## 4.2. GENERAL

### 4.2.1. Liaison with Regulatory Authorities

This strategy document shall be agreed with the regulatory authorities to confirm the proposed remediation works and verification plan.

During the remedial works, BRD will continue to liaise directly with the regulatory authorities. They will be consulted over any deviation from the remediation strategy and their representatives will be welcome to visit the site on any occasion throughout the site works.

### 4.2.2. Professional Supervision

The remediation works shall be undertaken under the supervision of a suitably qualified and experienced environmental consultant from BRD. It is envisaged that the asbestos contaminated soil excavation will be supervised on a full time basis and then the Made Ground excavation, inspection of gas protection measures and barrier water pipes will be on an as necessary basis through the construction.

### 4.2.3. Safety

The demolition, remediation and subsequent construction of the new development will fall within the remit of the Construction (Design and Management) Regulations 2015. Adherence to these regulations provides a framework for the management of health and safety during the redevelopment of the site.

### 4.2.4. Topographic and Photographic Surveys

During the remedial works, the extent of remedial and/or deep excavations and other features of interest, such as sample points, shall be surveyed by either tape measurements, recreational GPS device or accurate topographic survey as appropriate.

Photographs shall be taken throughout the remediation works and copies included within the verification report.

### 4.2.5. Materials Management Plan

The proposed soil material movements around the site should be undertaken in accordance with a CL:AIRE document 'Definition of Waste: Development Industry Code of Practice' (Version 2, March 2011). The materials movement plan would cover the re-use of materials onsite.

## 4.3. SITE CLEARANCE AND DEMOLITION

### 4.3.1. Demolition

The demolition of the nursery buildings has already been undertaken and therefore no more demolition works are required.

### 4.3.2. Asbestos Removal

Asbestos fibres have been identified within the soils in the vicinity of trial pit TP107. However, no asbestos containing materials have been identified on the surface of the site.

## 4.4. FURTHER GROUND INVESTIGATION

As all of the identified contamination sources have been delineated, no further investigation is required to inform this strategy.

## 4.5. PRE-CONSTRUCTION PHASE WORKS

### 4.5.1. Removal of PAH contaminated Made Ground – Nursery Access Tracks

The access tracks around the former nursery buildings has been proven to contain elevated Polycyclic Aromatic Hydrocarbons (PAHs). The extent of any remedial excavations of this material will be based on site observations by the BRD Consultant and/or the Contractor, but essentially involves scraping up all of the Made Ground making up the former access tracks. The depth of excavation will be dictated by the thickness of Made Ground, however, typically the Made Ground is between 0.2m and 0.4m in thickness. The Made Ground is visually different to the underlying natural soils and therefore it is quite easy to establish the required depth of dig. A selection of samples will be taken from the exposed natural soils landform for verification purposes.

The contaminated Made Ground will be excavated either directly in to tipper trucks for off-site disposal or to a stockpile for later disposal. Although not offering a potential risk from leaching, the contaminated soils will be stockpiled either on top of known similar contaminated areas or plastic sheeting.

Soils of differing nature will be segregated by selective excavation. Where contaminated soils appear to differ from that anticipated from the investigation data and may be uncontaminated, these soils will be stockpiled separately and samples taken for analysis.

The locations of the affected former access tracks are identified in the Pre-Construction Remediation Plan in Appendix 1.

#### *4.5.1.1. Waste Soil Disposal*

It is considered that the identified PAH contaminated Made Ground soils would be classified for disposal as ‘non-hazardous waste’. The chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 03 ‘Soil and Stones, containing dangerous substances’.

### 4.5.2. Removal of Asbestos (and PAH) contaminated soils – TP107

The Made Ground in the vicinity of trial pit TP107 extends to a depth of around 0.40m bgl and it is proposed that these soils are removed in their entirety. The Made Ground should be scraped up using a mechanical excavator to expose the underlying natural soils. The extent of the excavation will be dictated by previous sampling points and observations made by the supervising BRD Consultant.

This Made Ground should be stockpiled independently from other Made Ground soil types ready for offsite disposal.

In respect of this remediation work at TP107, the JIWG Decision Support Tool for CAR2012 Work Categories proposes that a low risk to construction workers is presented by these asbestos fibres and suggests that remedial work is classified as 'Non-Licensed Work'. Accordingly, all workers involved in the remedial works at TP107 (only) should be suitably trained and competent for it and EN149 type FFP3 disposable masks should be worn. Manual/localised dust suppression such as wetting the ground should also be applied and localised and basic personal decontamination facilities should be provided.

The location of the anticipated TP107 remediation excavation is identified in the Pre-Construction Remediation Plan in Appendix 1.

*4.5.2.1. Waste Soil Disposal*

Given the lack of asbestos fragments in this location and the recorded asbestos quantification of 0.002%, it is considered that the asbestos contaminated soils would be classified for disposal as 'non-hazardous waste'. The chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 03 'Soil and Stones, containing dangerous substances'.

Although not encountered to date, should any fragments of asbestos be found around TP107 during the excavation, these should be handpicked from the soil by a competent and qualified person. Any handpicked fragments of asbestos should be disposed of as 'hazardous waste'.

4.5.3. Constraints to Remediation Excavations

Contaminated soil will be removed as far is reasonably practicable, however, constraints to the excavation of contamination at the site are likely to include:

- Utility services to be retained and protected may limit the extent of the mechanical excavation i.e. gas main. However, this is not expected to impact the planned remediation works.

4.5.4. Excavation of clean soils

As part of the main phase of remediation works there will also be excavations undertaken for other reasons that will generate clean soils. Soils that have been identified as clean from investigation data shall be reused within the general 'cut and fill' earthworks, in accordance with the MMP for the development.

4.5.5. Previously unidentified contamination

Due to the nature of the site, there remains the potential for further unidentified contaminated soil being exposed during the demolition of buildings and removal of the extensive concrete surfacing. If any anomalous material is encountered during the pre-construction phase, then advice should be sought from BRD.

The regulatory authorities will be informed of any such contamination and, if required any further remediation will be agreed with them.

## 4.6. CONSTRUCTION PHASE WORKS

### 4.6.1. Gas Protection Measures

As discussed above, CS2 gas protection measures are required across for all proposed plots. In accordance with BS8485:2015 +A1 2019, the proposed development comprises a Type A building type and so a gas protection score of 3.5 points is required. It is proposed that this score will be achieved by:

- Pre-cast suspended segmental subfloor, i.e. beam and block (0 points)
- Proprietary gas resistant membrane fitted by a specialist contractor whom will provide certification that the membrane has been installed correctly as well as integrity testing of the system. All joints and penetrations sealed. Gas membrane must meet the requirements as set out in Table 7 of BS8485:2015 +A1 2019 (2 points).
- 'Good' or 'Very Good' performance passive clear void sub-floor dispersal layer. Ventilated clear void of at least 100mm thickness/depth. For buildings up to 15m wide the minimum area of side ventilation should be 1500mm$^2$/m run of wall on at least two opposite sides. For larger width buildings the side ventilation provisions should be at least 2000mm$^2$/m (1.5-2.5 points, depending on the number of internal cross openings, however, as 1.5 points will suffice this should not be a factor).

These three components will achieve the required score of 3.5 points.

Where the proposed garages are detached and therefore separate from the houses, it is considered that formal gas protection measures are not required for these structures given the following reasons:

- The relatively low risk gas regime identified at the site, with protection measures only being installed in the west as a precaution.
- The inherent gas protection measures in the construction of the garages, with either ventilated sub-floor void or reinforced concrete floor.
- The limited occupancy of garages.
- The inherent good ventilation within a garage.

It is important to note that where the proposed garages are not detached from the houses, gas protection would be required along the same lines as the main house.

As discussed in Section 5.3.1, the installed gas protection measures will need to be independently verified in accordance with CIRIA C735 as set out in Section 5.3.2.

### 4.6.2. Water Supply Pipes

Following the Client's consultation with the water supply company, they have confirmed that they only require barrier pipe to be fitted for supplies to Plots 4-17 only. The supplier's Potable Water Design layout plan is included in Appendix 1.

The barrier water supply pipes will be fitted by specialist contactors and verified by the water supply company.

### 4.6.3. Imported Topsoil / Subsoil

It is anticipated that there will be sufficient site won topsoil to complete the garden and landscaped areas of site, but if this is not the case, then imported topsoil will be required. Any such imported soils will need to be verified to confirm that they are suitable for use in a residential setting. The verification requirements are set out in Section 5.3.3.

# 5. VERIFICATION PLAN

## 5.1. INTRODUCTION

It is proposed that the remediation works will be completed in a phased approached. The initial remediation excavation works will be verified and reported separately from any construction phase elements, which will be undertaken as and when they are installed during the build process.

The details of the proposed verification works are described in the following sections.

## 5.2. VERIFICATION OF PRE-CONSTRUCTION REMEDIATION WORKS

### 5.2.1. Removal of PAH contaminated Made Ground – Nursery Access Tracks

As the contaminated soil is visually distinct to the underlying natural soils, the removal will be undertaken largely on a visual basis by the supervising BRD Consultant. However, it is proposed that some limited sampling is undertaken to provide further confirmation that the soils have been completely removed.

It is proposed that 8No. samples should be taken from across the surface of the exposed landform and tested for speciated PAH.

### 5.2.2. Removal of Asbestos (and PAH) contaminated soils – TP107

The removal of the asbestos contaminated Made Ground in the vicinity of trial pit TP107 will be on a largely visual basis as the underlying natural soils will be exposed at the base. However, a verification sample will be taken from the four exposed faces and tested for asbestos quantification and speciated PAH analysis to confirm that they are uncontaminated.

### 5.2.3. Remediation Assessment Criteria

All samples will be collected by the supervising BRD Consultant and will be placed and stored in suitable containers, prior to dispatch to the laboratory by overnight courier for analysis. Where samples cannot be transported direct from site they are temporarily stored in the BRD dedicated sample storage facility.

The results from all of the verification sampling shall be compared to the relevant assessment criteria detailed in the following table, which represents the generic assessment criteria from the previous investigation report that are protective of human health.

| CONTAMINANT | UNITS | ASSESSMENT CRITERIA |
|---|---|---|
| Naphthalene | mg/kg | 2.3 |
| Acenaphthylene | mg/kg | 170 |
| Acenaphthene | mg/kg | 210 |
| Fluorene | mg/kg | 170 |
| Phenanthrene | mg/kg | 95 |
| Anthracene | mg/kg | 2,400 |
| Fluoranthene | mg/kg | 280 |
| Pyrene | mg/kg | 620 |
| Benzo(a)anthracene | mg/kg | 7.2 |
| Chrysene | mg/kg | 15 |
| Benzo(b)fluoranthene | mg/kg | 2.6 |

| | | |
|---|---|---|
| Benzo(k)fluoranthene | mg/kg | 77 |
| Benzo(a)pyrene | mg/kg | 2.2 |
| Indeno(1,2,3-cd)pyrene | mg/kg | 27 |
| Dibenzo(a,h)anthracene | mg/kg | 0.24 |
| Benzo(ghi)perylene | mg/kg | 320 |
| Asbestos quantification | % | 0.001% |

Should any of the verification samples exceed the thresholds then the remediation excavation will be extended in the same manner and re-sampled once the contaminated soils have been removed.

### 5.2.4. Waste Soil Removal

Copies of waste transfer tickets and disposal records for the contaminated soils will be provided for inclusion with the verification report.

## 5.3. VERIFICATION OF CONSTRUCTION WORKS

### 5.3.1. Gas Protection Measures

In order to verify that gas protection measures set out in Section 4.6.1. are adhered to, the following verification items will be required in relation to each aspect of the protection measures in order to provide a clear methodology, in accordance with CIRIA A735.

| **GAS PROTECTION – APPLIES TO ALL PLOTS** | |
|---|---|
| **VENTILATION MEASURES** | Verification needs to be undertaken by an independent qualified and experienced installer, separate to the installation contractor. At least 25% of the vented voids need to be inspected prior to laying of the slab. If any discrepancies are noted then the verification rate shall be increased to 100% of the plots until the verifier is satisfied that the ventilation is being installed correctly at which point the rate can be reduced to 25% of plots. |
| **MEMBRANE** | Verification to be undertaken by an independent qualified and experienced third party verifier, separate to the installation contractor. Verifier to undertake a thorough visual inspection of membrane on at least 50% of the plots prior to concrete pour. Mechanical stress tests of membrane joints to be undertaken at the discretion of the verifier. The integrity of joints and pipe penetrations to be subject to air lance tests in line with ASTM D4437 on at least 25% of the plots.<br><br>An inspection report shall be provided by the verifier for the 50% of plots in line with Annex A5 of CIRIA C735. Installer to supply sign off sheets or verification evidence for the remaining plots.<br><br>Should any punctures / failures be identified then the membrane will need to be repaired / replaced and verified again using the same procedures. Verifier to increase inspection rate to 100% of plots until they are satisfied that the installation contractor has rectified any issues at which point the inspection rate can be reduced to 50%. |

### 5.3.2. Water Supply Pipes

Verification of the installation of barrier water supply pipes to Plots 4-17 will be via the local water supply company, however, there will also be a visual confirmation and supporting photographic evidence during the construction phase inspection visits undertaken by the BRD Consultant.

### 5.3.3. Imported Topsoil

It is anticipated that there will be sufficient site won topsoil to complete the garden and landscaped areas of site, but if this is not the case, then imported topsoil will be required. This, and any other imported soils should meet the criteria set out in the following table:

| CONTAMINANT | UNITS | ASSESSMENT CRITERIA |
|---|---|---|
| Arsenic | mg/kg | 37 |
| Cadmium | mg/kg | 11 |
| Chromium (hexavalent) | mg/kg | 6 |
| Chromium (total) | mg/kg | 910 |
| Copper | mg/kg | 2,400 |
| Lead | mg/kg | 200 |
| Mercury | mg/kg | 11 |
| Nickel | mg/kg | 180 |
| Selenium | mg/kg | 250 |
| Zinc | mg/kg | 3,700 |
| pH | Units | <5-10> |
| Naphthalene | mg/kg | 2.3 |
| Acenaphthylene | mg/kg | 170 |
| Acenaphthene | mg/kg | 210 |
| Fluorene | mg/kg | 170 |
| Phenanthrene | mg/kg | 95 |
| Anthracene | mg/kg | 2,400 |
| Fluoranthene | mg/kg | 280 |
| Pyrene | mg/kg | 620 |
| Benzo(a)anthracene | mg/kg | 7.2 |
| Chrysene | mg/kg | 15 |
| Benzo(b)fluoranthene | mg/kg | 2.6 |
| Benzo(k)fluoranthene | mg/kg | 77 |
| Benzo(a)pyrene | mg/kg | 2.2 |
| Indeno(1,2,3-cd)pyrene | mg/kg | 27 |
| Dibenzo(a,h)anthracene | mg/kg | 0.24 |
| Benzo(ghi)perylene | mg/kg | 320 |

The testing rate should be at a minimum of one test per 100m$^3$ of topsoil/subsoil and at least three results should be provided for each soil source. Test results should ideally be provided by the soil supplier to provide confidence that the source is uncontaminated. In any case samples will be

taken in-situ of the placed soil on site by the attending geo-environmental consultant. Sample density may need to be increased depending upon the consistency of the material and nature of the source. Alternatively, if a well-defined greenfield source is adopted then the sample density may be decreased.

It is not proposed to undertake TPH testing on imported soils as the source will likely be greenfield or a reputable topsoil supplier and as such petroleum hydrocarbons would not be expected.

If topsoil is imported from another development site then this should be in accordance with a U1 waste exemption registered with the Environment Agency or a Material Movement Plan developed in accordance with "The Definition of Waste: Development Industry Code of Practice" Version 2, Contaminated Land: Applications in Real Environments (CL:AIRE), March 2011.

### 5.3.4. Remediation Verification Report

Upon completion of the remediation works, BRD will prepare a remediation verification report, which will include commentary on the following:

- Description of all remedial works undertaken including dates.
- Records of all remediation excavations, verification testing and surveys of the extent of excavations.
- Details on any deviation from the remediation strategy.
- Details of contaminated soil disposed of off-site.
- Confirmation of the installation of gas protection measures, including,
    - Visual inspection records of ventilation measures.
    - Records / certification of air lancing, integrity testing of gas membranes and visual inspections.
- Confirmation on barrier water pipe installation.
- Copies of any key regulatory correspondence during the works.
- Photographic records.

The verification report will conclude with a statement confirming the site is fit for its intended use in respect of contamination.

# REPORT SPECIFIC REFERENCES


- "Site Investigation Report – Land off Wardentree Lane, Spalding, Lincolnshire", Ground Engineering, report ref. C14985, dated April 2020.
- "Geo-Environmental Site Investigation – Red Mile Nursery, Pinchbeck", BRD Environmental Ltd, ref. BRD3760-OR2-C, dated September 2021.

# *CONTAMINATION ASSESSMENT METHODOLOGY*

*UK Policy*

*The UK Government's policy in relation to land affected by historic contamination is based on a 'suitable for use' approach. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Contamination risks therefore need to be assessed on a site-by-site basis. The 'suitable for use' approach limits requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to either the current use or future use of the land.*

*The three main drivers for contamination assessment and remediation are:*

- *Voluntary action.*
- *Development as part of the planning regime.*
- *Regulatory action to mitigate unacceptable risks e.g. Part 2A of the Environmental Protection Act 1990.*

*Pollutant Linkages*

*For a contamination risk to exist there must be a 'pollutant linkage' from the contaminant (source) via a pathway (the route from contaminant to receptor) to a receptor (the entity that could be harmed). The absence of a contaminant, pathway or receptor breaks the pollutant linkage and therefore no contamination risk exists.*

*Contamination is typically present at a site (in the ground and/or in the underlying groundwater) as a result of a historic or current industrial use, usually as a result of leaks, spills or disposal of residues, wastes and excess raw materials from the industrial processes. Contamination may also be present due to:*

- *The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.*
- *Migration of pollutants from adjacent land.*
- *Naturally occurring processes e.g. elevated concentrations of particular heavy metals associated with specific geological strata.*

*Conceptual Site Model*

*The conceptual site model can be defined as a textual or graphical representation of the identified pollutant linkages for a given site. The model forms the basis for designing the investigation as the aim will be to target all of the potential pollutant linkages to determine, through the subsequent phases of risk assessment, whether or not they pose an actual risk.*

*It is important that the conceptual site model is updated with new information as the various investigation, risk assessment and remediation works are completed.*

*Technical Guidance*

*The technical and legal framework for contamination assessment is complex. The process adopted through this report for assessing contamination risks is in general accordance with the following guidance, as listed below:*

- *'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175:2011+A2:2017', The British Standards Institution 2017.*
- *'Model Procedures for the management of Land Contamination - CLR Document No. 11', Environment Agency, 2004.*
- *'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.*

*Risk Assessment Methodology*

*In line with the technical guidance, the contamination risk assessment follows a series of phased stages for each particular site:*

| PHASE | DESCRIPTION | RISK ASSESSMENT STAGE |
|---|---|---|
| **PHASE1** | *Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.* | ***Hazard Identification and Assessment***<br>*A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.* |
| **PHASE 2** | *This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.* | ***Risk Estimation***<br>*A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions.*<br>***Risk Evaluation***<br>*A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.* |
| **PHASE 3** | *The appraisal and selection of remediation techniques, their implementation and verification.* | ***Risk Management***<br>*The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.* |

*Risk Classification*

*The objective of risk assessment is to identify the nature and magnitude of the potential risks and should be based on a consideration of both:*

- *The likelihood/probability of an event [taking into account both the presence of the hazard and receptor and the integrity of the pathway].*
- *The severity of the potential consequence [taking into account both the potential severity of the hazard and the sensitivity of the receptor].*

*There is a need for a logical, transparent and repeatable system in defining the categories of severity of consequence and likelihood as well as for the risk itself and therefore the following risk rating matrix is employed:*

| | | ***SEVERITY OF CONSEQUENCE*** | | | |
|---|---|---|---|---|---|
| | | ***SEVERE*** | ***MEDIUM*** | ***MILD*** | ***MINOR*** |
| ***PROBABILITY*** | ***HIGH LIKELIHOOD*** | *Very High Risk* | *High Risk* | *Moderate Risk* | *Moderate/Low Risk* |
| | ***LIKELY*** | *High Risk* | *Moderate Risk* | *Moderate/Low Risk* | *Low Risk* |
| | ***LOW LIKELIHOOD*** | *Moderate Risk* | *Moderate/Low Risk* | *Low Risk* | *Negligible Risk* |
| | ***UNLIKELY*** | *Moderate/Low Risk* | *Low Risk* | *Negligible Risk* | *Negligible Risk* |

*These risk classifications are defined as follows:*

- *Very High Risk - There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remediation action.*
- *High Risk - Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remediation action.*
- *Moderate Risk - It is possible that without appropriate remediation action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.*
- *Low Risk - It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.*
- *Negligible Risk - The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.*

*This risk assessment matrix and classification system is based on guidance produced by Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency in connection with contaminated land assessment.*

***RISK ESTIMATION – SOILS***

*Introduction to Soil Human Health Generic Assessment Criteria (GAC)*

*The Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) had previously issued revised guidance following the consultation about the DEFRA publication "Assessing risks from land contamination – a proportionate approach. Soil Guideline Values: the Way Forward". This resulted in a revised version of the Contaminated Land Exposure Model (CLEA) model (version 1.06) and a few of the previously published Soil Guideline Values (SGVs) were revised.*

*The main legislative driver for dealing with historical land affected by contamination is Part 2A of the Environmental Protection Act 1990. Revised Statutory Guidance to support Part 2A was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health,1 where Category 1 includes land where the level of risk is clearly unacceptable and Category 4 includes land where the level of risk posed is acceptably low. The impact assessment for the new Statutory Guidance stated "The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land". The C4SLs are still derived using the CLEA model, but adopt a slightly different approach to toxicological assessment and exposure modelling.*

*In March 2014, the outcome of "SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Final Project Report" (CL:AIRE) was published. Due to slightly ambiguous wording within this report, Lord de Mauley, Parliamentary Under Secretary, DEFRA wrote to all local authorities on 3 September 2014 to confirm that the published C4SLs were final and that they can be used in risk assessment undertaken under the planning regime.*

*Whilst there are proposals for the industry to develop C4SLs for other contaminants, these have yet to produce any new values. BRD do not believe that C4SLs could be developed by a single organisation with sufficient confidence. BRD has therefore employed other, more conservative guidance based on the CLEA model (detailed below) within this assessment for compounds where C4SLs are not available. However, it should be noted that the results of this investigation may need to be reinterpreted as new C4SLs become available.*

*Due to the limited number of published C4SL values at this time, the Chartered Institute of Environmental health (CIEH) and Land Quality Management Ltd (LQM) have produced Generic Assessment Criteria (GAC) known as Suitable for Use Levels (S4ULs), for use in contaminated land human health risk assessment. These S4ULs (2014) have been derived for a large number of substances using the current CLEA model and are therefore consistent with current guidance. They also incorporate the revised exposure parameters as adopted by the C4SL programme, but have not adopted the revised toxicological approach adopted by the C4SLs and so remain a more conservative assessment criteria. The substances for which SGVs were previously published have also been revised as new S4ULs in light of the new exposure parameters proposed by the C4SL programme, and therefore effectively replace the existing SGVs.*

*In addition, in December 2009, other GAC for less common substances were produced by the Environmental Industries Commission (EIC), The Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE) using the CLEA model. These are referred to as the EIC/AGS/CLAIRE GAC.*

*In summary, C4SLs have been used where these are available. For those substances where C4SLs have yet to be issued, then the S4ULs have been adopted or in some cases, the EIC/AGS/CLAIRE GAC. All of the previously produced SGVs have now either been withdrawn, or superseded by the respective C4SLs or S4ULs.*

*The only exception to this approach is the PAH compound benzo(a)pyrene (BaP) where a C4SL guideline value has been produced, whereas BRD has adopted the S4UL value. The C4SL for BaP relates to its use as a surrogate marker compound representing all of the genotoxic PAH compounds as a mixture, rather than this individual compound. BRD has therefore adopted the compound specific S4UL value as the initial screening value, for consistency with the other PAH compounds before then employing the C4SL is necessary.*

*It should be noted that unless otherwise stated, all the assessment criteria adopted within this report have been derived based on a sandy loam soil at pH 7 and the values quoted are for a conservative soil organic matter content of 1% where applicable (i.e. organic contaminants).*

*Human Health - Soil Generic Assessment Criteria*

*The results of the soils analysis have been compared to generic assessment criteria for the default exposure scenarios comprising either residential land with plant uptake, residential land without plant uptake, or commercial/industrial land use. The criteria values selected are listed in the table below and full details on the source are referred to above. Where applicable, the results have also been assessed with reference to the required statistical tests presented within CLAIRE document "Guidance on comparing soil contamination data with a critical concentration".*

| ANALYSIS | GENERIC ASSESSMENT CRITERIA (mg/kg unless stated) | | | SOURCE |
|---|---|---|---|---|
| | RESIDENTIAL WITH PLANT UPTAKE | RESIDENTIAL WITHOUT PLANT UPTAKE | COMMERCIAL / INDUSTRIAL | |
| Arsenic | 37 | 40 | 640 | C4SL |
| Cadmium | 22 | 150 | 410 | |
| Chromium (total)[$] | 910 | 910 | 8,600 | S4UL |
| Chromium VI | 21 | 21 | 49 | C4SL |
| Lead | 200 | 310 | 2,330 | |
| Mercury* | 11 | 15 | 320 | S4UL |
| Selenium | 250 | 430 | 12,000 | |
| Nickel | 180 | 180 | 980 | |
| Copper | 2400 | 7,100 | 68,000 | |
| Zinc | 3,700 | 40,000 | 730,000 | |
| pH | <5 - 10> units | | | Professional judgement |
| Naphthalene | 2.3 | 2.3 | 190 | S4UL |
| Acenaphthylene | 170 | 2,900 | 83,000 | |
| Acenaphthene | 210 | 3,000 | 84,000 | |
| Fluorene | 170 | 2,800 | 63,000 | |
| Phenanthrene | 95 | 1,300 | 22,000 | |
| Anthracene | 2,400 | 31,000 | 520,000 | |
| Fluoranthene | 280 | 1,500 | 23,000 | |
| Pyrene | 620 | 3,700 | 54,000 | |
| Benzo(a)anthracene | 7.2 | 11 | 170 | |
| Chrysene | 15 | 30 | 350 | |
| Benzo(b)fluoranthene | 2.6 | 3.9 | 44 | |
| Benzo(k)fluoranthene | 77 | 110 | 1,200 | |
| Benzo(a)pyrene | 2.2 | 3.2 | 35 | |
| Indeno(1,2,3-cd)pyrene | 27 | 45 | 500 | |
| Dibenzo(a,h)anthracene | 0.24 | 0.31 | 3.5 | S4UL |
| Benzo(ghi)perylene | 320 | 360 | 3,900 | |
| TPH Aliphatic C5-C6 | 42 | 42 | 3,200 | |
| TPH Aliphatic C6-C8 | 100 | 100 | 7,800 | |
| TPH Aliphatic C8-C10 | 27 | 27 | 2,000 | |
| TPH Aliphatic C10-C12 | 130 | 130 | 9,700 | |
| TPH Aliphatic C12-C16 | 1,100 | 1,100 | 59,000 | |
| TPH Aliphatic C16-C35 | 65,000 | 65,000 | 1,600,000 | |
| TPH Aliphatic C35-C44 | 65,000 | 65,000 | 1,600,000 | |

| ANALYSIS | GENERIC ASSESSMENT CRITERIA (mg/kg unless stated) | | | SOURCE |
|---|---|---|---|---|
| | RESIDENTIAL WITH PLANT UPTAKE | RESIDENTIAL WITHOUT PLANT UPTAKE | COMMERCIAL / INDUSTRIAL | |
| TPH Aromatic C5-C7 | 70 | 370 | 26,000 | |
| TPH Aromatic C7-C8 | 130 | 860 | 56,000 | |
| TPH Aromatic C8-C10 | 34 | 47 | 3,500 | |
| TPH Aromatic C10-C12 | 74 | 250 | 16,000 | |
| TPH Aromatic C12-C16 | 140 | 1,800 | 36,000 | |
| TPH Aromatic C16-C21 | 260 | 1,900 | 28,000 | |
| TPH Aromatic C21-C35 | 1,100 | 1,900 | 28,000 | |
| TPH Aromatic C35-C44 | 1,100 | 1,900 | 28,000 | |
| Benzene | 0.87 | 3.3 | 98 | C4SL |
| Toluene | 130 | 880 | 56,000 | S4UL |
| Ethylbenzene | 47 | 83 | 5,700 | |
| Xylene^ | 56 | 79 | 5,900 | |
| MTBE | 49 | 73 | 7,900 | EIC/AGS/CL:AIRE GAC |

*Notes:*
** The S4UL for methyl mercury has been adopted as the worst case mercury compound as generally there is no desk study evidence to suggest the potential for elemental mercury on the majority of sites.*
*^ The lowest S4UL of either p-xylene, o-xylene or m-xylene has been adopted for each land use as a conservative measure.*
*$ S4UL for Chromium III adopted, as in the absence of Chromium VI it is likely that all of the chromium will be in this form as these are the two most common and stable forms of chromium in the soil environment.*

*Where no GAC is available, any concentrations exceeding the laboratory limit of detection are identified and discussed in more detail.*

*Water Environment - Soil Generic Assessment Criteria*

*There are no UK published Generic Assessment Criteria for soil test results in respect of the risk to the water environment and therefore risk estimation is on the basis of the professional judgement and experience of BRD to employ values that are a reasonable concentration above which concern for water resources is valid.*

*The Total PAH GAC employed is the sum of the 16No. priority PAH compounds regularly tested for in contaminated land analysis (i.e. US EPA 16PAHs). BRD employ a soil screening based upon the total PAH limit for 'inert waste' of 100mg/kg. The rationale is based on PAHs are recognised to be generally of low solubility and the risk to the water environment is correspondingly low.*

*In respect of Total Petroleum Hydrocarbons, BRD employ a value of 500 mg/kg as a screening value in comparison to the sum of the component aliphatic and aromatic TPH carbon bands. The employed soil screening value is based upon:*

- *In common with some other consultants, the professional judgement and experience of BRD suggests that this value is a reasonable concentration above which concern for water resources is valid. The rationale is based on the fact that lower concentrations of fuel based contaminants are more likely to naturally degrade than migrate any great distance.*

- *BRD is aware of regional Environment Agency groundwater and contaminated land teams historically employing 500 mg/kg as a screening value for considering whether or not TPH could represent a risk to water resources.*

- *The value mirrors the mineral oil Waste Acceptance Criteria limits for what is considered 'inert waste'.*

*Should elevated contaminants that pose a potential risk to the water environment be identified then site specific assessment criteria should be developed.*

*Building Materials and Services – Soil Generic Assessment Criteria*

*Some hydrocarbon compounds are known to both attack and permeate through certain plastic pipe materials, with the primary concern being the degradation and tainting of water supplies. The UK Water Industry Research (UKWIR) has therefore produced a document 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' (ref. 10/WM/03/21) that specifies threshold criteria for the adoption of 'standard' polythene (PE) or PVC pipes, protective barrier pipe and ductile iron/steel/copper pipes.*

*The UKWIR threshold assessment criteria from Table 3.1 of this document for standard PE pipes have been employed. It should be noted that the approach taken by UKWIR is very conservative, and both the document and research are flawed. However, it is these values that are being using to specify water pipe materials and therefore it is appropriate to consider them.*

*The UKWIR guidance is particularly flawed in respect of the chemical analysis it expects as it seeks a limit of detection that is generally below limits that are reasonable or commonly employed in contaminated land assessment. The UKWIR seeks that where a substance is below the limit of detection it should be taken as being present at half this concentration. For the larger suite of chemicals where the limit is against a sum of compounds, this approach would mean that a sample of virgin sub-soil from a greenfield site with absolutely no contamination would actually fail the criteria for using standard PE pipes. To avoid this situation, BRD have adopted the approach of summing only those compounds detected above their respective limits of detection.*

*In terms of building materials, the primary concern is in respect of concrete as certain commonly occurring natural ground conditions can adversely impact on buried concrete as discussed in 'Special digest 1:2005 Concrete in aggressive ground', BRE, 2005.*

| ***ANALYSIS*** | ***GENERIC ASSESSMENT CRITERIA*** | ***SOURCE*** |
|---|---|---|
| *pH* | *<5.5* | *BRE Special Digest 1:2005* |
| *Sulphate (w/s)* | *500 mg/l* | *BRE Special Digest 1:2005* |
| *Sum of any VOC above detection limits* | *0.5 mg/kg* | *Relevant compounds adapted from UKWIR Table 3.1* |
| *Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits* | *2 mg/kg* | |
| *Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits* | *10 mg/kg* | |
| *Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits* | *500 mg/kg* | |
| *Sum of BTEX + MTBE above detection limits* | *0.1 mg/kg* | |
| *Phenols* | *2 mg/kg* | |
| *Cresols and chlorinated phenols* | *2 mg/kg* | |
| *Naphthalene* | *0.5 mg/kg* | |
| *Benzo(a)pyrene* | *0.5 mg/kg* | |

***RISK ESTIMATION – GROUNDWATER***

*The initial assessment of the contamination risk to groundwater is by comparing dissolved groundwater concentrations with screening values (GAC) that are protective of groundwater resources.*

*The reference source for the target concentrations is generally the EA's Environmental Quality Standards (EQS) (accessed July 2018: http://evidence.environment-agency.gov.uk/ChemicalStandards/report.aspx?cid=17), the Water Supply (Water Quality) Regulations 2016 and the DW1/DW2 criteria from the Surface Water (Abstraction for drinking water)(classification) Regulations 1996. The target concentrations are outlined in the table below. The 'Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies'. CL:AIRE, 2017 has also been used as reference source for the values.*

| ANALYSIS | GENERIC ASSESSMENT CRITERIA (GAC) | SOURCE |
|---|---|---|
| Arsenic | 50 µg/l | DW1 & EQS |
| Cadmium | 5 µg/l | EQS |
| Chromium (total) | 50 µg/l | DW2 & EQS |
| Copper | 50 µg/l | DW1 |
| Nickel | 20 µg/l | EQS |
| Lead | 50 µg/l | DW1 |
| Mercury | 1 µg/l | WSR |
| Selenium | 10 µg/l | WSR |
| Zinc | 5 mg/l | DW2 |
| Cyanide | 50 µg/l | WSR |
| pH | 6 to 9 units | EQS |
| Benzene | 10 µg/l | EQS |
| Toluene | 74 µg/l | EQS |
| Ethylbenzene | 300 µg/l | WHO guideline |
| Xylene | 30 µg/l | EQS |
| Methyl tert-butyl ether (MTBE) | 15 µg/l | Taste and odour threshold. |
| Naphthalene | 2 µg/l | EQS |
| Benzo(a)pyrene | 0.0017 µg/l | EQS – Less than Limit of Detection (LOD) |
| Total PAH | 0.2 µg/l | DW1 |
| TPH Aliphatic C5-C6 | 15,000 µg/l | World Health Organization (WHO) guide values for TPHCWG fractions in drinking water |
| TPH Aliphatic C6-C8 | 15,000 µg/l | |
| TPH Aliphatic C8-C10 | 300 µg/l | |
| TPH Aliphatic C10-C12 | 300 µg/l | |
| TPH Aliphatic C12-C16 | 300 µg/l | |
| TPH Aromatic C5-C7 | 10 µg/l | |
| TPH Aromatic C7-C8 | 700 µg/l | |
| TPH Aromatic C8-C10 | 300 µg/l | |
| TPH Aromatic C10-C12 | 90 µg/l | |
| TPH Aromatic C12-C16 | 90 µg/l | |
| TPH Aromatic C16-C21 | 90 µg/l | |
| TPH Aromatic C21-C35 | 90 µg/l | |

*There are no available generic assessment criteria for some of the analytical parameters which have been scheduled, for example hexavalent chromium, and some VOC compounds. These parameters will be assessed based on professional judgement should they exceed the limit of detection.*

***RISK ESTIMATION – GROUND GAS***

*Introduction*

*A variety of potentially hazardous gases occur in naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include traces gases such as Hydrogen sulphide and Carbon monoxide.*

*Methane is a colourless and odourless gas that has the hazardous properties of being flammable and, at certain air/Methane mixtures, explosive. Methane has a low toxicity, but can be a simple asphyxiant due to the displacement of oxygen.*

*Carbon Dioxide is a colourless, odourless and non-combustible gas that has the hazardous property of being a highly toxic chemical. At concentrations of 3% by volume, shortness of breath and headaches will occur becoming acute by 6%. At levels of above 10% by volume headache, visual distortion, tremors and rapid loss of consciousness occur. Concentrations of Carbon Dioxide above 22% by volume are likely to be fatal. The effects of Carbon Dioxide poisoning are made more severe if there is accompanying reduction in oxygen concentrations.*

*Hydrogen sulphide is a colourless and flammable gas that has an odour of rotten eggs. It is important to that the sense of smell is over powered at higher concentrations. The gas is toxic and can be an asphyxiant.*

*Carbon monoxide is a colourless, odourless and explosive gas in air mixtures that has the hazardous property of being a highly toxic chemical.*

*Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every building contains radon, some buildings built in certain defined areas of the country might have unacceptably high concentrations and require special precautions to be taken. The maps contained within BRE211:2015 'Radon: guidance on protective measures for new buildings' identify areas where no radon protection measures are necessary or where higher concentrations are present that either basic or full radon protection measures are required to be fitted to all new buildings, extensions or refurbishments.*

*Basis of Gas Assessment*

*In order to classify the level of risk and need, if any, for gas protection measures at a site with the potential for a gas problem, consideration of each of the following is necessary:*

- *The source of the gas.*
- *The generation potential of the gas.*
- *The location of the source and the geological setting.*
- *Boreholes flow rate and estimated surface emission rate.*
- *The nature of the proposed development.*
- *Confidence in the knowledge of the gas regime.*

*The gas assessment is made with reference to 'C665 - Assessing risks posed by hazardous ground gases to buildings', Construction Industry Research and Information Association (CIRIA), 2007 and 'BS8485:2015 – Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings' BSi 2015.*

*Gas Screening Value*

*The methods within CIRIA C665 and BS8485 both use the gas concentrations together with the borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flow for Methane and Carbon Dioxide. This limiting borehole gas volume flow is called the Gas Screening Value (GSV) and is expressed below:*

*Gas Screening Value (l /hr) = borehole flow rate (l/hr) x gas concentration (fraction)*

*The calculation of GSV is completed for both Methane and Carbon Dioxide and then the 'worse case' maximum values are used in the assessment. The assessment is to determine the gas regime at the site is dependent upon the nature of the development.*

*Characteristic Gas Situation*

*The characteristic situation for many sites is determined from evaluation of the Gas Screening Value derived against the criteria in the following table.*

| Characteristic situation | Hazard potential | Gas Screening Value (CH4 or CO2 l/hr) | Additional factors |
|---|---|---|---|
| CS1 | Very low risk | <0.07 | Typically Methane ≤1% and/or Carbon Dioxide ≤5%. Otherwise consider an increase to characteristic situation 2. |
| CS2 | Low risk | 0.07 to <0.7 | Borehole air flow rate not to exceed 70 l/hr. Otherwise consider an increase to characteristic situation 3. |
| CS3 | Moderate risk | 0.7 to <3.5 | - |
| CS4 | Moderate to high risk | 3.5 to <15 | - |
| CS5 | High risk | 15 to <70 | - |
| CS6 | Very high risk | >70 | - |

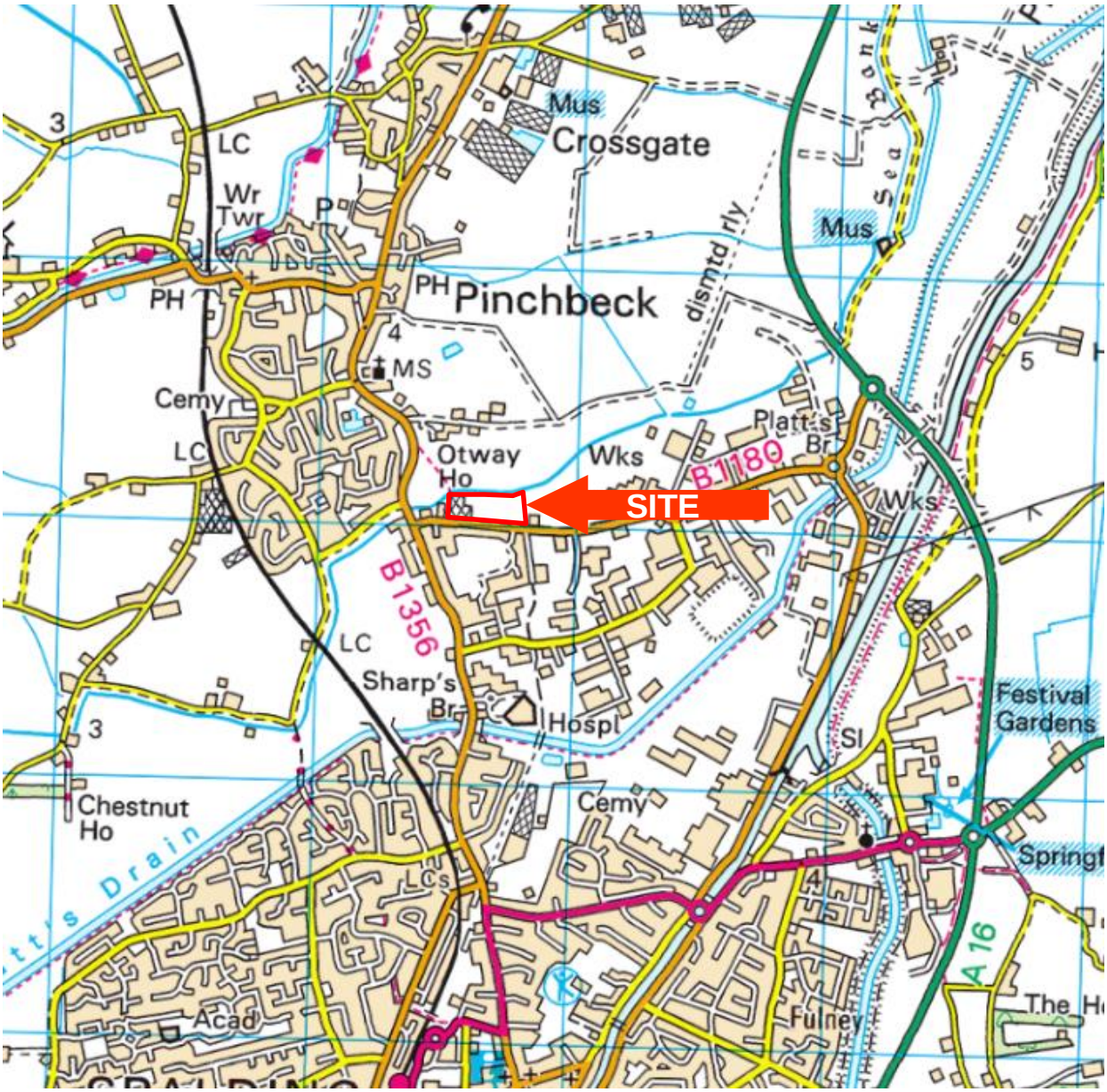
*Low rise housing with gardens – NHBC 'Traffic Lights'*

*The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m$^2$, suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.*

| Traffic Lights | Methane | | Carbon Dioxide | |
|---|---|---|---|---|
| | Typical maximum concentrations (%) | Gas Screening Value (l/hr) | Typical maximum concentrations (%) | Gas Screening Value (l/hr) |
| **Green** | ≤1 | ≤0.16 | ≤5 | ≤0.78 |
| **Amber 1** | 1> to ≤5 | >0.16 to ≤0.63 | >5 to ≤10 | >0.78 to ≤1.56 |
| **Amber 2** | 5> to ≤20 | >0.63 to ≤1.56 | >10 to ≤30 | >1.56 to ≤3.13 |
| **Red** | >20 | >1.56 | >30 | >3.13 |

# APPENDIX 1

# Site Location Plan




Not to scale.

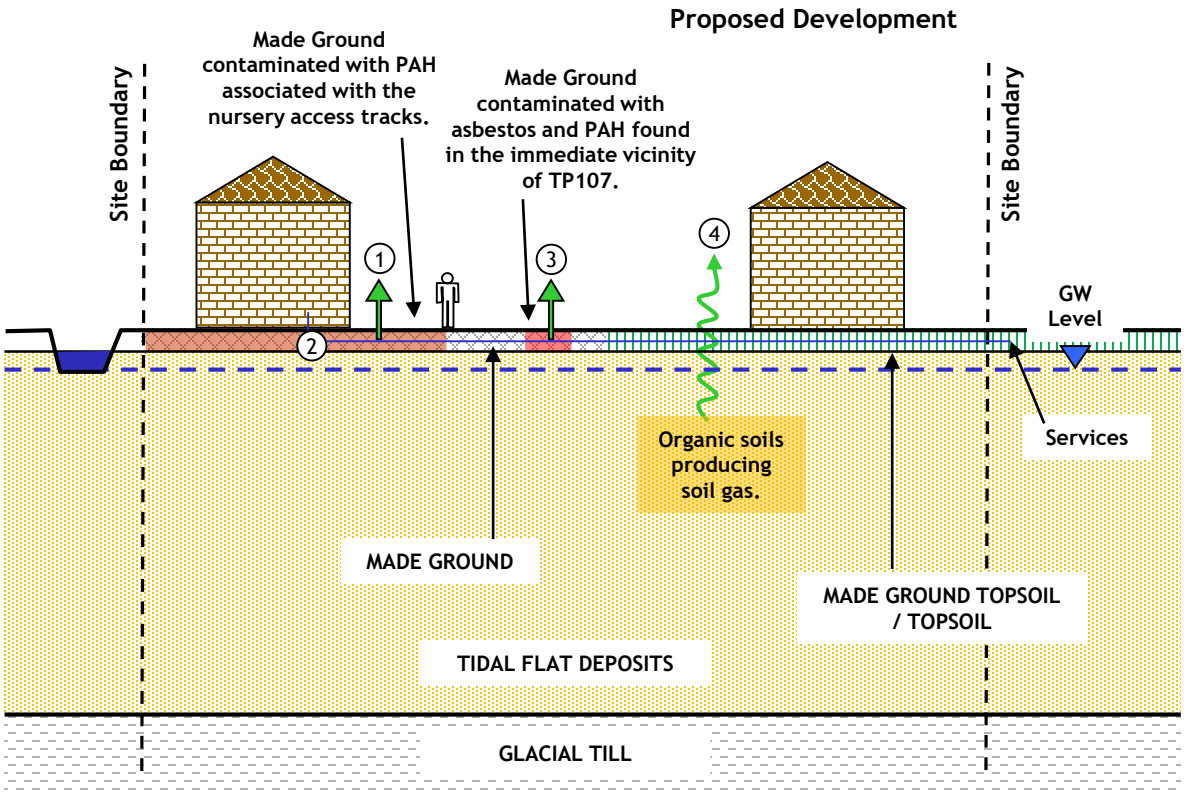
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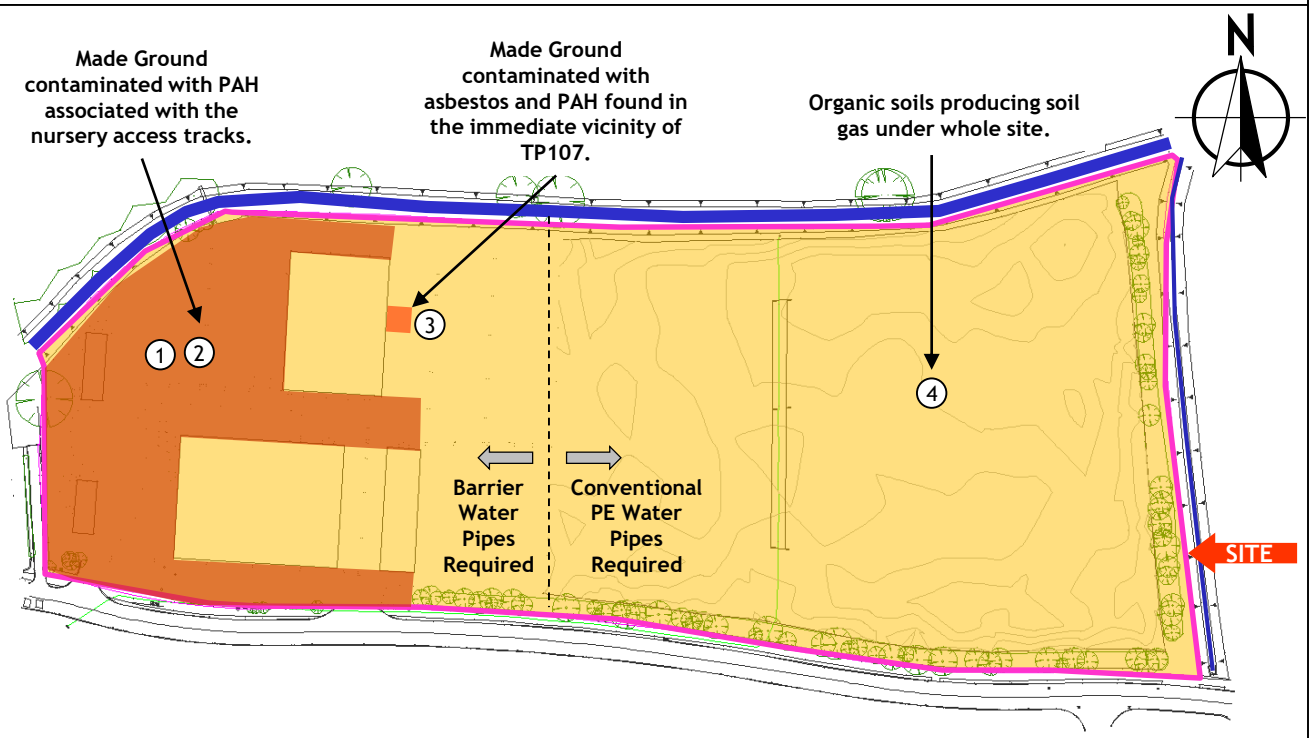
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| | |
|---|---|
| Project Title: | Red Mile Nursery, Pinchbeck |
| Client: | Bellway Homes |
| BRD Reference: | BRD3760-OP3-A |
| Date Issued: | July 2021 |

BRD
01295 272244
info@brduk.com

# Revised Conceptual Model




| | |
|---|---|
| Project Title: | Red Mile Nursery, Pinchbeck |
| Client: | Bellway Homes |
| BRD Reference: | BRD3760-OP6-C |
| Date Issued: | September 2021 |


BRD
01295 272244
info@brduk.com

| HOUSE TYPE SCHEDULE | |
|---|---|
| TA - Tailor - 3B | 9 |
| TH - Thespian - 3B | 11 |
| CH - Chandler - 3B | 10 |
| QU - Quilter - 3B | 10 |
| MA - Mason - 3B | 10 |
| SC - Scrivener - 4B | 14 |
| MI - Milliner - 4B | 8 |
| TOTAL MKT HOMES | 72 |
| | |
| BT-GF - Stationer - 1B2P AR | 3 |
| BT-FF - Bookbinder - 1B2P AR | 3 |
| MN - Manciple - 2B4P AR | 6 |
| MN - Manciple - 2B4P SO | 2 |
| TI - Tillman - 3B4P AR | 3 |
| TI - Tillman - 3B4P SO | 5 |
| CT - Cartographer - 4B5P AR | 2 |
| TOTAL AH HOMES | 24 |
| | |
| GRAND TOTAL | 96 |

SUDs in POS = 0.2103 Ha.
POS exc. SUDs = 0.9205 Ha.
POS Total = 1.1308 Ha.

Blue Gowt Drain

Drain

Drain

Existing PROW

Note: refer to Arboriculturalist and landscaping information for all tree information.

Note: refer to Arboriculturalist and landscaping information for all tree information.

SUDS = 0.0431 Ha.

SUDS = 0.0611 Ha.

LAP 100 m2

2 benches

Swale = 0.0453 Ha.

Swale = 0.0206 Ha.

Swale = 0.0220 Ha.

Swale = 0.0181 Ha.

Existing access closed & reinstated with kerb

WARDENTREE LANE

Note: refer to Arboriculturalist and landscaping information for all tree information.

3M cycle path link

Maintenance access for DB

Balancing Ponds

Amble Side

Neves

The Lodge

RED MILE

F. 01/12/21 Highway amendments.
E. 14/09/21 Highway amendments.
D. 27/07/21 HA mix amended.
C. 10/06/21 Swales / SUDs amended.
B. 03/06/21 LPA amendments.
A. 11/05/21 LPA amendments.
Revisions:

LMC - Architect Limited
87 Main Street, Lyddington,
Rutland, LE15 9LS
Tel/Fax 01572 820185
Mobile 07985 943743

Client:
Bellway Homes Limited (Eastern Counties)

Title:
Land off
Wardentree Lane
Pinchbeck, Spalding

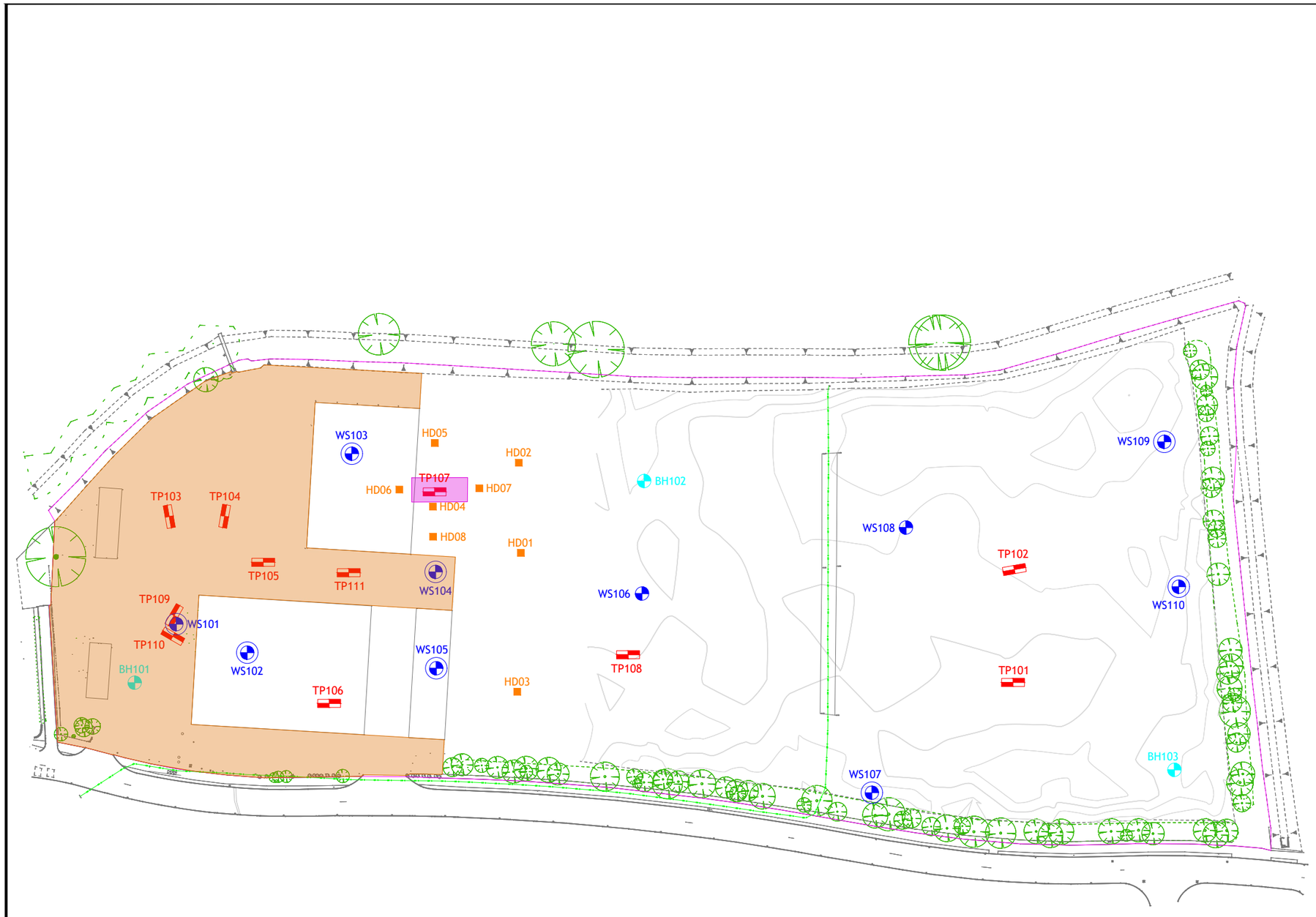
Drawing:
Planning Site Layout

| Scales: | Sheet Size: | Date: | Drawn: |
|---|---|---|---|
| 1:500 | A1 | 26/01/21 | LMC |

Drawing Number: 487-SK-01 Rev: F

Do not scale off or measure from this drawing.
All discrepancies should be reported to the architects. This drawing should be read in conjunction with the specification and standard details.
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1:100 1:200 1:500 1:1250 1:2500




Key:

- Made Ground in the location of TP107 to be removed due to presence of Asbestos. BRD to be in attendance throughout works.
- Made Ground underlaying access tracks to be removed in its enterity due to elevated PAH (extending to between 0.20m and 0.60m in thickness). BRD to be in attendance throughout works.
- WS — BRD Windowless Sample Borehole with monitoring well installed
- WS — BRD Windowless Sample Borehole
- BH — BRD Cable Percussive Borehole
- TP — BRD Trial Pit
- HD — BRD Hand Dug Pit (Approximate Position)
- Gas Main
- Site Boundary (Approximate Position)

Notes:

Reproduced from Safe Dig Surveys Ltd, 'PAS128-SURVEY', drawing ref: 20201222UCL-SPAL, Rev: A, dated 08/02/2021.

| Revision | Date | Description | Drawn | Approved |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

Drawing title: REMEDIATION PLAN

Project title: RED MILE NURSERY, PINCHBECK

Client: BELLWAY HOMES

| Scale | Original drg. size/colour | Date |
|---|---|---|
| 1:1250 | A3 / C | 15/02/2022 |
| **Drawn** | **Checked** | **Approved** |
| RM | NK | JB |

| Drawing Number | Rev |
|---|---|
| BRD3760-OD2 | A |

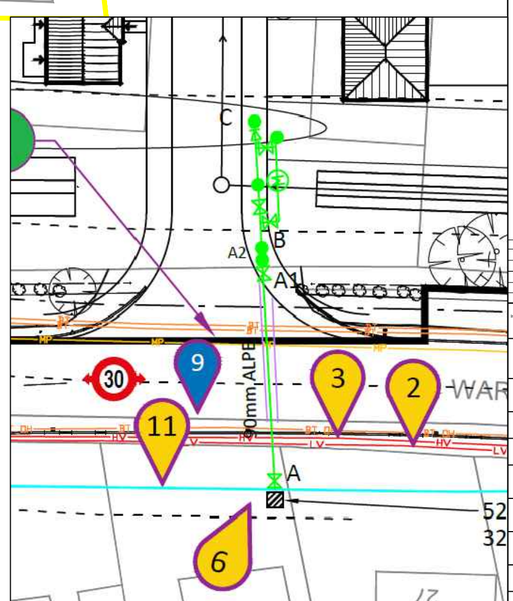
**BRD Environmental Ltd**

01295 272244
info@brduk.com
www.brduk.com

| HYDRANT SCHEDULE | | |
|---|---|---|
| POINT NUMBER | ADOPT Y/N | COMMENTS |
| 1 | N | |
| 2 | N | |
| 3 | N | |
| 4 | N | |
| 5 | N | |
| 6 | N | |
| 7 | Y | FH19542 |
| 8 | Y | FH19543 |

**SERVICES TO PLOTS 4-17 TO BE LAID IN BARRIER PIPE ONLY**




NORTH

**Note**

ALL END WASH OUTS TO BE POSITIONED NO MORE THAN 1m PAST THE LAST SERVICE. IF THE LAST SERVICE CONNECTION POSITION CHANGES FURTHER THAN THIS THE DEVELOPER MUST CONTACT INFRASTRUCTURE GATEWAY FOR ADVICE

## PIPE SPECIFICATION

| PIPE SIZE (mm) /MATERIAL | LENGTH (m) |
|---|---|
| 90mm PE | 331 |
| 125mm PE | 90 |
| 90mm ALPE | 121 |
| TOTAL LENGTH | 542 |

**General Notes**

**Material Specification**

PE & Barrier Pipe

Up to and including 63mm PE80 (MDPE), SDR11 (Light Blue)
90mm up to 315mm PE100 (HPPE) SDR17.6 (Dark Blue)

Ductile Iron

Confirm with designer before ordering.
All mains and services must be laid using an approved PE or PE Barrier pipe. When using PE Barrier pipe all joints & fittings must be wrapped in accordance with manufacturers instruction to prevent ingress of contamination into the water pipes.
Underground meter boxes must be installed using female iron couplings.
All mains & services (other than 32mm/25mm services) must be installed by 'WRA,' approved personnel only, and mains installed by non-approved personnel will not colMPly with water ( HSE regulations and will need to be replaced.
All external pipes and internal plumbing must colMPly with the Water Supply (Water Fittings) Regulations 1999 Schedule 2 and the Water Supply (Water Quality) Regulations 2001)

Ducting Specification

All ducting should be supplied and installed in accordance with BS4692 is a suitable standard for plastic ducting.

- Ducting can only be used for perpendicular carriageway crossings.
- Only one pipe is allowed per duct
- For service pipe the duct must be blue and perforated along it's entire length

Duct Sizes

| Water Pipe External Diameter | Duct Inside Diameter |
|---|---|
| 25mm & 32mm | 100mm |
| 63mm | 150mm |
| 90mm, 110mm & 125mm | 200mm |
| 160mm & 180mm | 300mm |
| 225mm & 315mm | 400mm |

**All pipes, fittings and valves must meet technical specifications:**

BS6437 - 1984; BS6572 - 1985; BS6730 -1986; BS5306: Part 2 -1990; WIS 4-24-01 - 1998; WIS 4-32-08 - Issue 3- April 2002
WIS 4-32-14 - 1995; WIS 4-32-15 - 1995; WIS 4-32-17 - Issue 2 -2001; DIN8074 - 1999; DIN8075 - 1999; DIN16963 Part 1 - 1980; ISO4427-1996; BS EN 12201; BS EN 13244; UNI 10910:2001

Contaminated Ground Conditions

Should the land on which the development is taking place to be contaminated, all underground pipes and fittings installed in conjunction with water mains and service connection will need to be of suitable material to meet the manufacturers specifications which are not adversely affected by the geotechnical conditions.
The developer will ensure that the service pipe material and fittings used on site are fit for purpose and suitable for use within contaminated land
In the event that contaminated land is discovered during construction then work should be stopped until the nature of the contamination is identified and alternative protective coated materials provided to allow continuation of main laying

Plan Notes

This plan shows those pipes owned by the BUUK Group. Any third part apparatus indicated on these drawings is shown for indicative purposes only. The developer should contact the third party direct for confirmation of their location or to agree any possible diversionary or abandonment works. The information shown on this plan is given without warranty, the accuracy thereof cannot be guaranteed. No liability of any kind whatsoever is accepted by the colMPany, it's agents, servants or contractors for any error or omission. Safe digging practices, in accordance with HS(G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that this information is provided to all persons (either direct labour or contractors) working for you on or near gas apparatus.

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Developers Responsibility

When the main has been laid it becomes the responsibility of the developer to ensure its protection, therefore backfilling should be carried out as soon as possible. Any damage or theft of any item once delivered to site is the responsibility of the developer.
Replacement and repair, including administrative costs will be fully recharged to the developer, irrespective of who the responsible party was. It will be the developer's responsibility to recover the costs from the third parties.

**Proposed Services**

Domestic supply-install all services up to & including 32mm at a depth of 750mm deep where laying in non 1350mm from finished surface level.
Where laying in contaminated land using barrier pipe or ductile iron, corresponding service pipe must also be of a barrier type

**Proposed Mains**

All mains to be laid in pre-excavated trench to 900mm cover, provided by the developer. Road crossings to be continuous plastic duct or drainage pipe sized to accommodate the mains shown on this drawing, at 900mm cover to the finished level.

update key

| Drawing Key | Colour | Proposed | As-Laid |
|---|---|---|---|
| Water Pipe | Blue | | |
| Services (IGL) | Blue | | |
| Services (DEVELOPER) | Light Green | | |
| Asset Boundary | Yellow | | |
| Water Mains (Incumbent) | Dark Green | | |

PE: Polyethylene BP: Barrier Pipe DI: Ductile Iron

| | | |
|---|---|---|
| UPVC Ducts | Black | |
| Water Connection Points | Green | |
| Wash Out Hydrant | | WO |
| Temporary Wash Out | | TW |
| Sluice Valve | | SV |
| Air Valve | | AV |
| Pressure Reducing Valve | | PRV |
| Fire Hydrant | | FH |
| Stop Tap | | ST |
| Meter | | M |
| Change of Pipe Size/Material | | |
| Multi Port Box (With Number of Meters) | | |
| Gun Metal Manifold & Chamber (With Number of Meters) | | |
| Non-Return Valve | | |

APPROVED CONSTRUCTION DRAWING

ALL VALVES TO BE CLOCKWISE CLOSE

Drawing Revision Details

| Date | Description | ID | CHK | APP |
|---|---|---|---|---|
| 29/07/21 | INITIAL DESIGN | TS | BB | SD |
| 24/09/21 | BARRIER PIPE USED | TS | BB | SD |
| 22/10/21 | FRS REQUIREMENTS ADDED | TS | AD | BB |
| 10/11/21 | NEW CAD LAYOUT | TS | AD | BB |

UIP/Contractor:
Infrastructure Gateway Limited, Vantage House, 2700 Kettering Parkway, Kettering, Northants, NN15 6XR
tel. 01536 21677 e-mail. post@igl.co.uk
fax. 08701 359975 website. www.igl.co.uk

Asset Owner:
WNL, Driscoll 2, Ellen Street, Cardiff, CF10 4BP
Phone: 02920 358717 Fax: 08714 269366

Location: Wardentree Lane, Pinchbeck

OS Ref: 524650, 325068

Developer: Bellway Homes (Eastern)

Drawing Title: Potable Water Design

Project Number: NGE21-4444

Type: C | Revision C

DRAWING TYPES M- Miscellaneous A- As Laid (Not Adopted) D- Design P- Proposal L- Wayleave/Easement C- Construction issue

Drawing Number: NGE21-4444-001

Scale: 1:500 | Sheet Size: A0