

## 8.5 Inaccessible Site Areas

Although all areas of the site were accessible during the site visit, the trial pit positions were dug within the field tram lines to minimise significant ground disturbance where possible

# C PRELIMINARY SITE MODELS

## 9 Conceptual Engineering Geological Ground Model

From the desk study information and walkover undertaken at this site the following conceptual ground model has been formulated.

| Data Source           | Comments                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Geology               | The mapped soils beneath the site comprise Clay-with-Flints Formation and Lowestoft Formation over Lewes Nodular Chalk. The previous site investigations show the interfaces between the units to be largely variable. A moderate chalk dissolution stability risk applies to the site.                                                                                                                                        |
| Former Site Use       | Historic mapping of the site indicates the land has only been used as agricultural land since at least 1881 when the first map was produced. The land in the north and west of the site has also remained the same since it was first mapped however in recent times residential developments have encroached closer to the eastern and southern boundaries of the site. Regionally the area has historic sporadic chalk pits. |
| Groundwater           | The Lewes nodular chalk has been designated as a Principal Aquifer and so groundwater should be expected if this unit is encountered. Hydrogeological mapping suggests that this could be around 70m below the site.                                                                                                                                                                                                           |
| Surface Water         | The site has not been reported to be at risk of surface water flooding.                                                                                                                                                                                                                                                                                                                                                        |
| Potential Geo-hazards | Shrinkage and swelling of high clay content materials is likely to affect the site. A moderate chalk dissolution subsidence risk is recorded in the database, and the potential for small unrecorded chalk pits applies regionally.                                                                                                                                                                                            |

On the basis of the available information the geotechnical categorization for the proposed structure(s) is considered to fall within Geotechnical Category– Conventional structure with no exceptional risk or difficult ground or loading conditions; Eurocode 7 Ref [15].

## 10 Conceptual Site Model

In the context of this report, the conceptual model summarises the potential pollutant linkages identified for the site and forms the basis of the risk assessment. The preliminary model comprises the potential sources of contamination, receptors that could be harmed and exposure pathways identified from the desk study and walkover survey. These potential linkages form the basis upon which the investigation is designed and reported.

### 10.1 Potential Sources of Contamination

The site has a history of agricultural use and is located within a mixed residential and agricultural/woodland area.

Very few potentially contaminative uses have been identified, both on site and in the locality.

Potential contaminants associated with these uses have been compiled from desk study information and our experience of such sites.

### 10.1.1 On-Site Sources

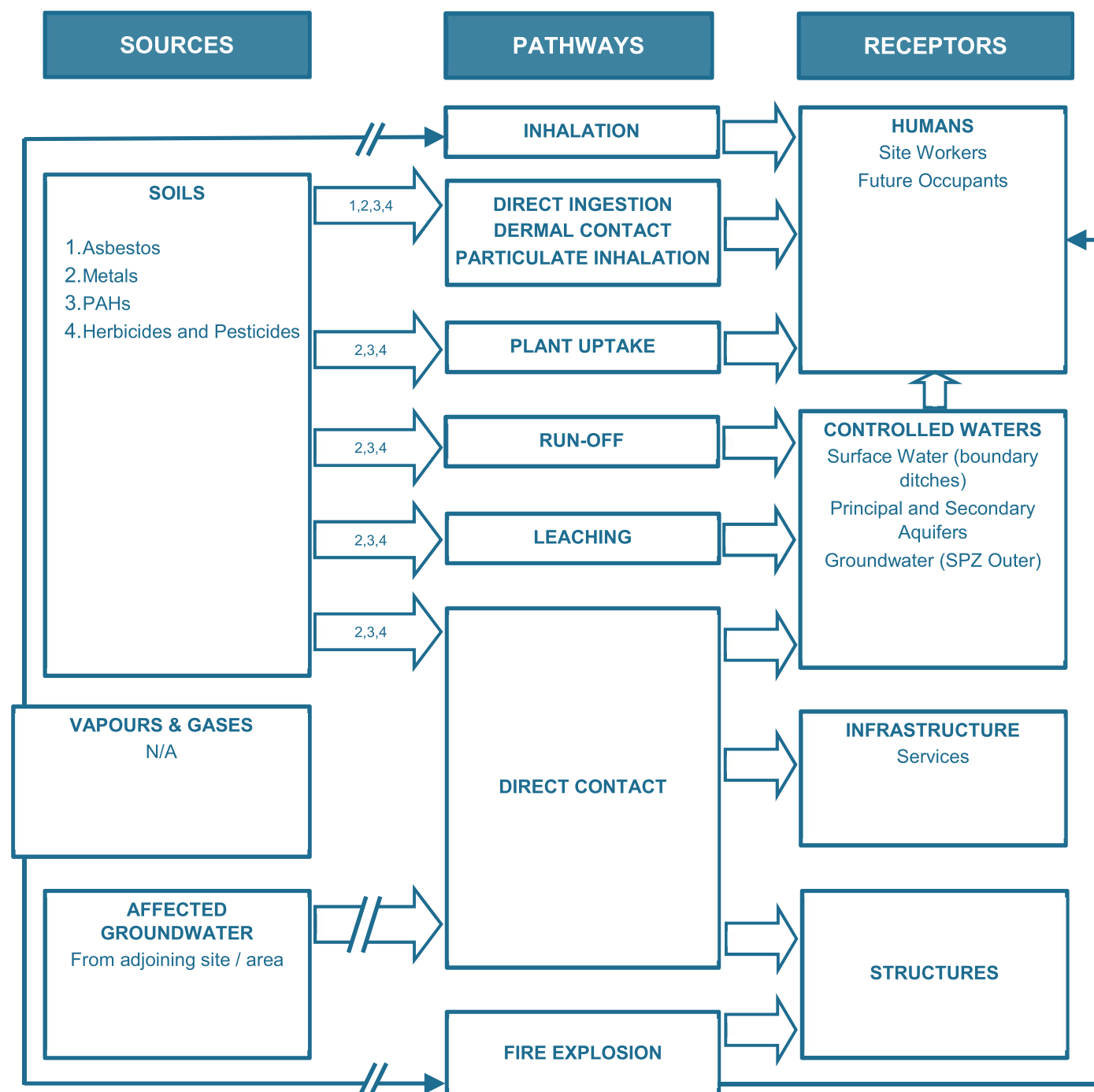
| Potential Source | Potential Contaminants     |
|------------------|----------------------------|
| Agricultural use | Herbicides and Pesticides. |

### 10.1.2 Off-Site Sources

The site may be impacted by contamination migrating from beyond the site boundary. At this stage no significant potential off-site sources have been identified in the desk study or walkover survey.

## 10.2 Pollutant Linkages and Conceptual Site Model Summary

The following diagram shows the potential pollutant linkages identified for the site and summarises the preliminary conceptual model:



## D GROUND INVESTIGATION

### 11 Strategy and Method

The strategy adopted for the intrusive investigation comprised the following:

| Activity / Method | Purpose                                                                                                             | Max Depth Range (mbgl) | Installations / Notes |
|-------------------|---------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------|
| TP01 – TP08       | Trial pit to investigate the shallow ground conditions.<br>BRE365 soakage assessments completed within TP01 – TP03. | 2.70 – 3.20m           |                       |

The exploratory hole locations were designed to provide the best general coverage and partly target known areas of potential drainage (where chalk was encountered at a shallow depth during the previous investigation). The locations are shown on Figure 2 in Appendix A. As discussed, the trial pit positions were dug within the field tram lines to minimise significant ground disturbance where possible.

In-situ test and sampling methods descriptions employed are given in Appendix B together with the test results.

### 12 Weather Conditions

The fieldwork was carried out on Thursday 25<sup>th</sup> November 2021, at which time the weather was generally cold and windy but dry.

### 13 Soils as Found

The soils encountered are described in detail in the attached exploratory hole logs (Appendix A), but in general comprised a covering of topsoil over gravelly clay. A summary is given below.

| Depth (m)     | Soil Type | Description                                                                                                                                                                                                                   |
|---------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GL – 0.3/0.45 | TOPSOIL   | Dark brown to grey brown clayey silty sandy gravelly TOPSOIL with rootlets. Gravels comprise fine to coarse, sub-rounded to sub-angular flint.                                                                                |
| – 3.2+        | CLAY      | Stiff grey / orange-brown mottled silty sandy gravelly CLAY. Gravels comprise fine to coarse, sub-rounded to sub-angular flint with occasional chalk. Often red brown with depth.<br>Hematite staining developing with depth. |

Generally, the soils found were in accordance with those anticipated. The Lewes Nodular Chalk was not encountered within any of the exploratory holes.

#### 13.1 Visual and Olfactory Evidence of Contamination

No visual or olfactory evidence of contamination were noted during the investigation, with only natural sequences encountered. This concurs with the site history.

### 14 Groundwater Observations

No groundwater seepages were observed during the investigation.

## E DISCUSSION OF GEOTECHNICAL TEST RESULTS AND RECOMMENDATIONS

The desk study identified the risk (moderate) of natural chalk dissolution related subsidence potential at the site. All of the investigations to date have not identified any outwardly obvious associated features, such as loose/voided ground or sub-vertical soil sequences. Earlier laboratory analysis infer a chalk substrate of Low Density. Whilst there has been no evidence to date to infer onerous conditions in this regard, prudent design should consider mitigation in respect of the residual risk.

### 15 Geotechnical Laboratory Tests

The following geotechnical laboratory testing was carried out on selected samples in order to aid material classification and characterise soil properties. The test method references and results are given in Appendix C.

| Laboratory Test  | Number of Samples Tested | Stratum              |
|------------------|--------------------------|----------------------|
| Moisture Content | 5                        | Superficial Deposits |
| Atterberg Limit  | 5                        | Superficial Deposits |
| BRE SD1 Suite B  | 8                        | Superficial Deposits |

### 16 Soil Classification and Properties

#### 16.1 Superficial Deposits

The deposits were often found as a stiff orange-brown / grey mottled silty sandy gravelly CLAY.

Five Atterberg limit tests were undertaken on samples of the unit, at depths ranging from 1-3m, which on average retained 10% coarse material. The plasticity index ranged between 36 and 54% in these samples with three of 40% or above, which on balance indicates that an NHBC High Volume Change Potential can be assumed.

### 17 Groundwater Levels

Groundwater levels vary considerably from season to season and year to year, often rising close to the ground surface in wet or winter weather, and falling in periods of drought. Long-term monitoring from boreholes or standpipes is required to assess the ground water regime and this was not possible during the course of this site investigation.

The groundwater table within the chalk at depth is inferred to be at 70m bgl from the hydrogeological mapping.

### 18 Swelling and Shrinkage

Shrinkable soils are subject to changes in volume as their moisture content is altered. Soil moisture contents vary from season to season and can be influenced by a number of factors including the action of roots. The resulting shrinkage or swelling of the soil can cause subsidence or heave damage to foundations, the structures they support and services.

The designer should be aware that precautions regarding swelling and shrinkage are applicable, and in this respect, NHBC precautions provide a helpful guide with respect to minimum foundation depths and deepening, particularly within the zone of influence of trees.

Assessment of foundation depths should take into account trees, hedgerow and shrubs which are to be removed, remaining or are proposed which may be allowed to reach maturity.

We would recommend that on balance a NHBC HIGH Volume Change Potential site classification be adopted for design purposes covering natural and undisturbed Superficial Deposits.

Full details of protective measures are given in NHBC Standards Ref [16], Chapter 4.2 to which the reader is referred.

## 19 Lateral Pressure & Heave

Where foundations are more than 1.5m deep, and are within the zone of influence of existing or removed trees, then precautions will also need to be taken against the effects of lateral swelling of soils beneath house units due to removal of trees, or cutting tree roots.

A helpful guide with respect to requirements for the relief of lateral pressure is set out in the NHBC Standards Ref [16], Chapter 4.2 to which the reader is referred. The basic requirement is that compressible material or void former should be installed on the inner face of external foundation walls. With piled foundations additional voids are required below ring beams.

### 19.1 Soakage Tests

Three soakage tests were carried out in trials pits TP01, TP02 and TP03. These tests all recorded little to no infiltration, which was not unexpected given the low permeability clay soils encountered.

The BRE paper DG365, Ref [17] describes a method for site testing to determine soil infiltration rates at the proposed site of a soakaway. The in-situ test method is described in Appendix B.

A total of three soakage tests were carried out across the site, at the locations shown on the attached site plan Figure 2, Appendix A. The full results of the soakage tests are presented within Appendix B.

The DG365 Ref [17], states that each pit should be allowed to drain three times to near empty, with filling on the same or consecutive days.

The infiltration rate from each trial hole is summarised in the table below. The soakage rate in this report is expressed as  $\text{l/m}^2/\text{minute}$ , which is a convenient rate to use. The BRE use a unit of  $\text{m/sec}$ , which is the value in  $\text{l/m}^2/\text{minute}$  divided by 60,000.

| Test ID | Test Depth (mbgl) | Design Infiltration Rate     |                       | Notes                                                                                              |
|---------|-------------------|------------------------------|-----------------------|----------------------------------------------------------------------------------------------------|
|         |                   | $\text{l/m}^2/\text{minute}$ | $\text{m/sec}$        |                                                                                                    |
| TP01    | 2.7m              | 0.0060                       | $9.99 \times 10^{-8}$ | Pit was not emptied; non-compliant value was calculated. Depth to top of permeable soils was 0.40m |
| TP02    | 3.0m              | 0.0000                       | 0.00                  | Water level did not fall during test. Depth to top of permeable soils was 0.30m                    |
| TP03    | 3.0m              | 0.0000                       | 0.00                  | Water level did not fall during test. Depth to top of permeable soils was 0.35m                    |

\*Where three fillings have not been carried out, a reduction factor should be applied to the result to provide a design infiltration rate.

In summary, the soakage results were very poor for the three test locations. None of the tests were able to be filled three times, in accordance with the BRE365 Digest.

Typically, a minimum soakage rate of  $0.1 \text{ l/m}^2/\text{minute}$  is required for conventional soakaways to meet the BRE365 requirement of a soakaway half empty time of less than 24 hours. Therefore, on the basis of these test results and given the soils types present, the site is not considered suitable for shallow soakaway drainage. On this basis we anticipate that surface run-off will act as the primary method for site drainage. Water should therefore be directed into ditches where possible. In periods of wet weather it is likely that the ground will remain wet.

The desk study has highlighted that the site falls within Source Protection Zone III. Therefore the Environment Agency should be consulted prior to the development of any drainage scheme incorporating soakaways.

The previous Borehole Soakaway Investigation completed by Southern Testing in February 2010 (Ref BS375), reported that good soakage rates can be achieved within the Upper Chalk which underlies the site, with rates of between 360-450  $\text{l/min}$  measured.

**Soakage locations should consider the general guidance on easements (moderate dissolution subsidence risk, low density chalk terrain) provided in Ciria C574 for developments on chalk areas, and any such scheme should usually seek approval from the Environment Agency, given the aquifer status of the deep substrate.**

## 19.2 General Guidance on Design of Soakaways

Any soakaway scheme may require the approval of the Environment Agency, Building Control and, where applicable, the adopting Highways Authority.

Soakaways are used to store the immediate surface water run-off from hard surfaced areas, such as roof or car parks, and allow for efficient infiltration into the adjacent soil. They should be designed to discharge their stored water sufficiently quickly to provide the necessary capacity to receive run-off from a subsequent storm. The time taken for discharge depends upon the soakaway shape and size, and the surrounding soil's infiltration characteristics.

Groundwater levels can vary considerably from season to season and year to year, often rising in wet or winter weather, and falling in periods of drought. As such, a high groundwater table may affect the storage capacity of soakaways. In addition, it should be noted that an unsaturated zone may be required between the base of soakaways and the groundwater table, by the Environment Agency. Longer term monitoring may be required to establish actual groundwater levels as part of the planning approval process.

The design of soakaways can be square, circular (conventional) or trench excavations, and may be rubble filled, perforated precast concrete ring units, plastic cells or any similar structure that collects rainwater and run-off and allow discharge directly into the ground. Depending on the geological conditions, and depth at which suitable infiltration is achieved, soakaways can also be deep bored.

Long-term maintenance and inspection must be considered during the design and construction process. Maintenance of silt traps, gully pots and interceptors will improve the long-term performance of soakaways. The use of wet well chambers within the soakaway system can further assist in pollutant trapping and extending the operating life of soakaways.

Generally, roof and surface run-off should not significantly impact on groundwater quality and, subject to appropriate approvals from the Environment Agency, could be discharged directly to soakaways. However, although again subject to approvals from the Environment Agency, paved surface run-off for larger trafficked areas should generally be passed through a suitable form of oil interception device prior to discharge to the soakaway.

Care must be taken to ensure that the discharge of large volumes of surface run-off into the soil does not disrupt the existing sub-surface drainage patterns. Similarly, in areas of sloping topography, consideration should be given to the siting of soakaways to avoid potential discharge and or flooding of down slope areas.

Soakaways should not normally be constructed closer than 5 m to buildings, although greater easements may apply based on the moderate chalk dissolution risk.

## 20 Sulphates and Acidity

Chemical analysis of the underlying soils has been undertaken to establish the aggressive chemical environment for concrete in accordance with the BRE Special Digest 1, Ref [18]. The site category determined is that of a natural ground location that contains pyrites (or potential pyrites), as the underlying soils form part of the Lowestoft Formation and Clay-with-Flints Formation.

A total of 8 sulphate tests were completed and as such the characteristic value for sulphate concentration has been determined from the mean of the highest two measured concentrations.

The recorded pH values are in the range 7.5 to 8.4, slightly alkaline, for the soils submitted for sulphate testing.

The BRE SD1 suites calculated the mean of the highest two measured concentrations of oxidisable sulphate was 0.0125%, with the highest two concentrations being found in TP04 at 1.00m (0.03% SO<sub>4</sub>) and TP05 at 2.00m (0.015% SO<sub>4</sub>). Therefore, pyrite is probably not present. The Total Potential Sulphate (TPS % SO<sub>4</sub>) was calculated as 0.027%, which is equivalent to class **DS-1** condition. Groundwater within this depth should be assumed to be immobile. The ACEC classification is therefore **AC-1s**.

## 21 Foundation and Bearing Capacity

On the basis of the investigations carried out to date, strip or trench fill foundations are likely to be viable.

For footings with formations formed upon the natural firm to stiff silty clays, at a minimum depth of 1.0m below ground level (bgl), a bearing capacity of 125kPa may be assumed. Additional deepening in the vicinity of vegetation (mature trees, including high water demand species, on boundaries) is required in line with NHBC High VCP substrate. With this in mind, it is conceivable that deepened foundation formations near site boundary trees will span from cohesive to non-cohesive substrate (clay to chalk) and inclusion of mesh reinforcement should be considered to mitigate against hypothetical settlement differentials, which may set up across the different media. Inclusion of reinforcement would also mitigate the residual risk of issues related to natural dissolution of the chalk substrate.

Allowance should be made for nominal upgrading of reinforcement to accommodate local loss of support (beams) in the event that groundworks or subsequent phases of fieldwork encounter more onerous conditions in relation to the naturally soluble chalk at depth.

A minimum foundation depth of 1000mm is anticipated for NHBC High Volume Change Potential soils. However, the designer should be aware that precautions regarding swelling and shrinkage are applicable and, in this respect, NHBC precautions provide a helpful guide with respect to minimum foundation depths and deepening, particularly within the zone of influence of trees hedgerows or shrubs; existing, proposed or removed.

Subject to the Engineers final design, excessive foundation deepening may be required. Based on NHBC guidance, foundations below 2.5m must be designed individually by an engineer on an individual property basis taking into account soil desiccation, heave, lateral pressure, trench stability and workmanship. At depths in excess of 2.5m, a piled foundation is usually the most appropriate foundation option.

## 22 Floor Slabs

Given the elevated volume change potential on some materials and dense vegetation, particularly along the site boundaries, allowance should be made for suspended ground floor slabs.

## 23 Settlement

Based on the recommendations given above, settlement for the proposed structure should be within tolerable limits.

## 24 Excavations and Dewatering

Statutory support will be required in all excavations where personnel must work.

The clay materials will be prone to instability in open excavations during wet weather or where seepages are encountered and will soften rapidly if exposed to moisture or the elements. The sand materials will run and be highly unstable in excavations or boring operations below the water table.

Where excavation is proposed in close proximity to existing structures, care will need to be taken to avoid undermining existing foundations.

Hard ground, such as rock bands may be encountered, and where necessary allowance should be made for breaking these using hydraulic hammers or the like, mounted on the excavation plant, to facilitate excavation.

Significant inflows of groundwater into excavations would not be anticipated, nor would the requirement for specialist de-watering activities.

## F DISCUSSION OF GEOENVIRONMENTAL TEST RESULTS AND RECOMMENDATIONS

### 25 Analytical Framework

There is no single methodology that covers all the various aspects of the assessment of potentially contaminated land and groundwater. Therefore, the analytical framework adopted for this investigation is made up of a number of procedures, which are outlined below. All of these are based on a Risk Assessment methodology centred on the identification and analysis of Source – Pathway – Receptor linkages.

The CLEA model Ref [1], provides a methodology for quantitative assessment of the long-term risks posed to human health by exposure to contaminated soils. Toxicological data is used to calculate a Soil Guideline Value (SGV) for an individual contaminant, based on the proposed site use; these represent minimal risk concentrations and may be used as screening values.

In the absence of any published SGVs for certain substances, Southern Testing have derived or adopted Tier 1 screening values for initial assessment of the soil, based on available current UK guidance including the LQM/CIEH S4UL's Ref [19] and CL:AIRE Soil Generic Assessment Criteria Ref [20]. In addition, in 2014, DEFRA Ref [21] published the results of a research programme to develop screening values to assist decision making under Part 2A of the Environmental Protection Act. Category 4 screening levels were published for 6 substances, with reference to human health risk only. This guidance includes revisions of the CLEA exposure parameters, presenting parameters for public open space land use scenarios, and also of the toxicological approach. The screening levels represent a low risk scenario, based on a 'Low Level of Toxicological Concern' rather than the 'Minimal Risk' of CLEA, and the analytical results of this investigation may be considered relative to these levels.

Site-specific assessments are undertaken wherever possible and/or applicable.

CLEA requires a statistical treatment of the test results to take into account the normal variations in concentration of potential contaminants in the soil and allow comparisons to be made with published guidance.

The results of any groundwater analyses are compared to relevant quality criteria, e.g. Environmental Quality Standards (EQS) or Drinking Water Standards (DWS).

Ground gases are assessed in accordance with the guidance given in CIRIA C665 Ref [3] and BS8485 Ref [22].

**The contamination screening values used are valid at the time of writing but may be subject to change and any such changes will have implications for the assessments based upon them. Their validity should be confirmed at the time of site development.**

### 26 Site Investigation – Soils

#### 26.1 Sampling Regime

Where no particular sources of contamination were identified, sample locations were chosen to provide general coverage of the site.

#### 26.2 Testing

The potential for contamination was identified in the preliminary conceptual model. Therefore, the following tests were selected.

| Test Suite          | Number of Samples | Soil Tested       |
|---------------------|-------------------|-------------------|
| STC Suite 2         | 10                | TOPSOIL & SUBSOIL |
| GC Pesticide Screen | 3                 | TOPSOIL           |

The test results are presented in full in Appendix E. A summary and discussion of the significance of the results and identified contamination sources is given below.

## 26.3 Test Results and Identified Contamination Sources

### 26.3.1 General Contaminants

The results of the key contaminant tests have been analysed in accordance with the CLEA methodology. The samples have been grouped into two populations comprising Topsoil and Subsoil. For each parameter in each population the sample mean is calculated and compared to a Tier 1 screening value. If the sample mean exceeds the screening value, the soil may be regarded as contaminated and further assessment may be required. If neither the sample mean nor any single value exceeds the screening value, the soil may be regarded as not contaminated, though further confirmatory assessment may be required. Where any single parameter value exceeds the screening value but the sample mean does not, further statistical analysis may be applied to that parameter if the available data is suitable. Such analysis would include an assessment of the Normality of the distribution of the data, consideration of the presence of outliers, and the calculation of a UCL estimate of the mean.

Summary data is presented in the tables below and the laboratory analysis is included in Appendix E. The screening values and source notes are presented in Table 1 “Tier 1 Screening Values” at the front of Appendix E.

#### **Soil Type: TOPSOIL**

| Contaminants                | Units | No of Samples Tested | Range        | Sample Mean | Residential with Homegrown Produce Consumption Tier 1 Screening Values |
|-----------------------------|-------|----------------------|--------------|-------------|------------------------------------------------------------------------|
| Arsenic (As)                | mg/kg | 8                    | 8.8 – 14     | 12          | 37                                                                     |
| Cadmium (Cd)                | mg/kg | 8                    | <0.2 – 0.7   | 0.26        | 11                                                                     |
| Trivalent Chromium (CrIII)* | mg/kg | 8                    | 23 – 31      | 26          | 910                                                                    |
| Hexavalent Chromium (CrVI)  | mg/kg | 8                    | <4.0         | <4.0        | 6                                                                      |
| Lead (Pb)                   | mg/kg | 8                    | 21 – 78      | 36          | 200                                                                    |
| Mercury (Hg)                | mg/kg | 8                    | <0.3         | 0.30        | 7.6                                                                    |
| Selenium (Se)               | mg/kg | 8                    | <1.0         | 1.0         | 250                                                                    |
| Nickel (Ni)                 | mg/kg | 8                    | 14 – 21      | 18          | 130                                                                    |
| Copper (Cu)                 | mg/kg | 8                    | 19 – 77      | 29          | 2,400                                                                  |
| Zinc (Zn)                   | mg/kg | 8                    | 36 – 170     | 65          | 3,700                                                                  |
| Benzo(a)pyrene (BaP)        | mg/kg | 8                    | <0.05 – 0.36 | 0.12        | 1.7                                                                    |
| Naphthalene                 | mg/kg | 8                    | <0.05        | 0.05        | 2.3                                                                    |
| Acidity (pH values)         | pH    | 8                    | 5.9 – 7.6    | 6.8         | -                                                                      |
| Soil Organic Matter         | %     | 8                    | 1.6 – 3.1    | 2.5         | -                                                                      |

\* Assumed as Total Cr minus CrVI

The topsoil samples analysed were free from significant contamination, which concurs with the history and observations made during the investigation.

Benzo(a)pyrene is used as a surrogate marker for all genotoxic PAH's, in line with HPA guidance Ref [23]. The test data has been compared with the concentration limits reported for the Culp study, as recommended by HPA.

### **Soil Type: SUBSOIL**

| Contaminants                | Units | No of Samples Tested | Range     | Sample Mean | Residential with Homegrown Produce Consumption Tier 1 Screening Values |
|-----------------------------|-------|----------------------|-----------|-------------|------------------------------------------------------------------------|
| Arsenic (As)                | mg/kg | 2                    | 13 – 17   | 15          | 37                                                                     |
| Cadmium (Cd)                | mg/kg | 2                    | <0.2      | <0.2        | 11                                                                     |
| Trivalent Chromium (CrIII)* | mg/kg | 2                    | 27 – 36   | 32          | 910                                                                    |
| Hexavalent Chromium (CrVI)  | mg/kg | 2                    | <4.0      | <4.0        | 6                                                                      |
| Lead (Pb)                   | mg/kg | 2                    | 20 – 25   | 23          | 200                                                                    |
| Mercury (Hg)                | mg/kg | 2                    | <0.3      | <0.3        | 7.6                                                                    |
| Selenium (Se)               | mg/kg | 2                    | <1.0      | <1.0        | 250                                                                    |
| Nickel (Ni)                 | mg/kg | 2                    | 21 – 24   | 23          | 130                                                                    |
| Copper (Cu)                 | mg/kg | 2                    | 15 – 23   | 19          | 2,400                                                                  |
| Zinc (Zn)                   | mg/kg | 2                    | 45 – 59   | 52          | 3,700                                                                  |
| Benzo(a)pyrene (BaP)        | mg/kg | 2                    | <0.05     | <0.05       | 1.7                                                                    |
| Naphthalene                 | mg/kg | 2                    | <0.05     | <0.05       | 2.3                                                                    |
| Acidity (pH values)         | pH    | 2                    | 6.9 – 7.8 | 7.4         | -                                                                      |
| Soil Organic Matter         | %     | 2                    | 1.1 – 2.1 | 1.6         | -                                                                      |

\* Assumed as Total Cr minus CrVI

No significant contamination has been reported from the subsoil samples analysed. Again, this concurs with the site history, the observations made during the investigation and the results for the topsoil analysed.

Benzo(a)pyrene is used as a surrogate marker for all genotoxic PAH's, in line with HPA guidance Ref [23]. The test data has been compared with the concentration limits reported for the Culp study, as recommended by HPA.

### **26.3.2 Asbestos Containing Materials**

No asbestos containing materials were detected in the samples analysed and none were observed in the exploratory holes. However, it should be noted that the exploratory holes are of small size relative to the area investigated. Therefore, the samples obtained may not reflect the full composition of the soils on the site, and there is always the potential for pockets of asbestos or for asbestos containing materials to be present, which have not been detected in the sampling.

On an agricultural site such as this, a careful watch needs to be kept for any areas of Made Ground, where asbestos and other contaminants might be encountered.

### **26.3.3 Herbicides and Pesticides**

Three topsoil samples recovered from the exploratory holes were screened for a wide range of herbicides and pesticides. For the majority of the compounds tested, concentrations within the samples were below the laboratory limit of detection.

However, two of the three samples screened reported minor concentrations of Pendmethalin, a widely used herbicide, certainly historically. The concentration range for the three samples screened was <10 – 34µg/kg (< 0.01 – 0.03mg/kg); with the minimum detection level being 10µg/kg.

Whilst there does not appear to be a set soil screening value for Pendimethalin, an EFSA Journal on Pendimethalin (10/2903/j.efsa.2016.4420), dated March 2016, indicates an acceptable daily intake of 125µg/kg (0.125mg/kg). EPA factsheets also cite that Pendimethalin has generally been shown to have low acute toxicity in humans, is essentially immobile in soils and does not represent a high risk to other flora and fauna below the proposed screening value.

On this basis, with the highest concentration being 34µg/kg, this suggests that the Pendimethalin impact is not significant. Some further screening of the topsoil samples for Pendmethalin is, however, recommended to confirm this.

Full results of the testing for herbicides and pesticides are presented within the contamination laboratory testing results within Appendix E.

## 27 Summary of Identified Contamination

No significant contamination has been identified for the soils analysed during this investigation. Whilst not considered significant, some additional screening is recommended for Pendmethalin to confirm the low concentrations recorded to date.

## 28 Risk Evaluation

The object of the risk evaluation is to assess the pollution linkages for specific contaminant groups considered in the conceptual model, identify any unacceptable risks and, therefore establish whether there is a need for further investigation and/or remedial action.

The risks are considered in the context of the specific development proposals for the site and, therefore, the conclusions may not be appropriate for alternative schemes.

## 28.1 Revised Conceptual Model

The preliminary site model has been refined in light of the findings of this investigation and is summarised below.

| Metals | PAHs | Herbicides and Pesticides | Asbestos | Pathways                                                   | Receptors                            |
|--------|------|---------------------------|----------|------------------------------------------------------------|--------------------------------------|
| N      | N    | N                         | N        | Ingestion and inhalation of contaminated soil and dust     | Human Health                         |
| N      | N    | N                         | n/a      | Dermal contact with contaminated soil and dust             |                                      |
| N      | N    | N                         | n/a      | Inhalation of vapours or gases                             |                                      |
| N      | N    | N                         | n/a      | Uptake into edible fruit and vegetables                    |                                      |
| N      | N    | N                         | n/a      | Surface water run-off into surface water features          | Water Environment                    |
| N      | N    | N                         | n/a      | Migration through ground into surface water or groundwater |                                      |
| N      | N    | N                         | n/a      | Off-site migration of contaminated groundwater             |                                      |
| N      | N    | N                         | n/a      | Vegetation on site growing in contaminated soil            | Flora and Fauna                      |
| N      | N    | N                         | n/a      | Aquatic life in affected waters                            |                                      |
| N      | N    | N                         | n/a      | Contact with contaminated soils                            | Building materials / buried services |
| N      | n/a  | n/a                       | n/a      | Fire or explosion                                          |                                      |

Key:

Y Pollutant linkage likely

N Pollutant linkage not likely

P Pollutant linkage possible

n/a Pathway not applicable to contaminant

No relevant pollution linkages have been identified. Some additional screening for Pendmethalin is, however, recommended to confirm the low concentrations reported to date.

## 28.2 Re-use of Soils

It is anticipated that the arisings from groundworks on this site will comprise topsoil, subsoil and natural strata

Clean natural arisings from groundworks may be re-used on site without further testing, where there is a definite use for such materials, e.g. raising levels or construction of landscaping layers or bunds as set out in the approved plans for the development.

Treated contaminated soils may be reused on site under an appropriate Materials Management Plan, where certain criteria are met, in accordance with the CL:AIRE Definition of Waste Code of Practice, Ref [24].

### 28.3 Disposal of Soils

Some soils will require removal from site and disposal to suitably licensed landfills. Different guidelines and charges will apply to different waste classifications. As waste producers, the Developer holds responsibilities under the various governing regulations, particularly the Waste Duty of Care Code of Practice under the Environmental Protection Act 1990, Ref [25].

The chemical analyses appended to this report can be used to inform the initial classification of the soils as either Hazardous or Non-Hazardous, and derive the appropriate EWC code, for offsite disposal or transfer. Waste Acceptance Criteria (WAC) testing may be needed for confirmation of the material's classification, and will be required to demonstrate an inert classification.

There are strict requirements in place for the accurate description of wastes using EWC codes and, therefore, it is essential that materials that would be given different descriptions (e.g. blacktop, made ground and natural soils), as well as those with different classifications, are carefully segregated during excavation and storage on site. This will also ensure the most cost effective disposal. Mixing these materials can give rise to significant difficulties in disposal and also substantially increase costs.

Soil arisings may be transferred to other development sites under a Materials Management Plan, where certain criteria are met, in accordance with the CL:AIRE Definition of Waste Code of Practice Ref [24].

All soils leaving site will need to be pre-treated. Waste minimisation by selective excavation is a recognised form of pre-treatment.

## 29 Discussion and Conclusions

Generally the site appears free from significant contamination which given the historic use is not entirely unexpected.

Some additional screening for Pendmethalin is, however, recommended to confirm the low concentrations reported to date.

The new development will likely involve the re-use of the existing topsoil on site. It is recommended that a specialist contractor is employed to assess the physical quality of the material and provide recommendations for soil management during construction.

As with any site, areas of contamination not identified during site investigation works may come to light in the course of redevelopment. Accordingly, a discovery strategy must be in place during the redevelopment to ensure that any hitherto unknown contamination is identified and dealt with in an appropriate manner. Depending on the nature of any such contamination, it may prove necessary to reassess the remedial strategy for the site.

A formal remediation strategy and verification plan should be agreed with the regulatory authorities prior to commencement of any remedial works.

## 30 General Guidance

Allowance should be made for experienced verification of any remedial works.

It may be that specific local requirements apply to this site, of which we are not aware at this time.

In general terms, the workforce and general public should be protected from contact with contaminated material. There is a range of relevant documents published by the Health and Safety Executive, and organisations such as CIRIA, and the BRE.

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