



Outline Remedial Strategy & Implementation Plan

Pfizer
32 New Lane
Havant
PO9 2NG

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PFIZER, NEW LANE, HAVANT

NON-TECHNICAL CLIENT SUMMARY

This report provides an Outline Remedial Strategy & Implementation Plan for the Pfizer Site, New Lane, Havant. Its purpose is to provide stakeholders in the site redevelopment with information necessary to understand the proposed approach to the management of identified and potential soil contaminant conditions at the site. This document can ultimately form the basis of a report to the local planning authority (LPA) as part of the discharge of pre-commencement planning conditions regarding contaminated land. The following points regarding the site are pertinent to this document:

- The site was previously a pharmaceutical manufacturing facility. On this basis, risks were identified associated with human interaction with shallow soils, intrusion of soil gases into buildings and risks to controlled waters from site-derived contamination.
- A previous Phase I Desk Study and Phase 2 Site Investigations have identified localised soil contamination, and some low-level impacts to shallow groundwater from chlorinated solvents.
- The most recent (Jan-Mar 2021) intrusive investigation found that the shallow and deeper soils from across the site do not pose a significant risk to future site users in a commercial setting. Moreover, laboratory testing of groundwater has not identified concentrations considered to pose a risk to the groundwater body, whilst soil vapour analysis has not identified a risk associated with intrusion of organic vapours into future buildings (or neighbouring properties).
- An initial programme of ground gas monitoring has found the site to fall into Characteristic Situation 1, for which no ground gas protection measures would be required.
- Due to the presence of active pharmaceuticals storage during the recent intrusive investigations, buildings were not entered. There are thus some gaps in the coverage of the investigation, which will require investigation once access, and in some areas, demolition has been completed. This has been termed Additional Ground Investigation. From current findings, gross contamination of soils is not anticipated in the areas yet to be investigated as evidence of such would be expected to have been identified in the shallow groundwater, which it has not. However localised soil contamination can be expected and has been evidenced in ground gas analysis which indicates potential localised hot spots of volatile hydrocarbons and chlorinated solvents. In light of this, a remediation plan is required to address these hotspots along with a formalised 'discovery strategy' to apply during groundworks to identify the procedure to ensure any soil contamination is looked for, identified and managed appropriately. Once the groundworks are complete, verification that the soils left on site are suitable for the site use is required and this verification and its evidence is required to be presented in report form. The plan to collect the necessary evidence for such reporting is included in this document.

By their very nature, the above bullet points represent a simplified summary of our work and must not be relied upon to form the basis for key decisions. A full picture is provided in the following report, or alternatively give us a call and we'll talk you through it.

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The report has been written, reviewed and authorised by the persons listed above. It has also undergone EPS' quality management inspection. Should you require any further assistance regarding the information provided within the report, please do not hesitate to contact us.

The National Planning Policy Framework 2019 requires a competent person to prepare site investigation information, which is defined as a person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation. EPS considers that it fulfils these criteria and would welcome any request for staff CVs or case studies to demonstrate it.

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1 INTRODUCTION

This report provides an Outline Remedial Strategy & Implementation Plan for the Pfizer Site, 32 New Lane, Havant. Its purpose is to provide stakeholders in the site redevelopment with information necessary to understand the proposed approach to the management of identified and potential soil contaminant conditions at the site. This document can ultimately form the basis of a report to the local planning authority (LPA) as part of the discharge of pre-commencement planning conditions regarding contaminated land.

A plan showing the site location is provided as Figure 1 and a proposed development plan is included as Appendix A.

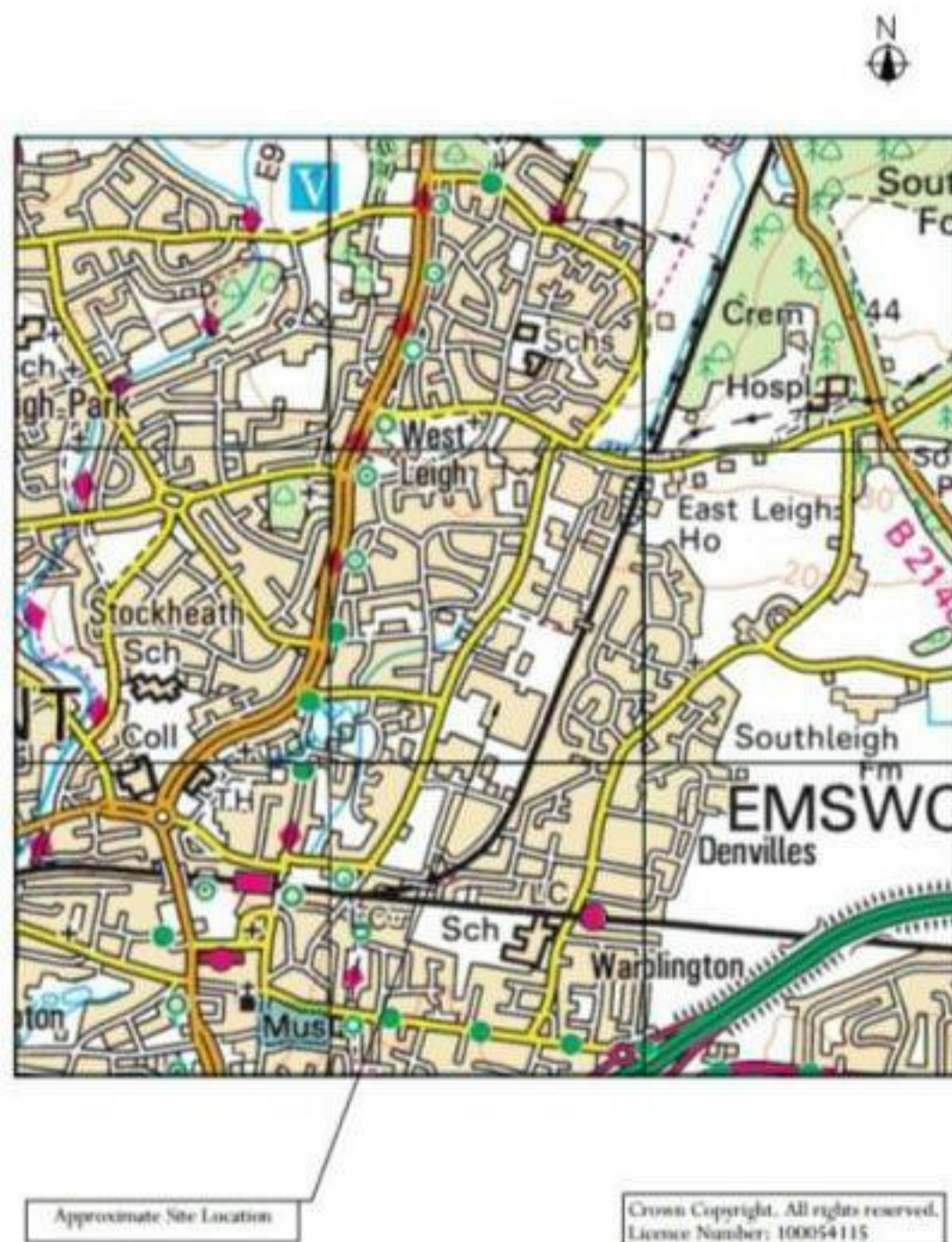


Figure 1 - Site Location

1.1 Objectives

The objective of this Outline Remedial Strategy & Implementation Plan is as follows:

- a) To outline the appropriate form(s) of remediation necessary to remove potentially unacceptable risks to receptors to ensure safe development.

1.2 Scope of Work

To prepare an Outline Remedial Strategy & Implementation Plan in accordance with the principles and requirements of the Environment Agency's *Land Contamination: Risk Management* ('LC:RM', 2020), the *National Planning Policy Framework* and DEFRA's '*Contaminated Land Statutory Guidance*', the following tasks were undertaken:

1.2.1 Remedial Strategy:

- Review of remedial objectives
- Development of a Remedial Strategy

1.2.2 Implementation of the Remedial Strategy (Implementation Plan):

- Define the process of remediation
- Present a Discovery Strategy to ensure that soil contamination is looked for, correctly identified and managed appropriately during site groundworks.
- Present a Verification Plan to determine how remediation has performed in relation to strategy.

1.3 Limitations and Constraints

The purpose of this report is to present an Outline Remedial Strategy & Implementation Plan for the site in terms of risks from contaminated land. When examining the data collected from the investigations made during the assessment, Environmental Protection Strategies Ltd (EPS) makes the following statements:

A Remedial Strategy has been presented based on the findings of an investigation carried out by EPS as well as information provided by third parties, the validity of any data others may have supplied, and which are included in the report, have been assessed as far as possible by EPS, however, EPS cannot guarantee the validity of these data.

This Remedial Strategy is based on a former intrusive investigation by EPS, included in Appendix F. No investigation method is capable of completely identifying all ground conditions that might be present in the soil or groundwater under a site. The locations of these excavations and sampling points are considered to be representative of the condition of the whole site subsurface however, ground conditions are naturally variable and it may be possible that the conditions encountered may differ to those found during the investigation.

This report does not include specific survey for the presence of either Potential Asbestos Containing Material or Japanese Knotweed at the subject site.

2 BACKGROUND & PREVIOUS REPORTS

This section provides a background and context to the site, as well as a review of the previous work undertaken.

2.1 Previous Reports

The site has been subject to previous Phase I and Phase II Geo-Environmental Assessments by EPS, it is recommended the reader reviews the following reports:

- *UK20.5052 Phase I Environmental Assessment: Pfizer, 32 New Lane, Havant, PO9 2NG (January 2021)*
- *UK20.5052C Phase II Geo-Environmental Assessment: Pfizer, 32 New Lane, Havant, PO9 2NG (March 2021)*

The previous Phase I Desk Study identified the site to comprise a pharmaceutical distribution centre, formerly used for manufacturing. On this basis, risks were identified associated with human interaction with shallow soils, intrusion of soil gases into buildings and risks to controlled waters from site-derived contamination. The Phase II Geo-Environmental Assessment is included in Appendix F.

2.2 Regulatory Feedback

Following the first issue of this report, Havant Borough Council's Environmental Health Officer (EHO) Mr Jonathan Driver provided a consultation response to planning application APP/21/00200 regarding the Phase I Environmental Assessment originally submitted. The response, dated 27th April 2021, is included in Appendix G.

In summary, the Council confirmed that the contamination assessment was accepted (i.e., the Phase I report). Other pertinent points included in the EHO response are summarised below along with detail on how EPS has taken account of them when undertaking the proposed remediation strategy:

- The EHO highlighted a need to amend the suite of conditions proposed by the Environment Agency in order to bring risks to human health into scope, and to ensure that the applicant is not unduly constrained by a strict interpretation of the provisions of the Grampian condition (EA's first proposed condition). This relates to the wording of the condition in relation to commencement, where the Council support a flexible approach as this is often an issue when undertaking contamination investigations on site's requiring clearance. EPS and the applicant welcome the Council's pragmatism in this regard.
- The broad conclusions of the Phase I report were accepted. However, the Council highlighted that off-site migration of contaminants to 'contamination sensitive' human receptors that are external to the development red-line area may also represent a significant risk driver. This is a similar point to that raised in the original pre-application response (4th August 2020, included as Appendix B of the Phase I report) and EPS therefore included these receptors in the Conceptual Site Model presented in the Phase II report.

- The EHO response (April 2021) highlighted the Section in Paragraph 7.3 of the Phase I report which suggested that sufficient information is available to 'outline' a 'remediation strategy'. The response stated they 'would challenge the 'face value' interpretation of this statement, at least in the absence of a comprehensive synopsis of available results to present a comprehensive conceptual site model which accounts for the result of investigations which had not to date been reported to the Council'. EPS consider this a reasonable point, and that statement was made largely to help inform the client. This Outline Remedial Strategy takes into account the existing Phase II report and makes allowance for the findings of the additional investigation which will be required in due course. As stated in the Phase II report (Sections 6.5 & 6.6) The contaminant linkages presented in the Conceptual Site Model require the dataset for the whole site prior to re-evaluation. Once the Conceptual Site Model is finalised, remedial requirements can be appraised and presented in a (final) strategy for review by regulators and the client. Therefore it appears that both EPS and the Council are in agreement and this point made by the EHO is again reasonable.
- The final two bullet points in the EHO response highlight the relevant gaps in the data (at that time) and the ongoing site investigation. The Phase II report should therefore address these points (subject to the necessary additional investigation). The response also highlights the possible application of statistical assessment and identification of discrete contamination sources / contamination-impacted areas. The Phase II report, and this Outline Remedial Strategy, identify specific areas of concern and contaminant sources which is considered a robust and defensible approach. However, as stated in the Phase II report (Section 3.1) *Due to the absence of a formal sampling pattern, the use of a three dimensional dataset (i.e. samples at varying depths) and targeted nature of the investigation taking into account the PAOCs, it is unlikely that any statistical analysis can be applied to the soil dataset in accordance with CL:AIRE's 2020 guidance. To generate two-tier confidence intervals representative of a dataset in accordance with this guidance, it would not have been possible to target the sampling or vary the depths at which the samples were taken without compromising the statistical assessment. EPS have followed best practice guidance as set-out in the EAs overarching Land Contamination: Risk Management guidance for scenarios such as this, where there is considerable data already provided from previous surveys, those recently undertaken and additional surveys to be carried out in due course once the buildings are demolished.*

EPS will align the additional investigation to the current statistical guidance wherever possible though (in terms of approach to sampling locations, using sampling patterns, consistent depths and sample quantities) although strict application of the guidance is still unlikely to be fully possible. EPS will collaboratively work with the Council's on the application of statistics to this dataset once it is finalised.

2.3 Identified Potential Contaminant Conditions

The EPS intrusive investigation comprised the drilling of 22 boreholes and 12 trial pits across the site in January and February 2021, with ground conditions found to comprise a moderate thickness of made ground overlying successive layers of cohesive and granular River Terrace Deposits. Below this lay London Clay, which comprised of a soft initial layer of silt overlying stiff, grey clay.

Laboratory analysis of shallow and deeper soils from across the site has not currently identified contamination capable of posing a significant risk to future site users in a commercial setting. Moreover, laboratory testing of groundwater has not identified concentrations considered to pose a risk to the groundwater body, whilst soil vapour analysis has not identified a risk associated with intrusion of organic vapours into future buildings (or neighbouring properties).

An initial programme of ground gas monitoring has found the site to fall into Characteristic Situation 1, for which no ground gas protection measures would be required.

Although significant risks have not been identified by the previous work and the site as a whole does not appear to be heavily contaminated, additional Ground Investigation of currently inaccessible areas of the site are planned prior to demolition of the existing buildings, some of which are potential contaminant source areas. Once these works are carried out, a refined Conceptual Site Model will be included in the finalised Remedial Strategy.

A plan of the site with building names is shown in Figure 2.

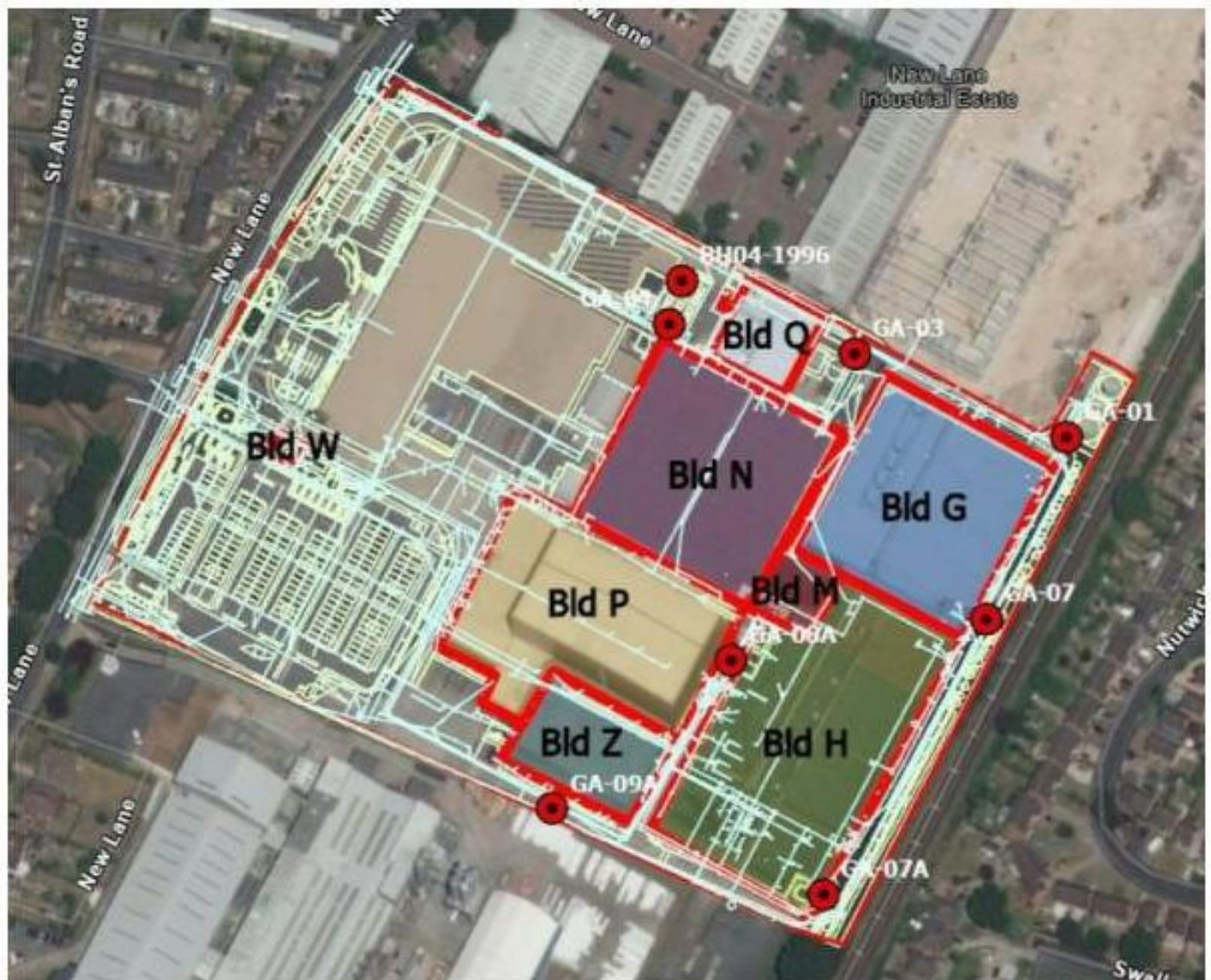


Figure 2 - A plan of the site with building names

The Areas Of Potential Concern (AOPC) for targeting this Remedial Strategy have been based on two lines of evidence:

- The locations occupied by potentially contaminating activities as shown in Figure 3 below.

- The plots of soil gas vapour for VOCs including the potential contaminants toluene and PCE shown in Figure 4.



Figure 3 - Site Plan showing the location of potentially contaminating land uses (blue arrow signifies interpreted groundwater flow direction)

These land uses are such that we consider the areas they occupied as AOPCs. They are as follows:

- Toluene and Fuel Storage Area
- Fine Chemical Mixing Unit
- Waste Storage Area
- Bulk Liquids Storage

The second data set used to identify AOPCs are the soil vapour results reported in the EPS Ground Investigation Report (UK20.5052C, included in Appendix F). The nature of soil vapour is such that it can indicate a presence of volatile contaminants either in soil or shallow groundwater in the vicinity. Such indications are useful as a single sample point can give a qualitative assessment of a larger area than a single soil sampling point. However, such interpretation needs to be done with caution, because an absence of soil vapour detections does not necessarily mean absence of contamination in the vicinity as soil vapour dispersion in the subsurface is highly dependent on many site-specific factors including soil types, stratigraphy, ground surface coverings among others. The following two Figures show interpreted soil vapour concentrations:

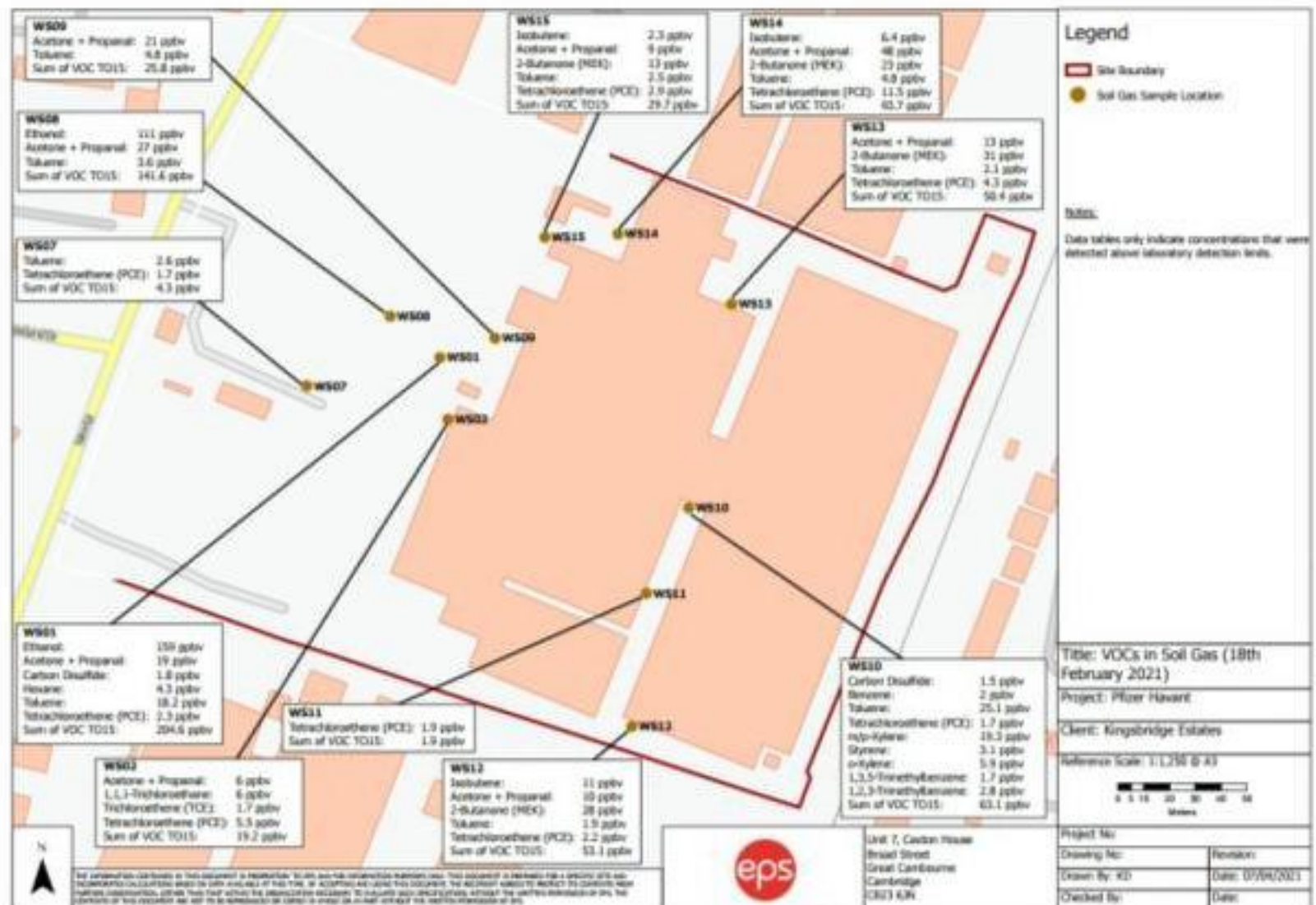


Figure 4 – Soil Gas VOC Analytical Results

The AOPCs from the soil gas review are as follows:

- Toluene and Fuel Storage Area
- Fine Chemical Mixing Unit
- Bulk Liquids Storage
- Parts of Building N and P footprints

The footprints of the combined AOPCs are shown in Figure 5 below.



Figure 5 - Location of AOPCs

3 OUTLINE REMEDIAL STRATEGY

In accordance with the Environment Agency's *Land Contamination: Risk Management*, there are three stages to managing contaminated land (Risk Assessment/Remedial Options Appraisal (Inc. Remedial Strategy)/Remediation and Verification).

The following Outline Remedial Strategy will be revised following completion of the additional Ground Investigation. The currently plausible identified contaminant linkages are limited in both the risks posed and extent, so a formal Remedial Options Appraisal has not been carried out. If more substantial contamination is encountered during the additional investigation, it may be necessary to revisit the remedial options appraisal in the final strategy.

EPS considers the following outline objectives to be appropriate for the remedial work at this site. All of these measures can be refined once further site data becomes available. This section represents the Remedial Strategy for the site.

Contaminant Linkage	Mitigation Measures
Exposure to Contaminated Shallow Soils	EPS has undertaken a generic quantitative risk assessment for commercial enduse of the site. The generic screening values can be applied to the site as re-use criteria to address the potential linkages of soil that could come into contact with site users. This includes future workers excavating for utility or drainage. These screening values (and their basis) was presented in the Phase II report and included in Appendix D. Where applicable (i.e. when using LQM's S4ULs 'Suitable For Use Levels for Human Health Risk Assessment'), criteria derived using standard sandy loam soil with 1% SOM have been adopted. If significant areas of soil contamination are identified (which is not expected) it may be appropriate to carry out a targeted quantitative risk assessment and generate Site Specific Target Levels (SSTLs). No soils containing free-phase product (i.e. Non-Aqueous Phase Liquid) will be permitted for re-use on-site, and some of the commercial generic screening values referred to in the Phase 2 report are in excess of saturation limits.
Exposure to contaminated soil around BH03	The intrusive investigation undertaken at the site identified a localised area of Phthalates (BH03). It is recommended that this material is defined once surface coverings have been removed to assess if it is part of a wider area of contamination with other contaminants associated with the former manufacturing area. Once a comprehensive dataset is available, the risk can be reviewed with the development of SSTL if necessary.
Inhalation of Asbestos	No asbestos has been detected in any soil sample from the recent investigations. Continued watching by applying the Discovery Strategy is required to confirm this absence during groundworks. If discovered, all Asbestos Containing Materials (ACMs) should be disposed of in accordance with the Control of Asbestos Regulations 2012.

Contaminant Linkage	Mitigation Measures
Ingress / Diffusion through Permeable Potable Water Supply Pipes	Currently there is not a need for this identified, however this situation should be reviewed after the Additional Ground Investigation has been completed. If required, aluminium barrier pipework meeting Water Industry Standard 4-32-19 and associated fittings should be used subject to agreement with the local water company. If other pipework is preferable, more detailed testing may be required in accordance with UK Water Industry Research Report 10/WM/03/21 - "Guidance For The Selection Of Water Supply Pipes To Be Used In Brownfield Sites" (2010).
Migration of Organic Vapour to Indoor Air	The results of investigation did not indicate that vapour membrane is required as a remedial measure. Based on the information collected to date there is no risk from carbon dioxide, methane or from the volatile soil or groundwater contaminant values detected. Soil data collected from the Additional Ground Investigation will also be assessed to confirm there is no risk. In addition, GAC values for soil will also be derived to be used as S4Uls to address any potential human health vapour linkage. These values will be used in the Discovery Strategy and will be used to assess soils left on site and reported in the Verification Report. As an additional precaution a gas membrane could be included in the building design. Any geomembrane must be installed in accordance with manufacturer's instructions by suitably qualified and experienced personnel and the installation must be verified by a third-party with integrity testing, in accordance with CIRIA 735 'Good practice on the testing and verification of protection systems for buildings against hazardous ground gases.
Soil Ingestion/ Inhalation (construction workers)	All construction workers operating at the site should be advised of the potential for contact with made ground in the subsurface at the site. Appropriate health and safety precautions should also be adopted during any excavation works to avoid exposure to contaminated soils. Reference should be made to relevant health & safety guidance including the following CIRIA document: R132 Guide to Safe Working on Contaminated Sites.

4 STAGE 3: REMEDIATION & VERIFICATION

4.1 Implementation of Remedial Strategy (Verification Plan)

To document the measures outlined in Section 3 the following details must be presented within a Verification Report for submission to Havant Borough Council on completion of the works to fully discharge likely planning condition(s) regarding contaminated land.

Specifically, the final document must contain the following details:

4.1.1 Discovery Strategy

The Discovery Strategy shall apply during all excavations of soil at the site. Its purpose is to identify potential soil contamination as it is exposed such that it can be contained, exposure of people or the environment prevented, and correct characterisation undertaken so that it can then be managed appropriately, either as suitable material for re-use on site or for correct disposal or treatment. The Discovery Strategy is summarised in the flow chart presented in Appendix C. The Discovery Strategy requires the advice of an expert oversight of soil excavations at the site. This is provided by a suitably qualified environmental consultant or contractor attending site either full time or as appropriate to observe soils exposed during the groundworks.

4.1.2 Delineation of Known and Potential Contamination around BH03 and AOPC 1

- Shallow made ground material (up to 2m) around BH03 should be delineated with trial pits, and also extending across AOPC 1. Sufficient soil sampling is to be undertaken to delineate possible contaminant hot spots.
- Once delineated, soils above Soil Re-use Levels are to be excavated and disposed of.
- Photographic evidence showing the removal of soils around BH03 and AOPC 1 should be taken.
- Validation sampling confirming effective removal of phthalate contamination from around BH03 and AOPC 1 should be completed.

4.1.3 Delineation of soils in AOPC 2 and AOPC 3 together with Discovery Strategy

- Any clearly visually impacted soils, (displaying dark staining and odour) present within the excavations should be removed and sent to a quarantine area pending characterisation through laboratory analysis. Visually impacted soils should be excavated until un-impacted material is encountered with on-site field screening procedures. These will include visual and olfactory screening as well as discrete soil sample testing using a photo-ionisation detector (PID) calibrated to a standard gas, which will be subsequently verified through soil sampling of the sides and bases of each excavation (EPS method statements will be made available upon request for PID testing). Anticipated sampling would comprise up to 5 No samples for TPH, SVOC, total and free cyanide and BTEX analysis from the excavation.
- Any impacted excavated soils, that have been moved to the quarantine area, that prove to exceed the re-use criteria, should be removed off-site for disposal at a suitably licensed facility or treated such that the contaminant levels are reduced sufficiently.

- If excavated soil volumes associated with the approach outlined above are likely to reach levels where the remedial approach could become unsustainable, then further assessment will be made and an appropriate way forward developed through consultation with the project team and relevant regulators. Reference will be made to sustainable remediation guidance prepared by the Sustainable Remediation Forum UK. (SURF UK)

4.1.4 Contaminant Permeation through Drinking Water Supply

The requirement for water supply pipework with a barrier will be assessed after the Additional Ground Investigation has been completed. If it was required, the following evidence would be incorporated in the Verification Report.

- Delivery notes, confirming supply of aluminium pipework for drinking water supply in the western part of the site.
- Photographic evidence showing their installation.

4.1.5 Soil Gas Protection

There is no requirement identified for soil gas protection measures, however if such measures were to be incorporated as a precaution, the following information would be required in the Verification Report.

- Details of soil gas membrane installation, including third party Verification Report documenting the installation, with product specification sheets and independent integrity testing of the membrane conducted in accordance with CIRIA C735. The geomembrane must be resistant to both ground gases and VOCs. A suitable product sheet will be included in the final Remedial Strategy.

4.1.6 Waste Management

The following waste records and management procedures must be recorded within the Verification Report.

- Waste transfer documentation, including for soils and ACMs must be retained by the applicant (or waste producer). All ACMs must be handled and disposed of in accordance with the Control of Asbestos Regulations 2012. If this process is mis-managed it may result in the deposition of loose ACM fragments across the site, which will render soils unsuitable for retention on site and potentially cause significantly higher waste disposal costs.

4.1.7 Materials Management Planning

If any excavated soils are to be re-incorporated into the site during the groundworks through cut and fill operations, or where unsuitable soils are treated on site and then re-used after treatment and verification to fill voids, then a Materials Management plan (MMP) will be required. A MMP provides a route to re-use soils on site and avoids the initially excavated soils being classified as waste. The protocol for materials management planning falls under the Environment Agency's Definition of Waste: Code of Practice (DoW:CoP) administered by CL:AIRE. A MMP must be produced and approved by a Qualified Person prior to groundworks commencing. On completion, the evidence of compliance with the DoW:CoP requirements must be included within the site Verification Report.

4.2 Additional Requirements

4.2.1 *Imported topsoil*

It is expected that some soils are likely to be imported onto the site to form a growing medium. These soils won't comprise a formal remedial measure as no significant contamination requiring remediation was found. However, in order to ensure that the soils brought onto the site are suitable for use it is recommended that they are obtained from a known and reliable source and supplied with appropriate and relevant quality certification. To manage the suitability of the material it is recommended that EPS' top soil checklist is used as a method of verification. The top soil checklist is included within Appendix C.

4.2.2 *Groundwater Monitoring*

To date groundwater beneath the site has been largely found free of significant contamination. However, it is considered good practice to complete a groundwater monitoring round of selected wells during and after the groundworks at the site to confirm the works have not had a detrimental effect on groundwater conditions and to thus close out any future concerns of groundwater contamination from the site.

Suitable wells can be selected in light of the findings of the Additional Ground Investigation across the identified AOPCs. It is anticipated that this groundwater monitoring and sampling programme would include 4 wells, one of which would be BH03.

It is recommended that the groundwater monitoring programme will include monitoring and sampling visits at approximately 12 weekly intervals, aimed to cover the period of ground works, and then finally at 12 weeks after the groundworks are completed.

4.2.3 *Discovery Strategy Implementation & Overwatch*

It is recommended that a suitably qualified environmental consultant is engaged to operate the Discovery Strategy during the site groundworks as outlined above to provide expert overwatch and to ensure that appropriate actions are taken. A method statement for action to be taken in the event of discovering unexpected contamination is included with this document as Appendix E. If the contamination relates to asbestos, reference should also be made to a Working Method which the environmental consultant must provide to support site-specific health & safety risk assessments and method statements.

APPENDICES

APPENDIX A

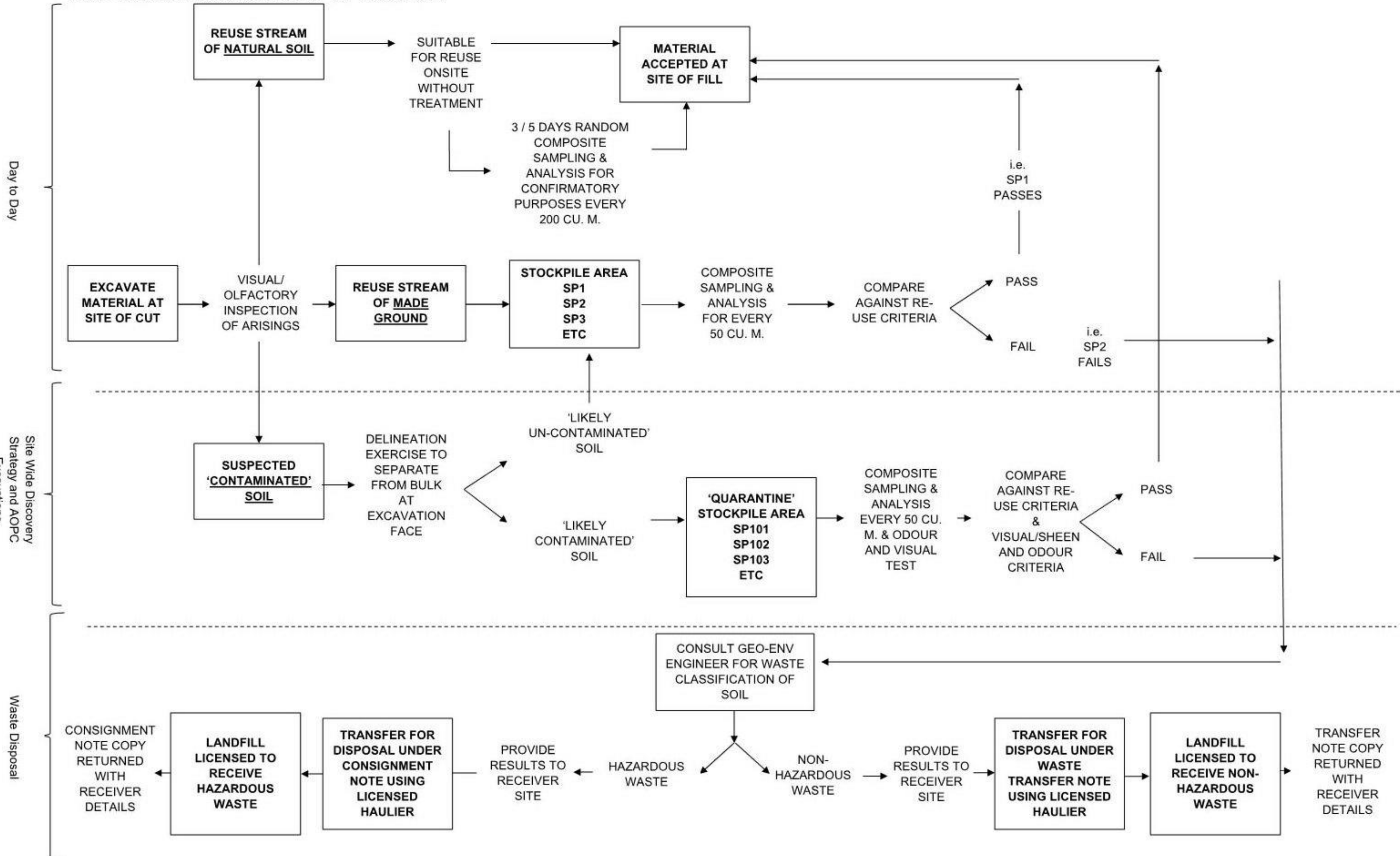
Proposed Development Plan

APPENDIX B

Discovery Strategy Flow Chart

Discovery Strategy Schematic Flowchart Demonstrating Material Management (V2)
 Process for Managing Soil Chemical Contamination – Pfizer Site, 32 New Lane, Havant

MATERIALS MANAGEMENT APPROACH



APPENDIX C

Imported Soils Checklist



Pre-Verification Cover System Checklist		Yes?
Soil Source	The soil must not be a waste. Please confirm that the soil is not a waste and has never been deemed as such in the past.	
	Has the source of the soil been provided?	
	Have all the delivery notes confirming the source, volume and type of soil been provided for all that is to be used?	
Soil Quality	The soils are free of invasive plant species such as Japanese Knotweed, and have not been sourced from an affected area?	
	Do the soils look clean and of a high quality? I.e. the soil must not have an odour or contain any visual evidence of contamination, including oils, asbestos, glass, plastic, rubble, metal, ash, tarmac/bitumen?	
	Testing to 'BS 3882:2015 <i>Specification for topsoil and requirements for use</i> ' is preferable but generally not essential for public health regulation, provided you can confirm the soils comply with the above points, are suitable for their intended purpose and will provide an adequate growing medium?	
	Has the soil been chemically tested prior to it arriving at site? Any soil test results presented to EPS by a third party must be current and clearly relate to the soil used, i.e. the testing must generally be dated within 6 weeks of delivery. The quantity of testing will be dependent on how much confidence is generated in the quality of the material, as well any specific local regulatory requirements. If the soil is clean soil from an established source such as British Sugar, the testing they provide at source may be sufficient alone. For other soils, EPS can advise on the likely testing frequencies but as a rule of thumb, anticipate at least one sample per plot. The testing would usually comprise the following: Heavy Metals, Poly Aromatic Hydrocarbons, Asbestos and Total Petroleum Hydrocarbons at an accredited lab. If adequate testing has not been completed, then EPS will need to test it from stockpiles prior to installation.	
Cover Thickness	Are all excavations ready which will allow the necessary thickness of cover soils to be installed?	
	If yes, can you provide waste transfer documentation for any excavated soils?	

APPENDIX D

Proposed Soil Suitable for Use Levels



EPS Generic Quantitative Risk Assessment

Generic Screening Criteria (C4SLs) - All Land Uses

	Soil Targets					
Contaminant	Residential		Allotments	Commercial	Public Open Spaces	
	With Home Grown Produce	Without Home Grown Produce			Residential	Parks
Unit	mg/kg					
Arsenic	37	40	49	640	79	168
Benzene	0.87	3.3	0.18	98	140	230
Benzo(a)pyrene	5	5.3	5.7	76	10	21
Cadmium	26	149	4.9	410	220	880
Chromium (VI)	21	21	170	49	23	250
Lead	200	310	80	2330	630	1300

Notes:

Targets for Human Health have been taken from the publicly available Category 4 Screening Levels (C4SLs) for assessment of land affected by contamination issued by DEFRA in December 2013.

Within the modelling for C4SLs, a Soil Organic Matter content of 6% has been used. Reference to site-specific data should be made where possible. EPS have carried out a sensitivity analysis in-house and the contaminant benzene is the current C4SL most susceptible to changes in SOM and therefore any risk assessment for this compound must account for this aspect.

EPS Generic Quantitative Risk Assessment - Commercial Landuse

Contaminant	Soil Targets			Groundwater Targets	
	Human Health	Controlled Waters		Controlled Waters	
		LGwRP	HGwRP	LGwRP	HGwRP
Unit	mg/kg			ug/l	
Arsenic	See C4SL	n/c	n/c	50	10
Cadmium	See C4SL	n/c	n/c	5	5
Chromium III	8600	n/c	n/c	250	50
Chromium VI	See C4SL	n/c	n/c	n/c	n/c
Copper	68000	n/c	n/c	28	28
Mercury (elemental)	58	n/c	n/c	1	1
Nickel	980	n/c	n/c	200	50
Lead	See C4SL	n/c	n/c	250	10
Selenium	12000	n/c	n/c	10	10
Zinc	730000	n/c	n/c	500	500
Benzene	See C4SL	0.252	0.008	30	1
Toluene	56000* (869)	1.17	1.17	50	50
Ethylbenzene	5700* (518)	15.0	10.0	300	200
Xylene (Para)	5900** (576)	0.885	0.885	30	30
MTBE#	7900	0.138	0.0276	75	15
Benzo(a)Pyrene	see C4SL	10	1.44	0.7	0.1
Naphthalene	190** (76.4)	0.934	0.02	10	0.1
Dibenz(ah)anthracene	3.5	n/c	n/c	n/c	n/c
Aliphatic C5-C6	3200** (304)	5.27	1.05	50	10
Aliphatic C6-C8	7800** (144)	23.2	4.64	50	10
Aliphatic C8-C10	2000** (78)	175	35.1	50	10
Aliphatic C10-C12	9700** (48)	1380	276	50	10
Aliphatic C12-C16	59000** (24)	27500	5490	50	10
Aliphatic C16-C35	1600000	3.46E+06	6.91E+05	50	10
Aromatic C8-C10	3500* (613)	8.74	1.75	50	10
Aromatic C10-C12	16000** (364)	13.8	2.76	50	10
Aromatic C12-C16	36000** (169)	27.5	5.5	50	10
Aromatic C16-C21	28000	86.9	17.4	50	10
Aromatic C21-C35	28000	690	138	50	10

Notes:

LGwRP - Low Groundwater Resource Potential

HGwRP - High Groundwater Resource Potential

* = S4UL exceeds vapour saturation limit (in brackets)

** = S4UL exceeds solubility saturation limit (in brackets)

Soil Targets

Targets for Human Health have been taken from S4ULs 'Suitable For Use Levels for Human Health Risk Assessment' – LQM and CIEH (2014) derived using standard sandy loam soil with 1% SOM, except (#) = EIC/AGS/CL/AIRE GAC 'Soil Generic Assessment Criteria' (2010). For sites where ground conditions differ significantly from sandy loam or site-specific SOM and pH are available, the generic human health targets may be revised.

Targets for Controlled waters have been derived using EA Remedial Targets Worksheet (v3.1) - using standard Sandy Loam ground conditions as described in Science Report SC050021/SR3, assuming no degradation for a 10m compliance distance with criteria of EQS or UKDWS for LGwRP and HGwRP respectively (see notes for GW targets).

Groundwater Targets

For LGwRP, targets have been taken as Freshwater EQS where available. For Ethylbenzene and BaP the WHO Health limit has been used and for MTBE and individual TPH fractions a 5 times multiplier of taste threshold and UKDWS has been taken respectively.

For HGwRP, targets have been taken as UKDWS where available, with the exception of Copper and Zinc where the EQS is lower than the DWS and therefore the EQS has been used as the groundwater target. For Ethylbenzene the upper WHO ATO limit has been used. For Toluene and Xylene, the WHO ATO limit is higher than the EQS and so the lower value has been taken. For MTBE the taste threshold has been taken.

Work carried out to calculate screening criteria for contamination in groundwater with respect of risks to Human Health has generally found that criteria far exceed (by at least 2 orders of magnitude) those listed for the protection of either LGwRP and HGwRP receptors. On this basis, the above groundwater criteria are also considered protective of human health and further evaluation of these risks should be considered alongside any detailed quantitative risk assessments carried out for groundwater on a site specific basis.

APPENDIX E

Method Statement for Unexpected Contamination



METHOD STATEMENT

ACTIONS TO BE TAKEN IN THE EVENT OF DISCOVERING UNEXPECTED CONTAMINATION DURING INTRUSIVE GROUNDWORKS

If at any point during intrusive groundworks at a site, evidence of unforeseen contamination is encountered in the form of significant noxious odours, discolouration, or instability within soils or sheen/ discolouration in groundwater, the following actions will be taken:

- Intrusive works in the immediate area of the impacted ground will be suspended and the continuation of work in other areas of the site will be considered within the context of the site specific health & safety plan.
- Environmental Protection Strategies Ltd (EPS) will be contacted and appraised of the situation so that arrangements can be made to characterise the impact and determine what action may be necessary in addition to the scheduled site works. Where possible / health & safety plan permits, digital photographs of the impacted ground will be taken and emailed to EPS at the address below to assist in the initial assessment
- It may well be necessary for EPS to attend site to undertake visual inspection and obtain samples for field and/or laboratory analysis, although the actions taken will be dependent on the nature of what is encountered
- In cases where EPS consider the unforeseen contamination likely to pose a significant risk of significant harm to adjacent site users or local environmental receptors, the local authority and the Environment Agency will be informed of the situation and the actions being taken
- Once appropriate action has been agreed and undertaken, a written summary will be produced by EPS for submission to the Local Authority, (and where relevant, the Environment Agency) in accordance with planning requirements. The submission will include details of work undertaken, analytical results of investigative and validation samples obtained and conclusions and recommendations for any further actions considered necessary
- Where regulatory bodies have been involved, site works should only recommence following their agreement and in all cases should only recommence when the site manager considers it safe to do so within the context of the site specific health & safety plan.

EPS Contact Details:

Marcus Bell	Associate Director	Tel: 0787 206 9979
Will Evans	Director	Tel: 0781 253 9655
Steve Bullock	Director	Tel: 0786 694 9221

Email: info@epstrategies.co.uk (Automatically forwarded to the above and office-based personnel)

APPENDIX F

Phase II Geo-Environmental Assessment (EPS, 2021)

PFIZER, 32 NEW LANE, HAVANT

NON-TECHNICAL CLIENT SUMMARY

This report presents the findings of a Phase II Intrusive Investigation undertaken to determine ground conditions, establish if there are any environmental risks associated with the site and its development and provide a geotechnical appraisal. Pertinent findings and conclusions may be summarised as follows:

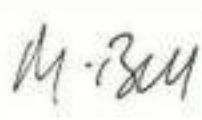
- The previous Phase I Desk Study identified the site to comprise a pharmaceutical distribution centre, formerly used as for manufacturing. On this basis, risks were identified associated with human interaction with shallow soils, intrusion of soil gases into buildings and risks to controlled waters from site-derived contamination.
- This intrusive investigation comprised the drilling of 22 boreholes and 12 trial pits across the site, with ground conditions found to comprise a moderate thickness of made ground overlying successive layers of cohesive and granular River Terrace Deposits. Below this lay London Clay, which comprised of a soft initial layer of silt overlying stiff, grey clay.
- Laboratory analysis of shallow and deeper soils from across the site has not currently identified contamination capable of posing a significant risk to future site users in a commercial setting. Moreover, laboratory testing of groundwater has not identified concentrations considered to pose a risk to the groundwater body, whilst soil vapour analysis has not identified a risk associated with intrusion of organic vapours into future buildings (or neighbouring properties).
- An initial programme of ground gas monitoring has found the site to fall into Characteristic Situation 1, for which no ground gas protection measures would be required.
- Although significant risks have not been identified by this work and the site as a whole does not appear to be heavily contaminated, further investigation of currently inaccessible areas of the site are planned subsequent to demolition of the existing buildings, some of which are key contaminant source areas. Once these works are carried out, a final Conceptual Site Model and if necessary, Remedial Strategy will be prepared to safely redevelop the site.

ENGINEERING SUMMARY

- The ground condition may be suitable for the use of conventional spread foundations with a bearing capacity of between 95kN/ m² and 125kN/ m² depending on depth and nature, although if structural loads exceed these capacities, then a deep foundation solution, such as piles may need to be considered.
- Suspended ground floor construction or an appropriately re-engineered fill beneath ground bearing floor slabs is recommended.
- Soakaway testing has identified the shallow ground conditions to be variable in permeability, although testing in the granular superficial deposits found high infiltration rates that may be suitable for infiltration drainage. However, due to the generally shallow groundwater found across the site, further targeted testing is recommended to identify an appropriate location and depth.
- A design sulphate class of DS-1 is considered suitable for concrete in direct contact with Made Ground and the superficial River Terrace Deposits at the site, with an aggressive chemical environment for concrete (ACEC) of AC-1. However, the underlying London Clay should be classified as DS3 (AC-3).

The above points represent a simplified summary of the findings of this assessment and must not form the basis for key decisions for the proposed development. A thorough review of the details is contained within the following report, or alternatively get in touch and we'll talk you through it.

Project Reference:	UK20.5052b	
Title:	Phase II Geo-Environmental Assessment – Pfizer, 32 New Lane, Havant	
Client:	ATG Services (England) Ltd	
Date:	24 th March 2021	
EPS Contact Details:	7B Caxton House Broad Street Cambourne Cambridge CB23 6JN	T: 01954 710666 F: 01954 710677 E: info@epstrategies.co.uk W: www.epstrategies.co.uk
Status:	Issue 1	

Author:	Reviewed:	Authorised:
	 	
Michael Judson	Marcus Bell	Steve Bullock
Senior Consultant	Associate Director	Director

This report has been prepared for the client(s) listed on the report title page. EPS accepts no liability or responsibility for use of, or reliance upon, this report and / or the information contained within it by third parties.

If third parties have been contracted / consulted during compilation of this report, the validity of any data they may have supplied, and which are included in the report, have been assessed as far as possible by EPS however, EPS cannot guarantee the validity of these data.

No part of this report, or references to it, may be included in published documents of any kind without approval from EPS. This report and its contents, together with any supporting correspondence or other documentation, remain the property of Environmental Protection Strategies Ltd until paid for in full.

Where ground investigations have been conducted, these have been limited to the level of detail required for the site in order to achieve the objectives of the investigation.

The report has been written, reviewed and authorised by the persons listed above. It has also undergone EPS' quality management inspection. Should you require any further assistance regarding the information provided within the report, please do not hesitate to contact us.

The National Planning Policy Framework 2019 requires a competent person to prepare site investigation information, which is defined as a person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation. EPS considers that it fulfils these criteria and would welcome any request for staff CVs or case studies to demonstrate it.

As stated within DEFRA's Contaminated Land Statutory Guidance (2012), with any complex risk assessment it is possible that different suitably qualified people may reach slightly different conclusions when interpreting the same information. EPS recognises this and considers the conclusions presented within this report to be robust and appropriate but input from the Local Authority and their judgement in line with this guidance would still be welcomed.

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1 INTRODUCTION

In January 2021, Environmental Protection Strategies Ltd (EPS) was commissioned by ATG Services (England) Ltd to complete a Phase II Geo-Environmental Assessment Report at Pfizer, 32 New Lane, Havant PO9 2NG ('the site'); see Figure 1. Selected site photographs are included as Appendix A and a Detailed Site Layout is included in Appendix B.

The work was commissioned in order to partially fulfil pre-commencement requirements relating to contaminated land for the demolition of the existing buildings and construction of a new commercial warehouse building (Havant Borough Council ref APP/ 21/ 00200). A proposed development plan is included as Appendix C.

An initial desk-based report, reference Phase I Environmental Assessment – 32 New Lane, Havant (Issue 4) – January 2021 (Reference: UK20.5052), was previously undertaken for the site by EPS in January 2021 (Issue 4), a summary of which is provided in Section 2. It is recommended that the previous report is reviewed before the reader examines the content of this document.

This current report presents the findings, conclusions, and recommendations of the Phase II Intrusive Investigation undertaken as instructed.

This report has been prepared and checked for quality under the National Quality Mark Scheme for Land Contamination Management (NQMS). This is a scheme developed by the National Brownfield Forum to provide visible identification of documents that have been checked for quality by a Suitably Qualified and experienced Person (SQP). The NQMS declaration is included as Appendix D.

1.1 Objectives

The objectives of this investigation were as follows:

- a) Investigate potential contaminant linkages identified in the Conceptual Site Model (CSM) by means of investigating shallow soils, groundwater and soil gases.
- b) Determine the potential risks posed by the site and make recommendations for further work that may be required, to ensure safe development in accordance with the Environment Agency's Land Contamination: Risk Management guidance (LC:RM, 2020) and the National Planning Policy Framework.
- c) Collect information on ground conditions and strength in order to make appropriate recommendations for geotechnical design.
- d) Undertake soakaway testing in order to assess the infiltration characteristics of the site and make recommendations for appropriate drainage design.
- e) Perform a preliminary Unexploded Ordnance (UXO) risk assessment.

1.2 Scope of Work

To perform an exploratory assessment of the site in accordance with the principles and requirements of DEFRA's 'Contaminated Land Statutory Guidance' (2012), BS10175 – 'Investigation of Potentially Contaminated Sites', BS5930:2015 'Code of practice for ground investigations' and BS EN 1997 'Geotechnical Design', the following tasks were undertaken:

Intrusive Investigation:

- Site walkover, inspection of any visual evidence of contamination at the site, obtaining photographic records.
- Health and safety briefing / site supervision.
- Drilling of 11 boreholes to depths of between 12.0m and 20.0m using a cable percussive drilling rig.
- Installation of groundwater monitoring wells within seven of the deep boreholes.
- Drilling of 11 window sample boreholes to a depth of 1.8m below ground level (bgl) using a track-mounted percussive rig.
- Installation of gas/ vapour monitoring wells within all window sampler boreholes.
- Excavation of 12 trial pits using a mechanical excavator.
- Soakaway testing at three locations.
- Continual logging of ground conditions including inspection of samples for visual and olfactory contamination, and laboratory analysis of selected representative soil samples.
- In-situ testing using a photo-ionisation detector (PID).
- One return groundwater monitoring visit and collection of groundwater samples for laboratory analysis.
- One return gas/ vapour monitoring visit using summa canisters and three additional gas monitoring visits using a GFM Gas Analyser and PID.

Reporting:

- Data collection
- Interpretation of data including completion of a Generic and Detailed Quantitative Risk Assessment

The findings and conclusions of these investigations are presented in the following sections. It should be noted that further investigations are intended once the existing buildings have been vacated and demolished.

1.3 Limitations and Constraints

The purpose of this report is to present the findings of a soil sampling investigation conducted at the location(s) specified. When examining the data collected from the investigations made during the assessment, Environmental Protection Strategies Ltd (EPS) makes the following statements:

No investigation method is capable of completely identifying all ground conditions that might be present in the soil or groundwater under a site. Where outlined in our report, we have examined the ground beneath a site by constructing a number of boreholes and / or trial pits to recover soil and / or groundwater samples. The locations of these excavations and sampling points are considered to be representative of the condition of the whole site subsurface however, ground conditions are naturally variable and it may be possible that the conditions encountered may differ to those found during the investigation.

No visible evidence of Japanese Knotweed was identified during the site walkover. However, this plant can be difficult to identify in the early stages of growth and therefore it is not always possible to identify its' presence at certain times of the year. For this reason, EPS cannot confirm that Japanese Knotweed rhizomes do not exist and it is recommended that if it is suspected that this species, or other similarly invasive plants are present at the site, a specialist contractor should be commissioned to make a detailed assessment.

The investigation was carried out to assess the significance of contamination resulting from the use of the site as identified in this report. Unless EPS has otherwise indicated, no assessment of potential impact of any other previous uses has been made.

2 SITE CHARACTERISATION

The following section provides a summary of the information collected for the previous Phase I Environmental Assessment completed by EPS in January 2021 in relation to the site location and geo-environmental context. The previous assessment was desk-based and has been supplemented by EPS as needed as part of the current phase of works. It should be noted that the previous report included a 'limb' of the site extending to the north, known as the 'North Site Distribution Warehouse'. This part of the site is no longer included in the redline boundary.

2.1 Site Location & Description

Detail	Description
Location	The site is located adjacent to the east of New Lane, in northeast Havant, Hampshire.
National Grid Reference	472540, 107180
Topography	The site area is flat, situated at around 15m Above Ordnance Datum (AOD).
Site Description	The property is an industrial facility covering around 66,000 square metres (6.6ha), of which around 28,000 square metres has been developed as buildings. A number of separate buildings lie within the site as detailed in Section 2.3. Currently the pharmaceutical operations undertaken on site involves repackaging injectables for onward supply, but manufacturing has taken place in the past. The site is predominantly surfaced with hardstanding, although a large, gravelled area is located towards the northwest. Vegetation is mostly limited to semi-mature to mature trees along the site boundaries.
Surrounding Land Use	The site lies in a predominantly urban area, with industrial facilities, a business centre and commercial outlets to the north and a site occupied by Sumika Polymers Ltd (a plastics extruding operation), and Kenwood UK south of the property, bound by a railway line to the east. Residential areas are located to the immediate west of the site along New Lane and to the east beyond the railway line.

A plan showing the site location is provided as Figure 1.

2.2 Geo-Environmental Setting

Detail	Description
Geology	Geological maps of the area suggest the natural ground conditions are likely to comprise superficial deposits covering the majority of the site, which are described as glacial / postglacial undifferentiated river terrace gravels. These comprise sands, silts and clays, with the exception of the western edge of the site where clay and gravels are present, referred to as Head (deposits). Bedrock below the superficial deposits is shown as the London Clay Formation.
Hydrogeology	Groundwater vulnerability maps for the area show that the superficial deposits are classified as a Secondary A Aquifer, whilst the underlying bedrock is classified as an Unproductive Strata. The site lies within an Inner Source Protection Zone (SPZ), designated as Zone 1c by the EA, covering sub-surface activity only (i.e. the groundwater is abstracted at depth from beneath the overlying confining low permeability London Clay). In previous work, Golder Associates inferred a groundwater flow direction from north to south and found that rest levels within 3m of the surface (around 12m AOD).
Hydrology	The nearest surface watercourse is the River Lavant, a watercourse which lies around 75m west of the site beyond New Lane. The watercourse flows in a roughly southerly direction, ultimately discharging into Langstone Harbour.
Landfill & Waste	No active or historic landfills are recorded within 1km.
Licensed Industrial Activities	The site formerly held an authorisation under the Integrated Pollution Control (IPC) regulations, licensed to Wyeth Research (UK) Ltd and to John Wyeth and Brother Ltd, for the manufacture and use of organic chemicals within the chemical industry. These authorisations have since been revoked. The site holds authorisations granted by the Environment Agency for various waste management activities on site, both as a Licensed Waste Management Facility and a Registered Waste Transfer site. These authorisations relate to the generation, storage and transfer of pharmaceutical-type wastes from primary site operations. EPS are not aware of any licensed radioactive sources that have been utilised at the site, and none are listed in the Envirocheck. Sumika Polymer Compounds UK Ltd, located just to the south hold a permit for the use of inorganic chemicals, including use of antimony.

Detail	Description
Summary of Site History	The site is located in the northern area of Havant and comprised undeveloped agricultural land from the mid to late nineteenth century until the post WW2 period. The main site was purchased in 1956 and was developed for pharmaceutical purposes in phases. In 1985 the northern distribution area (largely outside of current redline boundary) was purchased from Goodmans Loudspeakers. By the early 1950s, the central area was being used as allotment gardens with the remainder being undeveloped. In the following decade, the site underwent the first built development and by 1960, a factory building had been established in the north-western part, covering approximately 25% of the total site. Further expansion of the site was undertaken in the south-western and north-eastern areas of the site during the late 1960s and 1970s. By the early 1980s, the site comprised 5 large factory buildings and 6 smaller buildings throughout the property. Historical, 'tanks' are shown on the south west, centre north and the north east of the site around this time. By the early 1990s, further integration of the factory buildings had been carried out and much of the site was fully utilised. The configuration comprised rectangular buildings and a general absence of stand-alone structures such as tanks and storage vessels. Some demolition/ clearance of buildings has occurred in recent times as described in Section 2.3. The 2020 Ordnance Survey map shows the north-eastern and western areas to be site clear of buildings. In recent years, site activities have involved the repackaging of medical injectable products into dispensable units. Materials are imported into site in bulk quantities and no manufacturing of product is undertaken. Operations in the past did include primary and secondary manufacturing and of note in this respect, pharmaceutical operations began on site in around 1956/ 1957, a small fine chemicals manufacturing unit (FCMU) was established in 1961, and by 1992, a solvent recovery plan was installed at the site.

Detail	Description
Previous Site Assessment	Pfizer commissioned a report to reference their exit from the site from Golder Associates (UK) Ltd, entitled 'Divestiture Environmental Site Assessment' dated 26th September 2019. The 2019 Golder report covers a review of previous environmental investigations and works conducted at the site by another consultant, ERM, in 1999 and 2008, though does not include these original reports. The Golder report, however, provides an overview of the basis and detail of these investigations, and the primary conclusions of this review are as follows: • An investigation was carried out in the late 1990s in relation to the loss of solvents and effluent containing solvents (including chlorinated solvents) in the north eastern area of the site and around the FCMU. Following investigation and analysis of sub-surface (soils and groundwater) by ERM, although parts of the site had become contaminated from materials sourced in this area, the overall impact of the solvents was considered to be limited. Phenol, acetone and isopropanol were also detected in groundwater around the FCMU. Around 30 cubic metres of impacted soils were excavated along with the solvent area drainage channel and sump from this part of the site in 1999. ERM indicated that a former solvent store may have also existed near to their BH1, in the north eastern corner of the main site. Publicly available aerial imagery from 1999 (Google Earth™, 2021) shows earthworks underway in this area of the site, possibly associated with the remedial works. • An investigation was carried out in 2008 in the area of the current Biotech Packaging Facility (BPF) prior to the demolition of the former tabletting and dispensary buildings. Although parts of the site had become contaminated from materials sourced in this area, ERM concluded that there was no significant impact of site-derived contamination on the underlying sub-surface conditions and no remedial works were warranted. • An investigation was carried out in 2009 close to the former wastewater sumps prior to the site's connection to the foul sewer network. Although parts of the site had become contaminated from materials sourced in this area possibly associated with damaged drainage, ERM concluded that there was no significant impact of site-derived contamination on the underlying sub-surface conditions and no remedial works were warranted.

Detail	Description
Golder Groundwater Investigation & DQRA (2020)	In addition to the 2019 Golder report, EPS have also been provided with a Groundwater Investigation (ref 20137712.600/ A.0, February 2020) and Detailed Quantitative Risk Assessment (DQRA) for Controlled Waters (ref 20137712.602/ A.0, March 2020), with the key points summarised below: • Golder installed eight groundwater monitoring wells to sample groundwater through late 2019 into 2020. The well positions were based on previously recorded contamination down-gradient positions, as well as utilising a pre-existing well. • The historical well (BH4-1996) initially reported the chlorinated solvents TCE and PCE above screening criteria in 2019, but concentrations were markedly lower in the subsequent 2020 samples. ERM's boreholes BH1, BH3 and BH4 also identified chlorinated solvents when sampled in the past (in 1996). BH4-1996 was located in the central northern area, near the solvent warehouse, with GA04 nearby. GA07 was located on the eastern boundary outside Building G. • Vinyl Chloride (a daughter product of TCE and PCE) was reported above the screening criteria in GA04, and TCE in GA07. No other CoCs were detected in Golder's wells and they concluded a significant decrease compared to historical results. They also stated that based on observations made during drilling, the water table aquifer consists of a generally clayey material and migration is not a significant concern. The concentrations were not found to be widespread and appeared to be confined within the property boundary. • Acetone, Isopropanol and Phenol previously detected on the site, were not picked up by Golder's in 2019/ 2020. • The subsequent DQRA focussed on shallow chlorinated solvent concentrations and concluded that based on a 50m compliance point, the calculated contaminated concentrations would be significantly lower than comparison values protective of controlled waters. On that basis, no unacceptable risks were identified. EPS understands that there are other reports pertaining to the site in addition to those referenced above prepared by ERM. As with the ERM reports, these have not been seen or reviewed by EPS.

Detail	Description
Select Planning History	A review of Havant Borough Council's planning portal includes the following relevant records with regards to potential contamination at the site: 1) 91/ 52191/ 006 Extension to canopy on sheltered drum store in north east corner of site (May 1991). 2) 92/ 52191/ 011 Solvent emission control plant to include new chimney and solvent/ water disposal tanks (2 of) (November 1992). 3) 98/ 52191/ 021 Construction of a Firemain Pumphouse, two water storage tanks and the installation of an underground firemain (June 1998). 4) 98/ 52191/ 023 Demolition of existing manufacturing buildings and construction of new warehouse within the western part of the site (July 1998). 5) 98/ 52191/ 022 Construction of a housing over the existing pump station, the re-construction of the Solvent Capture Control Building and associated pipebridges within the northern part of the site (July 1998). 6) 01/ 52191/ 027 Removal of 2 oil storage tanks and bund wall. New bund wall and extension of existing plant room to north elevation. Installation of 6 chiller units with service canopy and extension to existing pipe bridge (March 2001). 7) APP/ 10/ 00955 Construction of new cold storage warehouse facility (February 2011). 8) APP/ 13/ 00837 Erection of new metal-clad substation enclosure (October 2013).
Drainage & Utilities	Golder stated that other than contained storage and use of diesel for power generation purposes (four generators exist on site in central southern area), there are no other above-ground storage tanks (ASTs) or underground storage tanks (USTs) used for oil storage. The remediation undertaken in the north east of the site in 1999, described above, was associated with damaged drainage. A CCTV survey did reportedly identify damage in that area although the remediation stated that the drainage (along with the impacted soils) was also removed as part of the remediation. It is not known whether any historical soakaway drainage exists. There is reportedly no oil-interceptor system associated with the site's surface water drainage arrangements. Golder also stated that there are six electricity substations on site, although they are 'dry-type' and do not contain PCBs. It is not clear however what substations were used in the past. No process wastewater is currently generated by the facility.

2.3 Current & Former Building layout

The following key current and former buildings have been identified and reference should be made to Appendix B for the current layout.

Building*	Location on Site	Description
A	NE corner	Small building built in 1974 of unknown use, possibly waste or former solvent store.
B	SE corner	Pharmaceutical building built in 1978, replaced by Building H.
C	SE corner	Bulk liquid store and laboratory built in 1978, including sugar solution storage for cough syrups.
D	Central Northern area	Possibly part of manufacturing support warehouse, built in 1964 replaced by Building N.
E	Central Northern area	Very small building built adjacent to boiler house ('R') in 1970. Unknown use.
F	Central Western Area	Built in 1956, central site building, replaced by Building S.
G (Present in 2021)	NE corner	Biotech Packaging Facility (BPF) which incorporates the site's waste storage area. Built c.2009.
H (Present in 2021)	Central Eastern area	Pharma Offices & Packaging Facility. c1992. Previously manufacturing of pharmaceuticals.
I	Central Western Area	Built in 1956, central site building, replaced by Building S.
J	Central Northern Area	BPF Switch room.
K (Present in 2021)	SE corner	Offices & packaging facility for quality control. c.1981-1990.
L (Present in 2021)	SE	Offices & Packaging Facility. c.1981-1990.
M	Central Eastern area	Transfer area associated with Building H.
N (Present in 2021)	Central Northern area	Low Bay Warehouse, just south of Building Q. c.1964/ 66
O	No records identified	-
P (Present in 2021)	Central	High Bay Warehouse just south of Building N containing the European Distribution Centre c.2009.
Q (Present in 2021)	Central Northern area	Site workshop and solvent (toluene) and oils store, just north of Building N. Partially redundant c.2002.
R	Central North/ NW area	Former boilerhouse. Now electricity substation.
S	Central northwest area.	'Injectables' and Nutritional SMA Large building demolished c.2002.
T	NW corner	Engineering workshop demolished c.2002.
U	NW corner	Former administrative building, demolished c. 2002.
V	Western area	Staff Restaurant. Demolished with northern site area in 2015-17.
W	Western area	Reception/ Security
X	No records identified	-
Y	No records identified	-

Building*	Location on Site	Description
Z (Present in 2021)	Central Southern/ SW Area	Cold Stores 2 and 3, built in 2011. Diesel generator adjacent to these stores.
Fine Chemicals Manufacturing Unit (FCMU)	NE	Built in 1961. Adjacent to solvent storage. Demolished 1998.
Solvent Recovery	NE	Built in 1992.
SMA Building	SW area	Built in 1971, associated with smaller Buildings J and N. Demolished c.2001. SMA is infant milk formula.
Tablet/Dispensary	NE area	Built in 1956 (tablet) and 1975 (dispensary) and are replaced by BPF (Building G). Former tabletting and dispensary buildings were in central area, near BPF
North Site Distribution Warehouse	NE 'limb' (Outside of current redline).	Building in 1985 (but not currently within redline site boundary).

*Note: Some of the earlier records do show that building references changed slightly as the site developed, for instance Building G was originally in the central northern area not the current BPF Packaging facility. EPS have attempted to use only the latest references for consistency.

2.4 Industry Profiles

Reference has been made to two Department of Environment Industry Profiles (published in 1995), which are available via CL:AIRE's Water and Land Library (WALL). The two profiles which have been reviewed are highlighted below:

DoE industry Profile – Chemical Works: Fine Chemicals Manufacturing Works

The profile describes fine chemicals as those which are manufactured to high and well-defined standards of purity. They include, amongst others, intermediates for pharmaceuticals, high purity laboratory reagents, vitamins, food additions and high purity solvents. The FCMU on this site appears to have been quite small scale. Some points which may be relevant to this site:

- Carrier solvents are used to transfer material mixes through the reaction steps, and may include toluene, methanol, dichloromethane and acetone.
- Solvent recovery plants are typical Potential Areas of Concern (PAOC) as are underground effluent drains (or soakaways)
- Contaminants of Concern (CoCs) include soluble organics such as alcohols, acetone, ethyl acetate and phenol, which can migrate considerable distances from the source and permeate water supply pipes. As well as less soluble solvents such as toluene and chlorinated solvents.

DoE Industry Profile - Chemical Works: Pharmaceutical Manufacturing Works

The profile describes primary and secondary processing (as was historically undertaken at this site). Primary processing is the extraction and production of the active ingredient from its sources using methods such as organic synthesis, biological processes, extraction of animal or vegetable substances or inorganic chemical preparation. Secondary processing is the conversion of the active ingredient into products suitable for administration.

- Organic solvents are mainly of concern in primary production, as solvents are used in far smaller volumes in secondary production.
- Acids and alkalis are used in both primary and secondary processes, occurring often in both bulk storage areas and associated pipework.

2.5 Key Potential Areas of Concern (PAOC)

The Phase I report identified a need for further investigation in several areas, summarised as follows:

- Localised detailed delineation of the already identified and partially remediated areas of potential concern in the north-east of the site including the FCMU, Waste Storage Area, Boiler House and Solvent Storage).
- Assessment of ground gas conditions beneath the areas of the site under future building footprints.
- Shallow groundwater conditions with some additional monitoring wells to bolster the existing monitoring well network and provide a single unified snapshot of groundwater conditions at the site now. This being for both human health and controlled waters protection.

Based on the available site records, additional PAOC would include:

- Diesel generator/ fuel storage in the central southern area, including former oil storage removed in around 2001.
- Former engineering workshop (Building T).
- Historical records in the Golder report shows that in 1995, Cyanamide products were transferred to the site. Cyanamide is a product associated with significant VOC, cyanide, PCB and metals contamination in America (specifically at Pfizer's Wyeth Holdings site in New Jersey in the 1990s). Reference –
https://www.nj.gov/dep/srp/community/sites/pi/american_cyanamid_fs.pdf
- It also has to be acknowledged that the 'contaminating potential' of the site is likely lower now than it was in the past, as primary and secondary processing no longer takes place. Therefore, the site layout when those processes were undertaken is potentially more significant in terms of contamination. During those periods, buildings were present to the centre, west and northwest, many of which do not remain or have changed significantly.

- Drainage infrastructure, particularly drainage runs present when the site was used for manufacturing but prior to full mains connections and solvent recovery should be considered a PAOC at this stage. It is known, based on the 1999 remediation, that the drainage did cause some contamination in the past but it is not known as to whether the problem extended further across the site. All drainage runs from the 1950-70s would likely be made of ceramic sections and not entirely water-tight. Even if no formal soakaway or infiltration drainage was present, the gradual accumulation of contamination in and around the drainage runs, including within any pea shingle surrounding the pipes, is plausible and should not be discounted.



2.6 Information Gaps & Uncertainty

EPS are not aware of any site-wide investigation, and only the Golder reports have been made available as background, but there is still a high level of historical records in terms of the contamination status of the site.

The remediation undertaken in 1999 should be beneficial but it is not known if all of the impact was captured, or what specifically the source was beyond the operations generally undertaken in that area (i.e., it is not clear whether the source was ongoing after the remediation was completed). EMR referenced a possible additional former solvent store to the north east (possibly Building A or in that area), which would be separate to the main solvent warehouse (Building Q).

Prior to the development of the solvent recovery plant in 1992, it is not known whether the solvent that was not recovered was simply lost through fugitive emissions or whether there was liquid loss to the drainage/ ground. The remediation undertaken in 1999 would suggest some solvent had been discharged through drainage. It is not known whether infiltration or soakaway drainage existed, but the shallow ground conditions may have been viable for it. The 2009 investigation referenced in the Golder report describes a connection to mains drainage in Section 2.2, suggesting the site was not fully connected to mains drainage in the past.

There is a record of 'fire chemicals' being stored on the site within the planning records. EPS are not aware of any perfluorinated chemicals (PFCs), i.e., perfluorooctane sulfonate (PFOS) or perfluorooctanoic acid (PFOA) which have been stored or used on site and have not therefore been considered CoCs in the CSM. The fire firefighting store is shown on Appendix B, in the central northern area. Equally, refrigerants used at the site, which are discussed in the Phase I assessment, are not considered capable of posing an ongoing risk from soil or water contamination and have also not been considered a CoC.

2.7 Regulatory Input

Within the Phase I report, an initial consultation was provided by Environmental Health team of Havant Borough Council for the redevelopment of the site for commercial purposes.

The officer, Mr Jonathan Driver, highlighted the following points:

- There are a number of potentially contaminating landuse features associated with the extant Pfizer site, and it is known that the underlying local geology (river terrace deposits) is capable of supporting contaminant migration over significant distances (well over a hundred metres) from the point of release.
- Whilst it is acknowledged that the proposals are for continued commercial use, it is nevertheless appropriate to address contamination associated with the prior (extant) landuse as a material planning matter to the redevelopment of the site.
- The risk driver for any remediation is likely to be off-site receptors (residential properties within 25-50m of the site boundary) but risks also must also be acknowledged for the protection of employees, and the development itself. Assessment is expected to be proportionate, and to respond to the context of the site.

- There are multiple features of interest at the site, and so securing sufficient coverage prior to demolition might prove difficult, and a condition may still be proposed if a Phase 2 investigation is limited by restricted access to the site.

2.8 Conceptual Site Model & Recommendations

Through consideration of the site's history and environmental setting and taking account of the previous desk-based assessment produced by EPS in 2021, several plausible contaminant linkages within the site-specific Conceptual Site Model have been identified both currently and that could become active through the proposed development.

These linkages are associated with the historical and ongoing use of the site for primary and secondary pharmaceutical & fine chemicals manufacturing with processing and packaging in recent years, including use of solvents on site from the late 1950s. Waste materials have also been stored and treated on site.

Whilst the proposed commercial enduse is not particularly sensitive to contamination, no more so than the current use, risks to neighbouring properties and receptors, including residential properties from site-derived contamination as well as controlled waters, still exist. No new contaminant linkages are likely to be introduced in terms of risks to these existing receptors but risks to new receptors such as groundworkers and future sites users are plausible. The Phase I assessment considered it unlikely that any off-site land uses could be identified as a significant source of contamination migrating onto the site.

The nature of the local underlying geological and hydrogeological conditions, underlain by a thin superficial drift deposit designated as a Secondary A Aquifer by the Environment Agency, is such that impact on soils and groundwater at shallow depths below the site could represent a longer term risk if not managed during the development of the site. The impact of site-derived contamination on strategic groundwater and water supply resources is considered low/ negligible however, given the presence of a thick unit of London Clay below the superficial deposits and the absence of water supply points in the vicinity of the site. If a piled foundation solution were to be used that penetrated the London Clay Formation (unlikely), then the CSM would need to be revisited as the deeper underlying chalk is a highly sensitive aquifer (within a SPZ I).

Taking account of the feedback from the local Environmental Health team, any groundwater within the superficial should also be considered as a pathway for contamination to migrate off-site. Any residual contamination from the previous allotment usage is also unlikely to remain capable of posing an ongoing risk to receptors.

On this basis, although it was recognised that ground investigation data was available stretching back over the last 20 years, it was recommended that targeted further investigation be undertaken including soil and groundwater testing and a ground gas and vapour monitoring programme.

The fabric of the site buildings will need to be considered in light of potential environmental exposure during site development; as such, materials including Asbestos Containing Materials (ACMs), containerised liquids, oils, cleaning materials, wastes and refrigerants will require management during site demolition and development activities. EPS have assumed that appropriate good practise and duty of care will be applied during this process, and not create any additional contaminant linkages or worsen any soil or groundwater contaminant concentrations.

Based on the available information, EPS have therefore undertaken a Phase II Intrusive Investigation to investigate potential contamination based on the following Conceptual Site Model. The scheduled chemical analyses have been based upon the CSM with the relevant Contaminants of Concern (CoC) shown each for source:

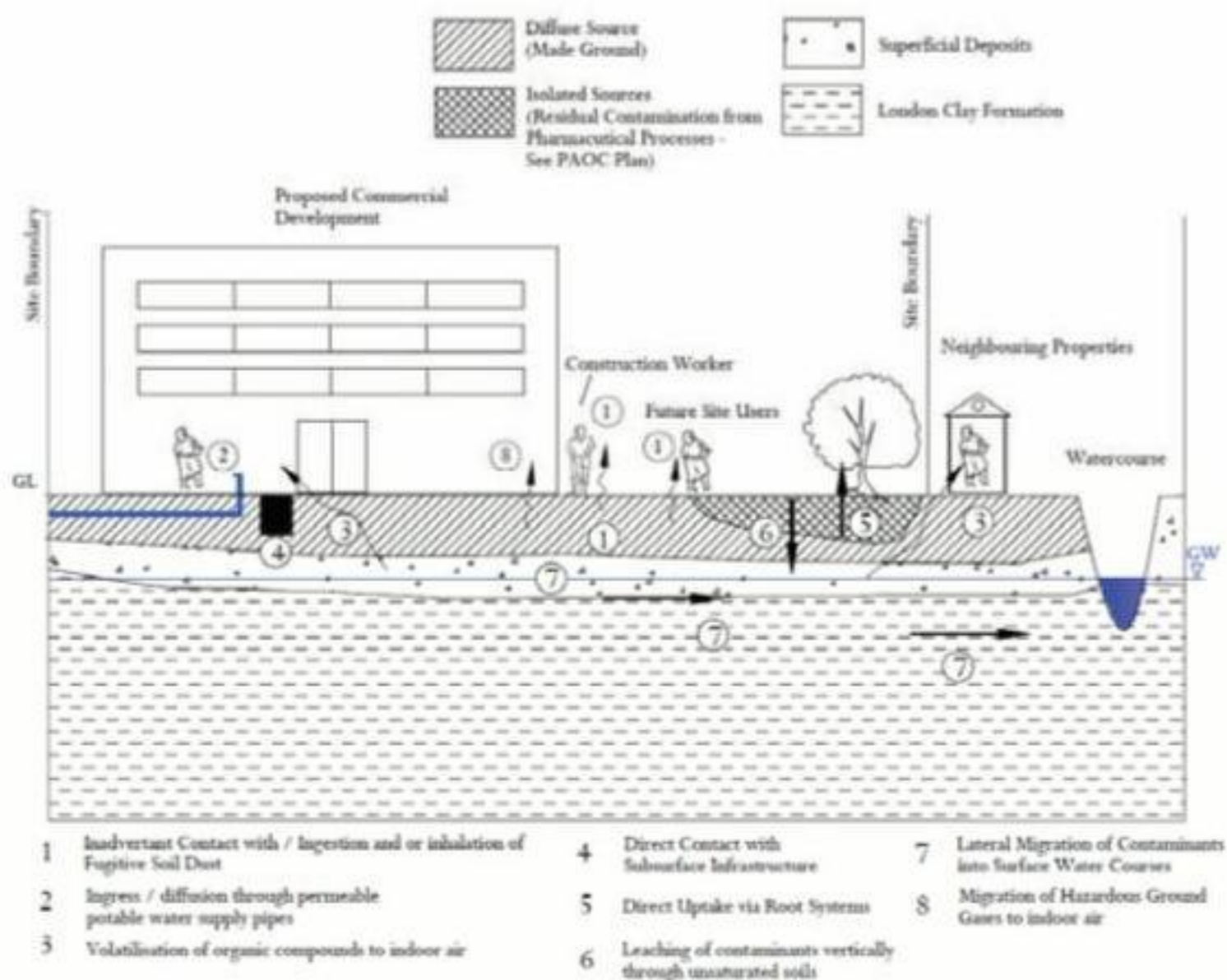
Source	Pathway	Receptor
On-site: Contaminated Soil/Infilled Material Site Wide – Made ground CoCs - PAHs, Metals, ACM, Ground Gases (CH ₄ & CO ₂)	Direct contact and inadvertent ingestion by eating or smoking with dirty hands	Construction workers during redevelopment & site users
Area around Building Q (Solvent Warehouse) / FCMU & Northern Distribution Area VOCs (Inc. BTEX & Chlorinated Solvents) SVOCs, Acetone, Isopropanol, Phenol, TPH, PAH	Inhalation of fugitive dusts	Site users
Area around Building G (BPF) and former tableting/ dispensary used for waste storage and recorded contamination in 2008 VOCs (Inc BTEX & Chlorinated Solvents), TPH, PAH, Metals	Ingress / diffusion through permeable potable water supply pipes	
Current/ Former Diesel/ Oil fuel storage areas (current generators adj. Building Z - Cold Stores) TPH (Inc BTEX), TPH, PAH)	Generation & Migration of Ground Gases to Indoor Air	
Former Workshop (Building T) (TPH, PAH)	Direct uptake via root systems	Plants
Historical Primary and Secondary Pharmaceutical Manufacturing VOCs (Inc BTEX & Chlorinated Solvents) SVOCs, Acetone, Isopropanol, Phenol, TPH, PAH, Metals, Acids/ Alkalis	Direct Contact	Buried Infrastructure
Cyanamide Product Management c.1995 VOC (Inc. Benzene), cyanide, PCBs, Metals Drainage Infrastructure VOCs (Inc. BTEX & Chlorinated Solvents) SVOCs, Acetone, Isopropanol, Phenol, TPH	Leaching of contaminants vertically through unsaturated soils	Groundwater

Source	Pathway	Receptor
Contaminated Soil/Groundwater	Lateral migration of contaminants in soil, through run-off, drainage or groundwater (& subsequent volatilisation of organic compounds to indoor air)	Surface waters
		Site users & Neighbouring Site Users

Notes:	PAH	Polycyclic Aromatic Hydrocarbons	ACM	Asbestos Containing Materials
	VOCs	Volatile Organic Compounds	sVOCs	Semi-Volatile Organic Compounds
	TPH	Total Petroleum Hydrocarbons	BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
	CH ₄	Methane	CO ₂	Carbon Dioxide
	PCB	Poly-Chlorinated Biphenyls		

The following diagram provides an illustration of the plausible contaminant linkages that may be active at the site and which may need further investigation or control to ensure safe development:

Illustrative Conceptual Site Model – Pfizer, Havant



2.9 Unexploded Ordnance

A preliminary Unexploded Ordnance (UXO) Assessment was obtained for the site. This concluded that the potential for UXO to be present at the site is unlikely and that no further action was required to address the risk prior to breaking ground. A copy of this report is included as Appendix D.

3 SUMMARY OF INTRUSIVE INVESTIGATIONS

Intrusive ground investigations were undertaken between 20th January and 11th February 2021 in accordance with EPS standard operating procedures, copies of which will be made available on request. A summary of all site activities is presented in the following sections:

3.1 Exploratory Hole Locations

Exploratory hole locations were selected through consideration of the potential contaminant linkages identified through the Phase I Desk Study, the proposed development layout, the client's requirements, current access limitations and the location of below ground utilities, as well as operational and health & safety considerations associated with an active site.

Eleven window sample boreholes (WS01-WS02, WS07-WS15) were formed at the site to a depth of 1.8m using a track-mounted percussive drilling rig.

Eleven cable percussive boreholes (BH01-BH04, BH08, BH10-BH13, BH16-BH17) were drilled to depths of between 12m and 20m.

Twelve trial pits (TP1-TP2, TP11-TP13, TP15-TP16, TP18-TP19, TP22, TP29-TP30) were excavated using vacuum excavation techniques and a mechanical excavator to a maximum depth of 2.7m. Soakaway testing was also undertaken in three trial pits.

The exploratory hole layout was not designed through a formal stratified systematic sampling pattern, with the constraints at the site (primarily the existing buildings in active use) restricting the positions available. Due to the absence of a formal sampling pattern, the use of a three dimensional dataset (i.e. samples at varying depths) and targeted nature of the investigation taking into account the PAOCs, it is unlikely that any statistical analysis can be applied to the soil dataset in accordance with CL:AIRE's 2020 guidance (Comparing Soil Contamination Data with a Critical Concentration). It is therefore likely that the most significant sampling result for each source or averaging zone will drive the risk assessment and design of remedial measures.

The overall objective in terms of exploratory hole locations was to provide an appropriate lateral and vertical coverage of the soils/ groundwater/ soil gases underlying the site in order to offer information relating to their quality and nature as well as provide information for geotechnical design. The exact locations were agreed amongst the project team prior to the beginning of the works. Further rationale for each sampling location is provided within the table below:

Location	Rationale
BH1, BH3, BH8, BH12-BH13, BH16-BH17	Drilled across the site to provide vertical and lateral information on the geology underlying the site and to allow installation of groundwater monitoring wells.

Location	Rationale
BH4, BH10, BH11	Drilled across the site to provide information on the geology at depth below the proposed building area, in order to aid pile design.
WS01-WS02, WS07-WS15	Boreholes drilled to facilitate installation of gas and vapour monitoring wells below the proposed new building area.
TP1-TP2, TP11-TP13, TP15-TP16, TP18-TP19, TP22, TP29-TP30	Excavated across the accessible western half of the site to provide information on the nature and quality of the shallow geology underlying the site. This generally targeted the areas of gravel/ shingle and car parking where historic buildings were present.
SK01, SK02, SK05	Undertaken across the site to complete soakaway testing to understand the infiltration characteristics.

Groundwater monitoring standpipes were installed within seven of the deep boreholes (BH1, BH3, BH8, BH12-BH13, BH16-BH17) to enable follow up groundwater sampling. Groundwater sampling pipes were installed using 50mm diameter uPVC well casing and fitted with a gas tap. Slotted casing (1mm slot) was installed at each location from the base of the borehole to approximately 1.0m below the surface. The installations were completed to ground surface using plain casing. All piping was sleeved with geo-sock. A filter pack of 2-3mm of washed gravel extended from the base of the boreholes to approximately 0.1m above the slotted section with a bentonite seal to surface. All installations were finished with flush-mounted, bolt-down headworks.

Soil vapour monitoring wells were installed in all window sampler locations. The positions were designed to target specific sampling horizons within the subsurface. Each sampling point was fitted with a stainless steel sparge point at the base of the borehole (1.8m). A filter pack of 2-3mm washed gravel extended from the base of the installation to approximately 0.1m above the sparge point, with a bentonite seal to the surface.

As part of the investigation EPS also identified a number of the boreholes drilled by Golders in 2019/ 20 (as well as one from an investigation in 1996), which were incorporated into EPS' investigation in the form of groundwater monitoring. The boreholes used comprised the following:

- BH GA 01
- BHGA 02
- BHGA 03
- BHGA 04
- BHGA 07
- BHGA 07A
- BHGA 08A
- BHGA 09A
- BH04 1996

A borehole and trial pit location plan is presented as Figure 4.

3.2 In-Situ Testing & Soil Sampling

Each borehole was logged for ground conditions encountered and inspected for any physical evidence of contamination, such as soil staining, odour and the presence of separate phase liquids on a precautionary basis. Borehole and trial pit logs are presented in Appendix E.

Standard or cone penetration tests (SPT / CPT) were carried out in all materials using an automatic trip hammer. The number of blows required to advance a standard split spoon, (or solid 60° nose cone for the CPT test) over the final 300mm of a 450mm total drive was recorded, and is shown on the borehole records at the penetration resistance ('N' value).

Where potentially volatile organic compounds are suspected, EPS carries a Photoionisation Detector (PID), which can be used to measure the relative concentrations of vapour associated with soil samples collected from different depths and locations at the site. In these circumstances, soil samples will be placed into plastic bags, sealed, shaken and then allowed to rest for a few minutes to allow time for volatile vapour to accumulate in the air trapped within the bag. The PID probe will then be used to pierce the bag and sample the air above the soil to measure the concentration of volatile compounds that have accumulated. PID readings are only used to provide EPS with a basic means to quantify areas of volatile organic compound in the field to help guide the investigation. As potentially volatile organic compounds were identified in the conceptual site model, PID readings were collected during this intrusive investigation. These readings are included within borehole logs presented as Appendix E and the results are discussed further in later sections.

3.3 Laboratory Testing

Samples obtained for analysis of identified contaminants of concern were submitted to Element Materials Technology of Flintshire, who hold appropriate UKAS / MCERT accreditation for the required testing. Samples were transported in laboratory supplied containers and delivered to the laboratory by approved courier. An environmental laboratory testing schedule is included as Table 1.

Geotechnical testing was undertaken by Soil Property Testing, Huntingdon, a UKAS accredited laboratory. A geotechnical laboratory testing schedule is included as Table 2.

Copies of chain of custody documentation are held by EPS and will be made available on request.

3.4 Groundwater Sampling

EPS returned to site on 18th February 2021 to collect groundwater samples from selected monitoring wells (including those from previous investigation at the site). Groundwater samples were collected using the 'low flow' sampling technique in accordance with EPS standard operating procedures. Each borehole was monitored for dissolved oxygen, redox, pH and temperature before sampling. The results of this monitoring are included in Table 3.

3.5 Ground Gas & Vapour Monitoring

One round of soil vapour monitoring was also undertaken on the 19th February 2021 to measure the presence and concentration of contaminants and ground gases within the soil vapour. Soil vapour samples were collected using Summa canisters, which connect to the sampling point via a dedicated sampling train supplied by Element Materials Technology of Flintshire.

Subsequently samples obtained for analysis of identified contaminants of concern were submitted to Element Materials Technology of Flintshire, who hold appropriate UKAS / MCERT accreditation for the required testing. Samples were transported in laboratory supplied containers and delivered to the laboratory by approved courier.

During sampling of soil vapour within each of the monitoring points, leak test of the sampling train was undertaken. Limonene present within shaving foam was used as a potential leakage indicator. The joints within the sampling train were treated with shaving foam containing limonene, and subsequently all soil gas samples were tested for presence of limonene.

Three further rounds of ground gas monitoring were undertaken following completion of the intrusive works, on the 25th February, 5th March and 9th March 2021 to measure the presence and concentration of ground gas (including carbon dioxide, oxygen and methane) and organic vapour using a GFM 435 gas analyser, PID and flow meter respectively.

Recorded ground gas monitoring data is included as Table 4 with the results and implications of this data discussed in later sections of this report.

4 FINDINGS OF THE INVESTIGATION

This section of the report provides a summary of the findings of the various aspects of the ground investigation.

4.1 Ground Conditions

A total of 22 boreholes and 12 trial pits were formed at the site and the ground conditions encountered, from surface level, have been interpreted to comprise:

- Made Ground
- River Terrace Deposits
- London Clay Formation

Site specific borehole and trial pit logs are included as Appendix E and give descriptions and depths of strata encountered. A summary of the general strata encountered across the site is provided in the table below, with more detailed description given in the following sub sections.

Geological Strata	Maximum Depth to Base of Strata (m bgl)	Strata Thickness (m)
Made Ground	2.5	0.15-2.5
River Terrace Deposits	7.8	2.8-6.6
London Clay Formation	> 20.0 (not proven)	> 5.8-> 14.7 (not proven)

4.1.1 Made Ground

Made Ground was encountered within the vast majority of boreholes below variable surfacing of concrete, tarmac and gravel. It predominantly comprised a brown, gravelly clay with brick and concrete fragments, although in places it was noted to comprise a more granular material. Some hardcore (likely representing subbase material) was found in places. Its thickness was variable but fairly regularly in the range of 1.0-1.5m and was proven to a depth of 2.5m in BH01.

A concrete slab was encountered within BH01 at a depth of 2.2-2.5m, whilst another was found in BH17 between 1.4m and 1.6m. These are considered remnants of historic foundations.

4.1.2 River Terrace Deposits

Below the made ground in all boreholes lay soils interpreted as River Terrace Deposits. These generally comprised an initial layer of brown, gravelly clay with variable gravel content and some gravel lenses. Gravel was brown, black, and white, angular to sub-rounded flint and chert. Although logged in the field as a clay, some of the geotechnical laboratory testing indicates it could be gravellier in places. Some significantly softer layers of more cohesive soils were also encountered in the River Terrace Deposits in a number of locations, such as BH13, BH16, BH17 TP11 and TP29, although there seemed to be no particular distribution to these soil layers.

Below this layer in the majority of borehole locations lay dense to very dense, black, brown and white, angular to sub-rounded, sandy gravel. This was noted to range quite substantially from a gravelly sand to a cobbly gravel with very little sand content. The depth of this layer ranged between 1.8m and 7.8m and was found to vary in thickness across the site. It was not encountered within BH3, BH4 and BH13.

It should be noted that the geotechnical laboratory testing recorded unnatural materials such as concrete, glass and brick in three samples ranging in depth from 2.0m to 4.0m. However, no physical evidence of made ground at these depths was identified and therefore this is considered to represent drag down during the drilling process, as opposed to being evidence of significant thicknesses of made ground.

4.1.3 London Clay Formation

Encountered directly below the River Terrace Deposits in all deep shell & auger boreholes lay soils interpreted as part of the London Clay Formation.

This generally comprised an initial layer of soft, grey, clayey silt / very silty clay, overlying generally stiff to very stiff, brownish grey clay, which extended to the base of all boreholes.

4.2 Groundwater

Groundwater was struck within all shell & auger boreholes during the investigation and follow up monitoring identified groundwater to rest at levels ranging between 2.13m (BH8) and 3.40m (BHGA01 – borehole from previous investigation) bgl.

Groundwater elevation ranges between 11.46m AOD (BH12) and 12.95m AOD (BH16) and appears to flow in a westerly / south-westerly direction towards the River Lavant. These findings are broadly comparable with Golder Associates previous work (2019, 2020), although they interpreted the flow direction to be from north to south, therefore slightly different to EPS.

4.3 Physical Evidence of Contamination

Despite the presence of a limited thickness of made ground, there was no palpable evidence of contamination, waste or putrefiable material encountered across the majority of the site. The only physical evidence comprised a moderate fuel odour within shallow soils in TP15.

This was supported by headspace testing undertaken at regular intervals during the field works which did not identify any concentrations of organic vapours above 10ppmV.

4.4 Chemical Laboratory Analysis

4.4.1 Soil

A laboratory analysis testing schedule is presented as Table 1 and all environmental sample results obtained from the laboratory are included as Appendix F. The key results of laboratory testing on environmental soil samples are summarised below.

Contaminant	No. of Samples	No of Detections	Range of Detections (mg/kg)		Highest Location & Depth (m bgl)
			Min	Max	
Arsenic	29	29	1.9	12.7	WS8 (0.9-1.0)
Cadmium	29	22	0.2	0.7	TP30 (1.8)
Chromium	29	29	25.0	204.3	WS7 (0.5-0.7)
Copper	29	29	3	34	BH12 (0.0-0.5)
Lead	29	23	6	98	BH17 (0.4-0.6)
Mercury	29	0	-	-	-
Nickel	29	29	4.9	39.6	BH8 (11.95-12)
Selenium	29	0	-	-	-
Zinc	29	29	9	96	BH17 (0.4-0.6)
Naphthalene	29	0	-	-	-
Benzo[a]pyrene	29	7	0.05	0.71	WS2 (0.3-0.5)
Dibenz(ah)anthracene	29	2	0.05	0.10	WS2 (0.3-0.5)
Cyanide	9	0	-	-	-
Benzene	29	0	-	-	-
Toluene	29	3	0.008	0.026	BH13 (1.0)
Ethylbenzene	29	1	-	0.006	BH13 (1.0)
m/ p - xylene	29	2	0.009	0.036	BH13 (1.0)
o - xylene	29	1	-	0.006	BH13 (1.0)
TPH CWG	29	5	182	1674	TP15 (0.3-0.7)
PCB	15	0	-	-	-
VOC	28	4	0.006	0.082	BH13 (1.0)
SVOC	27	4	0.014	55.123	BH03 (0.0-0.8)
Ammoniacal Nitrogen	29	0	-	-	-
Asbestos (%)	35	0	-	-	-

Notes:

- Contaminant not found above laboratory detection limits
- PAH Polycyclic Aromatic Hydrocarbons
- BTEX Benzene, Toluene, Ethylbenzene, Xylenes
- TPH CWG Total Petroleum Hydrocarbons (Criteria Working Group)
- VOC Volatile Organic Compounds
- SVOC Semi-Volatile Organic Compounds
- PCB Polychlorinated Biphenyls

- Detectable concentrations of heavy metals were encountered across the site.
- Detectable concentrations of PAHs and TPH were encountered at selected locations above method detection limit.
- Low and isolated concentrations of VOC and SVOC were found at selected locations. The most notable concentration comprised 53.568mg/ kg of the SVOC compound Butylbenzyl phthalate, which made up the bulk of the detected SVOC.

- Asbestos was not encountered above minimum detection limits (MDL) of 0.001% in any sample.

4.4.2 Groundwater

The key results of laboratory testing on environmental groundwater samples are summarised below.

Contaminant	No. of Samples	No of Detections	Range of Detections (ug/l)		Highest Location
			Min	Max	
Arsenic	16	1	-	6.6	BHGA07A
Cadmium	16	1	-	5.0	BH04 1996
Calcium	16	16	34.8	132.5	BH12
Chromium	16	5	1.5	8.6	BH04 1996
Copper	16	0	-	-	-
Lead	16	0	-	-	-
Magnesium	16	16	1.1	8.6	BH12
Mercury	16	0	-	-	-
Nickel	16	6	2	33	BH12
Selenium	16	1	-	4	BHGA03
Zinc	16	10	3	16	BH17
Naphthalene	16	1	-	0.2	BH17
Benzo[a]pyrene	16	2	0.027	0.047	BH12
Dibenz(ah)anthracene	16	0	-	-	-
Phenols	16	0	-	-	-
BTEX	15	0	-	1	-
TPH CWG	15	1	-	208	BH3
VOC	15	3	6	9.2	BH3
SVOC	16	0	-	-	-
PCB	3	0	-	-	-
Cyanide	16	0	-	-	-
Ammoniacal Nitrogen	16	16	0.05	1.42	BHGA07

Notes:

-

PAH

BTEX

TPH CWG

PCB

Contaminant not found above laboratory detection limits

Polycyclic Aromatic Hydrocarbons

Benzene, Toluene, Ethylbenzene, Xylenes

Total Petroleum Hydrocarbons (Criteria Working Group)

Polychlorinated Biphenyls

- Minor and isolated concentrations of metals, PAH, TPH, VOC and SVOC were found at selected locations across the site however mostly within an order of magnitude of the method detection limits.
- At BH3, the identified VOCs were interpreted as TCE and cis-1-2-Dichloroethene, both chlorinated solvents.

4.4.3 Soil Vapour

The below table summarises the findings of the soil gas / vapour analysis undertaken by the laboratory analysis. For ease of use, only those VOCs / SVOCs identified above method detection have been summarised.

Contaminant	No. of Samples	No of Detections	Range of Detections ($\mu\text{g}/\text{m}^3$)		Highest Location & Depth
			Min	Max	
Carbon Dioxide (%)	11	2	0.05	0.07	WS14
Carbon Monoxide (%)	11	0	-	-	-
Hydrogen (%)	11	0	-	-	-
Methane (%)	11	0	-	-	-
Nitrogen (%)	11	11	79.1	79.4	WS07
Oxygen (%)	11	11	20.5	20.9	WS9, WS10, WS12, WS14, WS15
Hydrogen Sulphide (%)	11	0	-	-	-
Isobutene	11	3	5.3	25.2	WS12
Ethanol	11	2	209.1	299.6	WS01
Acetone & Propanal	11	8	14	114	WS14
Carbon Disulphide	11	1	-	5.6	WS01
2-butanone	11	4	38	91	WS13
Hexane	11	1	-	15.2	WS01
m/ p - xylene	11	1	-	83.8	WS10
o - xylene	11	1	-	25.6	WS10
Styrene	11	1	-	13.2	WS10
1,2,3 - Trimethylbenzene	11	1	-	13.8	WS10
1,2,5 - Trimethylbenzene	11	1	-	8.4	WS10
Trichloroethene (TCE)	11	1	-	9.1	WS02
Tetrachloroethene (PCE)	11	7	11.5	37.3	WS02
1,1,1-Trichloroethane	11	1	-	32.7	WS02
Sum of VOC TO15 Compounds	11	11	12.9	449.6	WS01
Aliphatic C4-C6	11	4	40	7431	WS10
Aliphatic C8-C10	11	4	80	122	WS01
Aliphatic C10-C12	11	7	72	190	WS07
Aromatic C5-EC7 (Benzene)	11	1	-	6.4	WS10
Aromatic EC7-EC8 (Toluene)	11	9	7.2	94.6	WS10
Aromatic EC8-EC10	11	1	-	201	WS10
Limonene	11	0	-	-	-

Notes: VOC Volatile Organic Compound

The laboratory testing has identified minor concentrations of a number of volatile organic compounds within various boreholes across the site.

4.5 Preliminary Waste Analysis

Waste classification (i.e. hazardous or non-hazardous) was undertaken on samples of both made ground and natural soils, which included total concentrations of metals and hydrocarbons, using computer software provided by HazWaste Online™. The results of the WAC analysis are included within Appendix F and the outputs from the software are included in a Waste Classification Report in Appendix G.

Waste Acceptance Criteria was subsequently undertaken on one sample each of the cohesive and granular layers of River Terrace Deposits respectively, and one of the underlying London Clay Formation. Although these results are preliminary given the limited sampling density, they are considered likely to represent the major waste streams produced through the development. These results, together with those of the waste classification above are summarised in the following table:

Strata	Typical Depth (m bgl) and Description	Is it Hazardous?	Waste Acceptance Criteria	Appropriate Landfill
Cohesive River Terrace Deposits	0.3-> 6.3 - Brown sandy CLAY	No	Passed criteria for Inert Landfill	INERT
Granular River Terrace Deposits	1.8-7.8 - Brown, black and white angular to rounded sandy slightly silty GRAVEL	No	-	NON-HAZARDOUS*
London Clay Formation	> 5.8-20.0 - Brownish grey SILT and dark grey CLAY	No	Passed criteria for Inert Landfill	INERT

Based on the above, both the shallow natural cohesive River Terrace Deposits and London Clay Formation can be classified as **INERT** for the purposes of off-site disposal, under the waste code 17 05 04.

At present, the layer of granular River Terrace Deposits can only be classified as Non-Hazardous because not enough sample was provided to undertake the inert WAC test. However, this will be addressed during the following phases of investigation to confirm whether this layer can be classified as inert.

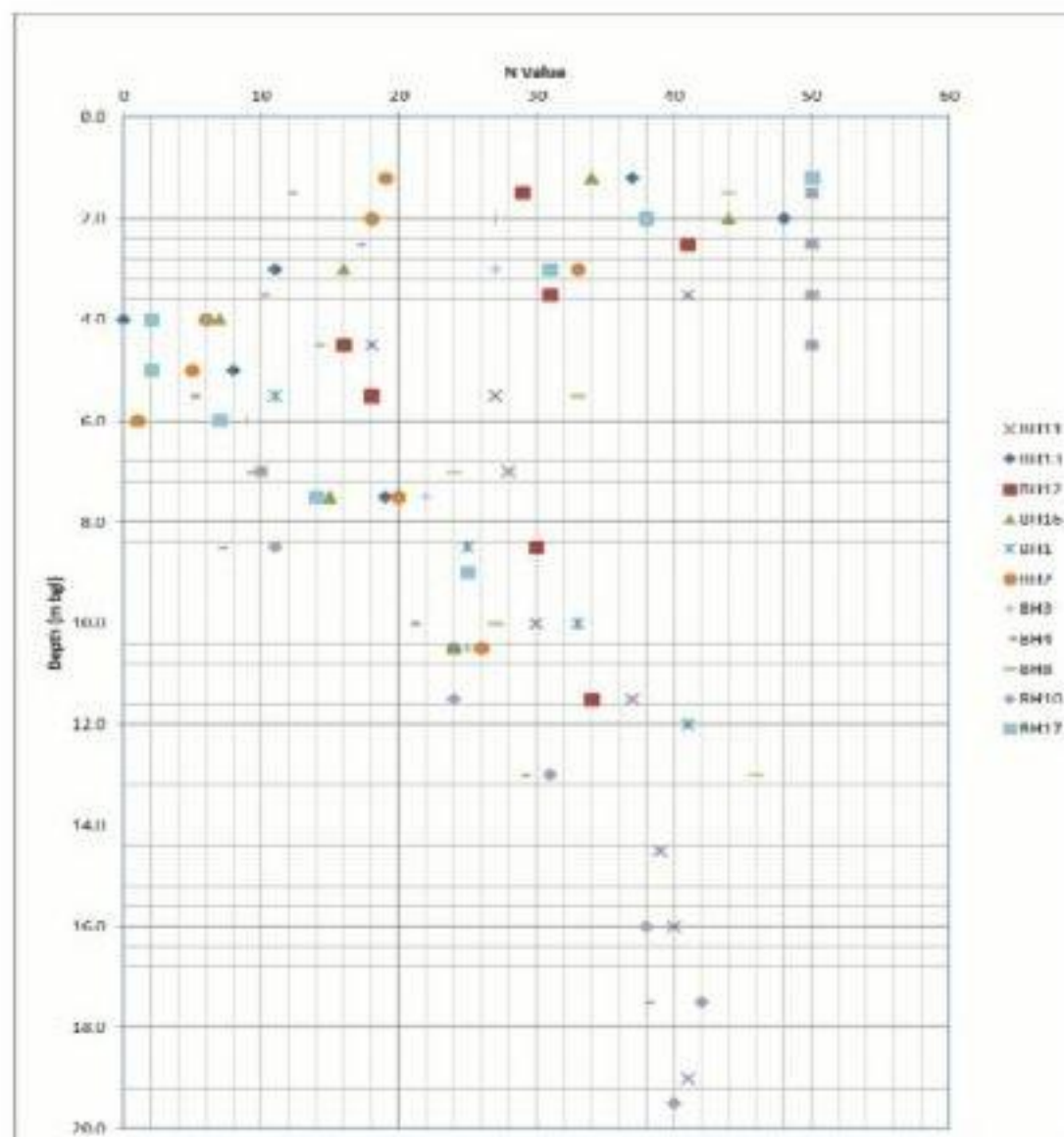
Due to the size of the site and the volume of variable made ground which will likely be disposed of, assessment of the waste characteristics of this material has not been made at this stage, particularly given that the most potentially contaminated area of the site is yet to be investigated in detail. It is therefore recommended that classification of this material be undertaken at a later date, possibly during construction works. However, based on the available testing already done, it is likely that the vast majority of it will be classified as non-hazardous.

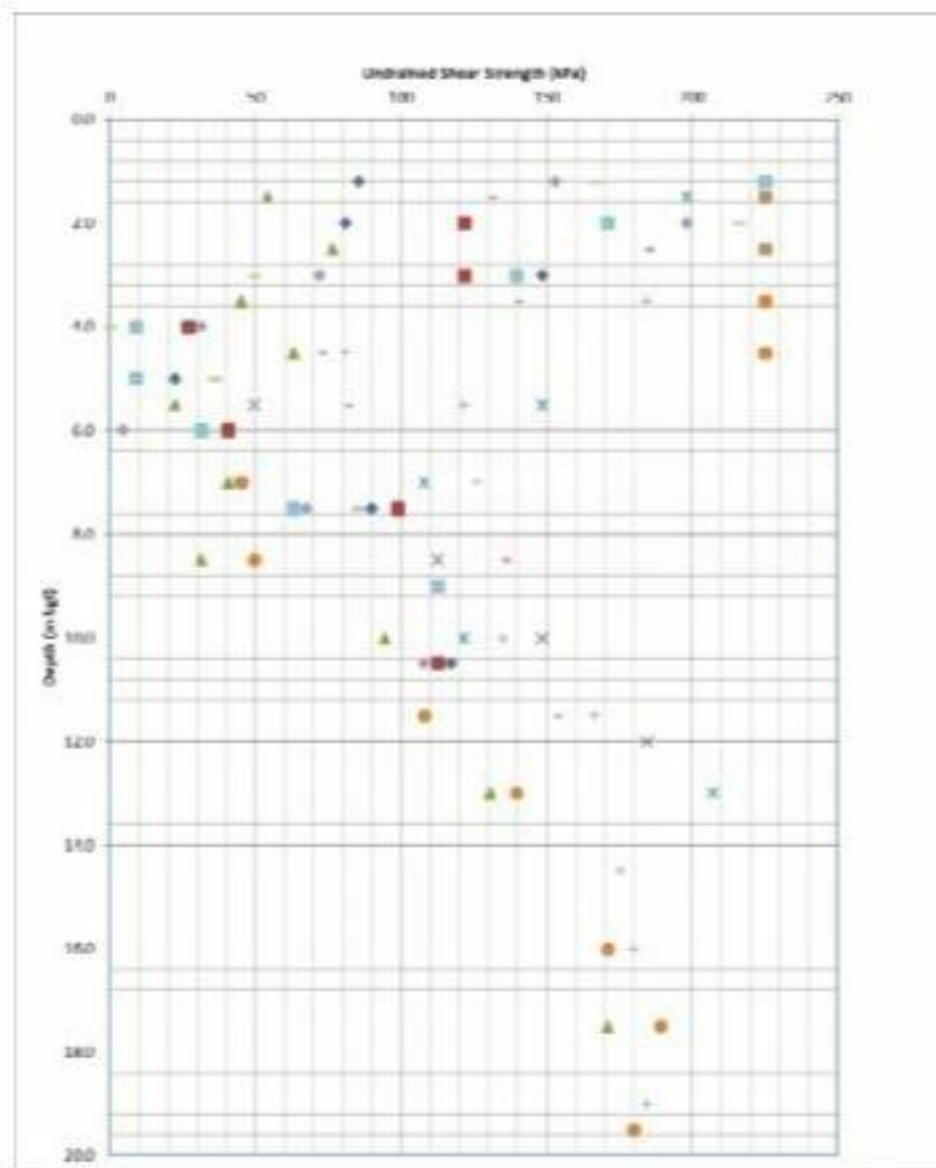
For made ground present on a brownfield site such as this, although the soil sampling process did not identify potentially hazardous concentrations of Asbestos Containing Material (ACM) within the soil, it must be acknowledged that the material may exist within areas which were not sampled or accessible during the investigation. Any visually identifiable fragments of ACM can invalidate any non-hazardous waste classification, as such, the above waste classifications are made on the proviso that any visually identifiable fragments of ACM are removed from the material prior to its disposal off-site. The subsequent ACM must then be disposed of in accordance with the Control of Asbestos Regulations 2012.

4.6 Geotechnical Testing

4.6.1 In-Situ Geotechnical Testing

The results of in-situ geotechnical testing are summarised in the graph below.





The above data indicates that the natural River Terrace Deposits to depths of around 4.0m are generally competent, although slightly variable in strength. However, between depths of around 4.0m and 7.0m, low strength soils were encountered associated with the silty upper layer of the London Clay Formation. Below this, the London Clay became generally stiff, typically increasing in strength with depth.

4.6.2 Laboratory Geotechnical Testing

The results of geotechnical laboratory testing are summarised in the table below and all geotechnical sample results obtained from the laboratory are included as Appendix H. The key results of laboratory testing on geotechnical soil samples are summarised below.

Strata	Range of Parameters										
	Moisture Content (%)		Plasticity Index (%)		Particle Size Distribution (%)			Undrained Shear Strength (kPa)		Coefficient of Volume Compressibility (m ² /MN)	
	Min	Max	Min	Max	Fines	Sand	Gravel	Max	Min	Max	Min
River Terrace Deposits	9.4	27.2	12 (4)	21 (12)	1-22	3-36	57-96	51		-	-
London Clay Formation	21.2	30.7	7	49	44-86	14-44	0-12	14	155	0.0	0.38

() adjusted for granular content

Moisture contents and Atterberg Limit was established for nine samples of cohesive soils in accordance with BS EN ISO: 17892-1: 2014 & BS1377: Part 2: 3.2, 4.4, 5.3, 5.4.

Particle Size Distribution was undertaken on 12 samples of granular soils in accordance with BS1377: Part 2: 1990: 9.2.

Undrained Triaxial Tests were done on 17 samples of cohesive soils in accordance with BS 1377: Part 2: 1990:3 Determination of Moisture Content, Part2: 1990:7 Determination of Density, Part 7: 1990: 8 Undrained Shear Strength, 9 Multistage Loading.

One Dimensional Consolidation Tests were undertaken on six samples of cohesive soils in accordance with BS 1377: Part 5: 1990: 3.5.

Sulphate contents and pH values determinations were carried out by the analytical laboratory, the results of which are included in Appendix F and summarised in section 6.4

A laboratory analysis testing schedule is presented as Table 1.

5 GEOTECHNICAL APPRAISAL

The ground conditions have been found to comprise a moderate thickness of made ground underlain by cohesive and granular River Terrace Deposits. Below this lay silt and clay of the London Clay Formation.

It should be appreciated that further intrusive investigations are proposed once the existing buildings have been vacated and demolished and this appraisal will be supplemented once findings from further investigations are available.

5.1 Geotechnical Category

Geotechnical Category (BS EN 1997-1:2004)	Definition
GC1	Geotechnical Category 1 (GC1) should only include small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations with negligible risk in terms of overall stability or ground movements and in ground conditions which are known.
GC2	Geotechnical Category 2 (GC2) should include conventional types of structure and foundation with no exceptional risk or difficult or loading conditions. Designs for structures in Geotechnical Category 2 should normally include quantitative geotechnical data and analysis.
GC3	Geotechnical Category 3 (GC3) should include structures or parts of structures, which fall outside the limits of Geotechnical Categories 1 and 2. This may include very large or unusual structures, structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions, or structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.

The proposed development comprises a limited number of a large commercial warehouse structure, and therefore the below assessment has been undertaken in accordance with Geotechnical Category 2 (GC2), including conventional types of structure and foundation with no exceptional risk or difficult ground or loading conditions, as defined by BS EN 1997-1:2004.

5.2 Structural Foundations

5.2.1 Spread Foundations

As detailed above, the development is understood to comprise the construction of a large commercial warehouse, with foundations being vertically loaded. The foundation assessment has been undertaken in accordance with BS EN 1997-1:2004 to take in to account;

- Bearing Pressure (Ultimate Limit State)
- Settlement (Serviceability Limit State)

The ground conditions are considered suitable for the use of conventional spread foundations, either strip footings or pad foundations bearing on the underlying River Terrace Deposits.

Allowable bearing capacities have been calculated for depths of up to 2.0m for the underlying natural soils and are provided in the table below:

Foundation Depth (m)	Allowable Bearing Capacity* (kN/m ²)	
	Strip	Pad
1.0	95	110
1.5	100	120
2.0	105	125

* BS EN 1997 (EC7) Geo Load Combination 2

The allowable bearing capacity is the permissible increase in vertical stress at the level of the underside of the foundation, above existing overburden pressure, which may be calculated on the basis of a soil density of 18kN/ m³. The above allowable bearing capacities are provided on the basis that a minimum undrained shear strength of 60kPa can be achieved in any foundation excavation and if this isn't the case foundations would need to either be deepened or an alternative solution considered.

At the above bearing capacity, total settlements in soils are unlikely to exceed approximately 20mm to 25mm. Settlements in cohesive soils will comprise a relatively small proportion of immediate settlement and a larger portion of consolidation settlement which will take place over a long period of time. Settlements in granular soils will occur rapidly as loadings increase, with limited long-term consolidation being anticipated. Where foundations cross a change in strata, from cohesive to granular, it is recommended that nominal reinforcement is incorporated to control the effects of differential settlements.

A minimum foundation depth of 0.8m, below existing or proposed ground level is currently considered suitable for the site, subject to the following provisos: -

- Foundations should fully penetrate any made/ disturbed ground (currently recorded up to 2.50m deep) and should extend a minimum of 150mm in to undisturbed natural strata. It should be noted that foundations are to be removed from much of the site and this will likely disturb ground to greater depths than already encountered and will most likely result in foundations significantly deeper than the advised minimum.

- b) The cohesive soils will be subject to volume change (subsidence and / or heave) due to the presence of trees / vegetation. Foundations will therefore need to take into account the presence of trees, including those adjacent to the site boundaries. Laboratory analysis has established that the shallow cohesive River Terrace Deposits as having 'low volume change' potential in accordance with NHBC Standards Chapter 4.2 'Building Near Trees', whilst the deeper London Clay has a 'high volume change potential'.

It is recommended that all trees present locally, including those to be planted or recently removed, are given full consideration in the design process so that the impact of these may be taken in to account in foundation design.

Where foundations exceed 1.5m in depth due to the influence of trees / vegetation, full anti-heave precautions will need to be adopted.

5.2.2 Piles

Should structural loads exceed the allowable bearing capacities advised in Section 5.2.1 above then the use of a deep foundation solution, such as piles could also be considered.

Piles are considered likely to terminate in the underlying London Clay and will likely carry their loads in a combination of end bearing and skin friction. It would be unwise to assume any positive contribution to skin friction within any made or disturbed ground.

A preliminary assessment of potential pile capacities, for single isolated continuous flight auger (CFA) piles has been provided in the table below, although in view of the wide variety of piles sizes available, and the range of installation plant and techniques, the design of the piles should be carried out by, and should remain the responsibility of the specialist piling contractor, who will reflect their own methods, experience and design procedures within their proposals.

Depth of pile below ground level (m bgl)	Approximate Allowable Working Load (kN)		
	300mm Diameter Pile	450mm Diameter Pile	600mm Diameter Pile
15	195	325	475
18	255	415	600

5.3 Ground Floor Construction

Given the depth of made ground encountered and the underlying cohesive soils, the use of suspended ground floor slabs would typically be the most appropriate.

However, it is recognised that this may not prove an economic solution for a development of this nature and if required, consideration could be given to the use of ground-bearing floor slab construction, provided any shallow made ground or natural cohesive material is removed and replaced with an imported granular fill that is compacted in layers to a suitable specification to ensure that the slab is constructed within allowable tolerances.

5.4 Groundworks

Whilst excavations in the natural cohesive soils may remain stable for short periods (although they were very gravelly in places) during construction the long-term stability of these and any excavations in granular soils or made/ disturbed ground should not be relied upon in unsupported excavations.

Heavy plant and stockpiles of materials should not be permitted close to the edges of unsupported excavations. Further reference may be made to CIRIA Report No. 97 'Trenching Practice' 1992.

Groundwater has been found to rest at depths as shallow as 2.13m and therefore, it is possible that significant quantities of groundwater could be present in excavations. On this basis, shoring and groundwater control techniques may be required.

5.5 Drainage

Infiltration testing was undertaken in three trial pit locations (SK01, SK02, SK05) in general accordance with BRE Digest 365. The results of the testing are detailed in the table below:

Trial Pit Location	Test Depth (m bgl)	Infiltration Rate (m/s)	Comments
SK01 (test 1)	1.35	2.117×10^{-5}	Complete test
SK02 (test 1)	1.5	4.261×10^{-5}	
SK02 (test 2)	1.5	2.459×10^{-5}	
SK05 (test 1)	1.5	-	Readings could not be taken in this test due to rapid infiltration. The entirety of a 2000L water tanker drained almost instantaneously into the ground, with the rate at no time slow enough to take readings. It took approximately 12 minutes to drain the tanker on each occasion.
SK05 (test 2)	1.5	-	
SK05 (test 3)	1.5	-	

The results of the infiltration testing in SK01 and SK02 are generally indicative of 'medium to low permeability' conditions.

The testing in SK03 indicates good permeability conditions and is likely to be associated with it being undertaken in the granular layer of River Terrace Deposits.

Based on the results, it is possible that an infiltration drainage solution will be suitable at the site, particularly if the water drains directly into the granular layer and provided the water table is not too high. Further testing targeting this layer is recommended to be undertaken to confirm this.

It is further recommended that soakaways aren't placed within 5m of existing or proposed structures.

5.6 Concrete Grade

Sulphate contents and pH values determinations were carried out for the natural material by the analytical laboratory, the results of which are also included within Appendix F. Results for concrete grade are summarised within the following table:

Strata	Water Soluble Sulphate (mg/l SO ₄)		Total Potential Sulphate		pH	
	Min	Max	Min	Max	Min	Max
Made Ground	6.6	412.7	-	-	8.67	11.16
River Terrace Deposits	3.2	182.2	-	-	7.97	9.44
London Clay Formation	12.2	275.8	0.84	3.00	7.92	9.02

In accordance with Part 1 of the BRE Special Digest 1 'Concrete in Aggressive Ground' 2005, a Design Sulphate Class (DS) of DS-1 with an aggressive chemical environment for concrete (ACEC) of AC-1 is considered appropriate for the Made Ground and River Terrace Deposits on site. However, for the underlying London Clay, a Design Sulphate Class (DS) of DS-3 is considered appropriate, with an aggressive chemical environment for concrete (ACEC) of AC-3 due to concentrations of total potential sulphate.

5.7 Re-Use of Materials

Depending on final site levels, there may well be the opportunity to re-use site-won materials on site as part of either structural or indeed general filling operations. This would require the materials to be proven 'suitable' in both an environmental and geotechnical sense and any potential wastes would need a suitable framework such as a Materials Management Plan (see Section 6.8) to justify their re-use.

Initially, it would seem that shallow natural cohesive soils are likely to comply with the requirements of Class 2, General Cohesive Fill, of the 'Manual of Contract Documents for Highways Works, Volume 1, Specification for Highways Works', whilst the natural granular soils are likely to comply with the requirements of Class 1, General Granular Fill. Some of the granular may well be suitable as Class 6, Selected Granular Materials, although the fines content does appear slightly high in some locations. Testing detailed below should be undertaken as part of the further works to confirm appropriate materials classification.

5.7.1 General Fill Specification

In general, all fill should comply with the 'Manual of Contract Documents for Highways Works, Volume 1, Specification for Highways Works'. Compaction of any fill materials shall be in accordance with Table 6/ 4 of the Specification for Highways Works.

Immediately prior to placing the first layer of any fill, all surfaces upon which fill is to be placed shall be cleaned of all objectionable materials in an approved manner. Such surfaces shall have all water removed from depressions and shall be properly monitored to obtain a suitable bond with the fill.

No vegetable matter, other perishable material shall be placed in the fill.

The fill shall be prepared by levelling, moistening (if required) and rolling so that the surface materials will be compacted and will provide a satisfactory bonding surface.

Materials to be used for fill, which for whatever reason become, or when placed are too wet for immediate compaction shall be placed in temporary stockpiles or removed until the moisture content is reduced sufficiently to permit adequate compaction. Conversely, excavated material with a moisture content lower than that required, to ensure adequate compaction shall be wetted before placement.

Prior to placement, the fill shall be tested for the following:

- Particle Size Distribution
- Plasticity Index
- Optimum Dry Density (2.5kg compaction)
- Natural Moisture Content

The in-situ competency of the fill shall be checked at regular intervals to ensure that they are placed to the required effort. This should include either, plate load testing, sand replacement density testing or nuclear density meter testing. In addition, the fill may also be checked using a hand shear vane or perth penetrometer, depending on material properties.

The fill should be placed to ensure that at least 95% of the optimum dry density is being achieved. If this is not achieved, then the fill may need to be removed and re-compacted.

6 ENVIRONMENTAL APPRAISAL

The following section outlines the approach applied to assessing the risks posed to human health and controlled waters, then identifies any sample results found by this investigation which warrant further consideration. In accordance with the Environment Agency's Land Contamination: Risk Management, this section represents the second tier of Stage 1, the Generic Quantitative Risk Assessment.

6.1 Human Health

6.1.1 Land Use Setting & Generic Screening

In order to screen laboratory data for concentrations of contaminant in soil with potential to cause harm to human health in a commercial land-use setting, relevant generic screening values for contaminants in soil have been used. The technical framework used to derive the assessment criteria and the documents in which they are published are summarised as follows:

- EA Science Reports (SC050021/ SR2, SC050021/ SR3, and SC050021/ SR7)
- EA Soil Guideline Value Science Reports
- Suitable for Use Levels (S4ULs) for Human Health Risk Assessment – LQM and CIEH (2015)
- Soil Generic Assessment Criteria for Human Health Risk Assessment - EIC/ AGS/ CL: AIRE (2010)
- Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 – DEFRA (2013)

A summary of the screening criteria and the methodology used to derive them is included in Appendix I.

6.1.2 Assessment of Results- Human Health

The results of the screening process for on-site human receptors showed that generic screening criteria, where available, protective of future site users were not exceeded for any contaminant at any location.

Some relatively low concentrations of VOCs and SVOCs have been identified at selected locations, with one more notable concentration (53.568mg/ kg) of Benzylbutyl Phthalate identified within a shallow soil sample in BH3. This borehole is located in the north-eastern part of the site where contamination has been historically identified. However, a groundwater sample from the same borehole did not identify concentrations of this compound above method detection limit, suggestive that vertical migration has been limited. It is therefore unlikely to represent contamination capable of posing a significant risk to future site users as any human interaction will be prevented by capping of the site, however further testing in this area should be undertaken during the second phase of works to confirm this low level of risk. Once a comprehensive dataset is available, the risk can be reviewed with the development of site-specific assessment criteria if necessary.

6.2 Controlled Waters

6.2.1 Generic Screening

In addition to screening the recorded concentrations of contaminants in soils capable of posing a risk to human health, EPS has also screened the results of groundwater analysis for potential to cause harm to water resources.

The criteria used for this process were derived by EPS using the following technical guidance:

- Environment Agency Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination.

Resource Sensitivity of Area	Basis of Tier 1 Criteria
High Groundwater Resource Potential (HGwRP) - Principal Aquifers	UK Drinking Water Standards (UKDWS)
Low Groundwater Resource Potential (LGwRP) - Secondary Aquifers not being abstracted and Unproductive groundwater strata	UK Environmental Quality Standards (EQS)

Screening criteria for Low Groundwater Resource Potential (LGwRP) have been adopted for this site due to the underlying geology being classified as a Secondary A Aquifer and taking account of the nearby watercourse (where EQS would typically apply).

6.2.2 Assessment of Results- Controlled Waters

The screening process has shown that screening criteria, where available, protective of controlled waters have not been exceeded by any groundwater samples.

Although very minor detections of the chlorinated solvents TCE, DCE and Vinyl Chloride were identified within the groundwater sample obtained from BH3, the concentrations of these detections (5ug/l, 4ug/l and 0.2ug/l) are very low and only very slightly above method detection limit, and all within their respective Water Quality Standards. Even if the most-sensitive UK Drinking Water Standards are referenced, the concentrations recorded on site for these chlorinated solvents are still very low (UK DWS of 10ug/l, 10ug/l and 0.5ug/l would apply respectively for these compounds).

On this basis, the identified contamination is considered unlikely to be capable of posing a significant risk to controlled waters in the context of the sensitivity of the site. This is a preliminary finding, which will need to be confirmed once further investigation data becomes available for key areas of the site (particularly across the north, and northeast).

6.3 Assessment of Risks from Soil Vapour – Inhalation

To assess the risks to future site users from vapour intrusion, a series of 11 soil gas monitoring points were fitted with a stainless steel sparge point towards the base of the borehole. The screened section was installed between 1.65m and 1.8m within each borehole.

This risk assessment has been undertaken using site-specific information, where available, to derive risk-based assessment criteria.

6.3.1 Methodology

Following collection of soil vapour analytical data, it is possible to further assess the vapour migration and inhalation pathways. The focus of this assessment is on vapour intrusion to indoor air as this is the critical exposure pathway for the vapour inhalation pathways.

Use of soil vapour data removes some of the uncertainty when assessing risks from vapour intrusion, as the partitioning and volatilisation from soil/ groundwater to soil gas does not need to be modelled as it is measured directly.

6.3.2 Model Selection

There are a number of human health modelling software packages capable of modelling risks from CoC concentrations measured in soil gas. One of these is CLEA 1.07 and as such it has been adopted as a suitable modelling tool to assess the potential risks to human health receptors from CoC in soil gas.

6.3.3 Chemical and Toxicological Parameters

The toxicological parameters were selected following the guidance presented within SR2 using the pre-loaded data within the CLEA model.

6.3.4 Model Input Parameters

In order to accurately reflect the risk to the offsite receptors, the following basic model input parameters were used.

Land Use	Commercial
Receptor	Female (com) 16-65yrs
Building	Office (post-1970)
Soil Type	Sandy Loam

It should be noted that the model set up is considered to represent a conservative scenario as for the purpose of risk assessment.

6.3.5 Selection of Contaminants of Concern

A number of contaminants were measured at concentrations above laboratory MDL. In the absence of detailed modelling information available for some of these contaminants, the following have been used to represent the potential risks associated with inhalation of volatile contaminants by neighbouring residents.

- Carbon Disulphide
- Xylenes
- Styrene
- Trichloroethene
- Tetrachloroethene
- 1,1,1 – trichloroethane
- Aliphatic C5-C6
- Aliphatic C8-C10
- Aliphatic C10-C12
- Aromatic EC5-EC7 (Benzene)
- Aromatic EC7-EC8 (Toluene)
- Aromatic EC8-EC10
- 2 Propanone (Acetone)

6.3.6 Assessment of Risks from Vapour Inhalation

Maximum concentrations of the selected contaminants measured within the soil vapour sampled were input into the model to assess the risks to current and future on-site receptors. The CLEA Output is presented as Appendix J.

The results of the soil gas assessment indicate that the maximum measured concentrations of all contaminants in soil vapour do not present an unacceptable level of risk to current or future site users, with the calculated hazard indices for all contaminants being 0.00, which falls significantly below the trigger value of 1.0.

As such the risks to future site users from volatile contamination originating at the site is considered to be acceptable. This assessment also demonstrates that off-site risks from site-derived contaminant sources generating organic vapours to neighbouring residential properties are unlikely to be significant.

In addition, concentrations of volatile organic compounds were not identified above 0.5ppmV during any soil gas monitoring visit (see Table 4), which corroborated the low-risk findings of the quantitative assessment.

6.4 Preliminary Ground Gas Risk Assessment

The results of the soil gas monitoring are presented in Table 4 and have been assessed in accordance with CIRIA guidance 'Assessing Risks Posed by Hazardous Ground Gases to Buildings' (C665). It is acknowledged that the current dataset (three monitoring visits but none at falling barometric pressure) is too limited to generate Gas Screening Values in accordance with this guidance. As such these preliminary values have been calculated, with the final values to be confirmed once further monitoring data becomes available for the whole site.

Results of the monitoring visits show that no discernible flow was recorded at any of the borehole locations and that no methane was measured above minimum instrument detection limits of 0.1% v/ v. Carbon dioxide was only encountered at a maximum of 0.1% within three boreholes.

As proposed development plans are understood to include the construction of a commercial warehouse building, the 'Modified Wilson and Card Classification System' has been used to assess the risks from ground gases, (in accordance with CIRIA C665).

The maximum individual Gas Screening Value (GSV) is calculated by multiplying the maximum borehole flow rate (l/ hr) by the maximum gas concentration (%). This gives a gas screening value for both methane and carbon dioxide of <0.0001l/ hr, which falls into the 'very low risk' category and Characteristic Situation 1 (CS1) conditions.

These results are also confirmed by the findings of the laboratory gas analysis from the summa canisters obtained on site, which did not identify any concentrations of methane above method detection limit of 0.05%, whilst carbon dioxide was measured at a maximum concentration of 0.07%.

6.5 Refined Conceptual Site Model

The contaminant linkages presented in the Conceptual Site Model all require the dataset for the whole site prior to re-evaluation. As this is not yet available, a refined CSM cannot yet be presented. However, based on the available findings there is no reason to suggest that additional linkages should be included in the CSM and the majority, if not all, of the current linkages may well not be active. That would remove the need for any formal below-ground remediation, with the exception of measures typically required to protect buried infrastructure. Barrier drinking water pipes are likely to be required regardless of the findings of the supplementary investigation.

6.6 Summary of Findings

The previous Phase I Desk Study identified the site to comprise a pharmaceutical distribution centre, formerly used as a pharmaceutical manufacturer. On this basis, a number of plausible contaminant linkages were identified associated with human interaction with shallow soils, intrusion of organic vapour to buildings and risks to controlled waters.

The intrusive investigation comprised the drilling of 22 boreholes and 12 trial pits across the site, with ground conditions found to comprise a moderate thickness of made ground overlying successive layers of cohesive and granular River Terrace Deposits. Below this lay London Clay Formation which comprised of a soft initial layer of silt overlying stiff, grey clay.

Whilst this investigation involved detailed investigation of the western half of the site, only sporadic investigation was possible in the eastern and north eastern areas due to the presence of operational buildings. These latter areas include the majority of the Potential Areas of Concern, so further investigation will be needed to finalise the Conceptual Site Model and, if necessary, the Remedial Strategy for the whole site to ensure safe redevelopment. These initial findings should therefore be considered preliminary. However, the sporadic investigation and monitoring that was possible in these areas, coupled with findings of the available previous investigation (by Golder Associates and ERM in the past), suggests that significant risks from site-derived contamination do not exist and there is no obvious barrier to redeveloping the site (in terms of contamination). In addition, even without the remaining data the available dataset almost certainly confirms that the site does not pose a significant possibility of significant harm to existing receptors and would not warrant determination as 'contaminated land' under Part 2A of the Environmental Protection Act 1990 (although that decision would remain the value judgement of the LPA).

Laboratory analysis of shallow and deeper soils from across the site has not identified concentrations of contaminants to exceed the adopted screening criteria protective of future site users in a commercial setting. An initial assessment of the risks posed has not identified a significant risk to either human health or controlled waters, although further testing during the supplementary phase of works is necessary confirm the risk assessment and final Conceptual Site Model. As part of this process, it may be necessary to develop site-specific assessment criteria for certain compounds which currently lack readily available published screening criteria, such as the semi-volatile organic compounds encountered in BH3.

In addition to this, laboratory testing of groundwater has not identified concentrations which are considered to pose a risk to the groundwater body, whilst detailed quantitative soil vapour analysis has not identified a risk associated with intrusion of volatile organic compounds into future buildings. An initial programme of ground gas monitoring has found the site to fall into Characteristic Situation 1, for which no ground gas protection measures would be required.

Once the Conceptual Site Model is finalised, remedial requirements (if needed) can be appraised and presented in a strategy for review by regulators and the client. Even if no risks are identified through the next phase of investigation, there will still be a need for an outline remedial approach for dealing with any unforeseen contamination, through a Discovery Strategy.

In the context of potentially unacceptable or acceptable risks as outlined within the Environment Agency's Land Contamination: Risk Management guidance, risks have not been identified by this work that require mitigation, however it should be noted that further investigation is planned in currently inaccessible areas of the site, subsequent to demolition of the current buildings.

6.7 Recommendations

Although significant risks have not been identified as part of this investigation, additional investigation is currently planned subsequent to the demolition of the onsite buildings. It is recommended that as part of these works, additional soil, ground gas and groundwater monitoring be undertaken, particularly in the east and north / north-eastern sections of the site in order to further assess the risks from remaining Potential Areas of Concern, areas of contamination identified in historic investigations, as well as the concentration of Benzylbutyl Phthalate found in BH3 during this investigation.

The issue of whether the necessary site clearance is considered 'commencement' of the planning permission should be discussed with the LPA to ensure that a breach of planning consent is avoided. The agreement of the final Conceptual Site Model and Remedial Strategy would typically be a pre-commencement requirement, but in this instance, it is not possible to complete these aspects without undertaking the site clearance for the reasons stated above. This is not an uncommon issue and likely to be agreeable with the LPA provided no construction commences before all pre-commencement requirements of the planning process relating to contamination have been fully agreed.

The site is obviously large and complex so prior to undertaking any further investigation, this report should be submitted to Havant Borough Council (who may consult the Environment Agency) so that any comments that either regulatory body wish to make can be accommodated into the scope of works.

6.8 Waste Management

Depending on the requirements of the final scheme and any associated earthworks balance, it is possible that the site will be subject to a materials management exercise to ensure all potential waste soils are handled and re-used in a legally correct sustainable fashion.

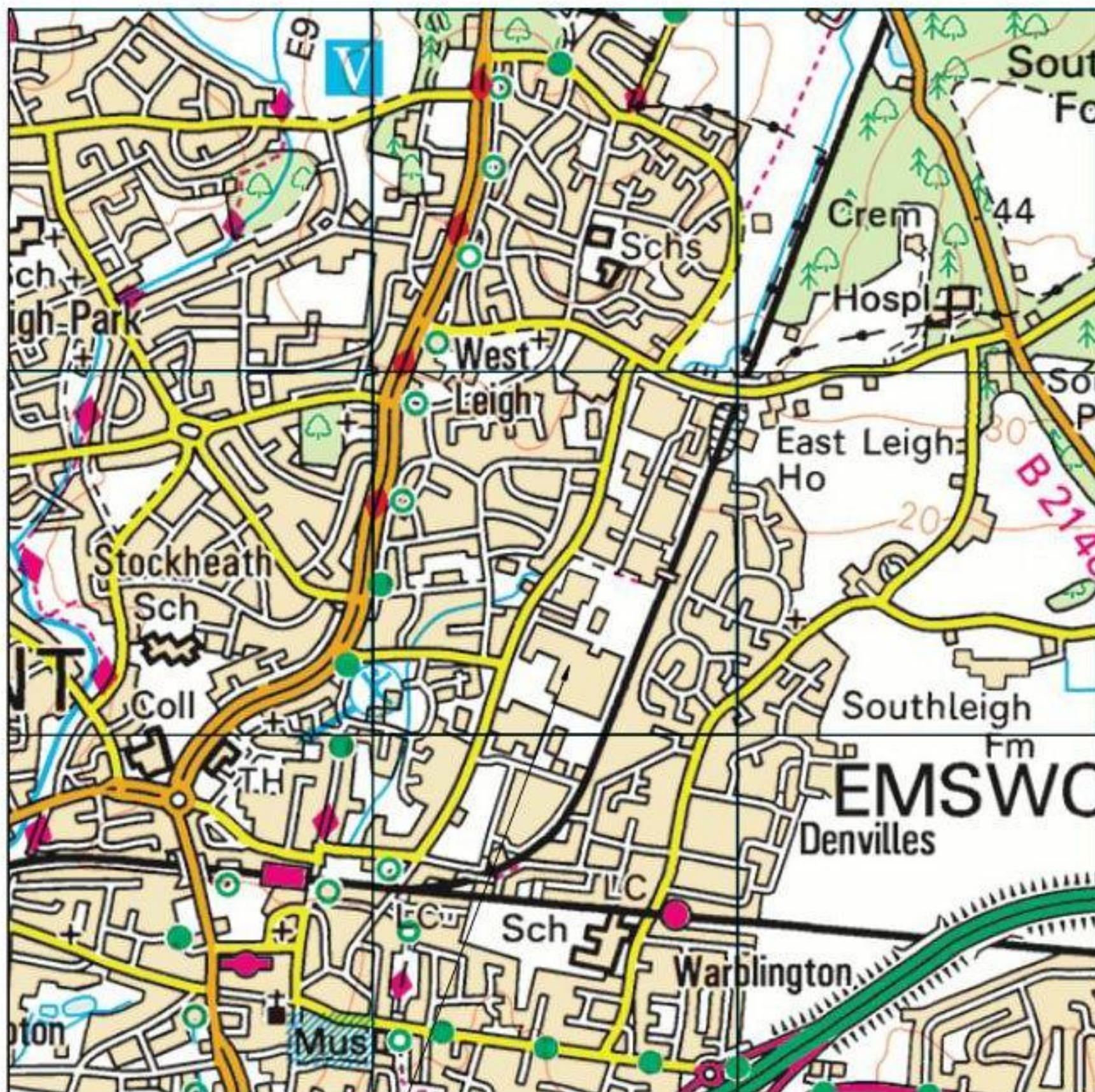
In those circumstances, through a risk assessment process and in accordance with CL:AIRE's Definition of Waste: Development Industry Code of Practice, re-use criteria can be defined for site-won soils which are suitable for use being both protective of relevant receptors and geotechnically appropriate (with input from the structural engineers as necessary). If requested, EPS can prepare a Materials Management Plan and have it formally declared by a Qualified Person prior to commencement of groundworks. EPS can also assist with similar mechanisms for re-using waste materials exempt of an environmental permit, such as a U1.

Where viable, EPS would always encourage the employment of an MMP to sustainably manage the re-use of site won soils and minimise the highly unsustainable practise of landfilling.

7 GLOSSARY

BPF	Biotech Packaging Facility
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes
CoC	Contaminant of Concern
CSM	Conceptual Site Model
DCE	1,1 Dichloroethene
EA	Environment Agency
EDC	European Distributing Centre
FCMU	Fine Chemicals Manufacturing Works
HBC	Havant Borough Council
MTBE	Methyl Tert Butyl Ether
PAOC	Potential Areas of Concern
PCE	Tetrachloroethene
PFC	Perfluorinated Chemicals
PFOA	Perfluorooctanic Acid
PFOS	Perfluorooctane Sulforate
UST	Underground Storage Tank
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
VC	Vinyl Chloride
WALL	CL:AIRE Water and Land Library

FIGURES



Approximate Site Location

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Title: Site Location Plan

Project: 32/New Lane, Havant

FigNo: 1

Scale: NTS

Drawn By: MJ

Approved By: SB

Job/No: UK20.5052c

Dwg/No: 32NewLane/ 0321/ 01

Date: March 2021



— Approximate Site Boundary

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Title: Current Site Layout

Project: 32 New Lane, Havant

Fig No: 2

Scale: NTS

Drawn By: MJ Approved By: SB

Job No: UK20.5052c

Dwg No: 32NewLane/0321/02

Date: March 2021



— Approximate Site Boundary

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Title: Aerial Photograph

Project: 32 New Lane, Havant

Fig No: 3

Scale: NTS

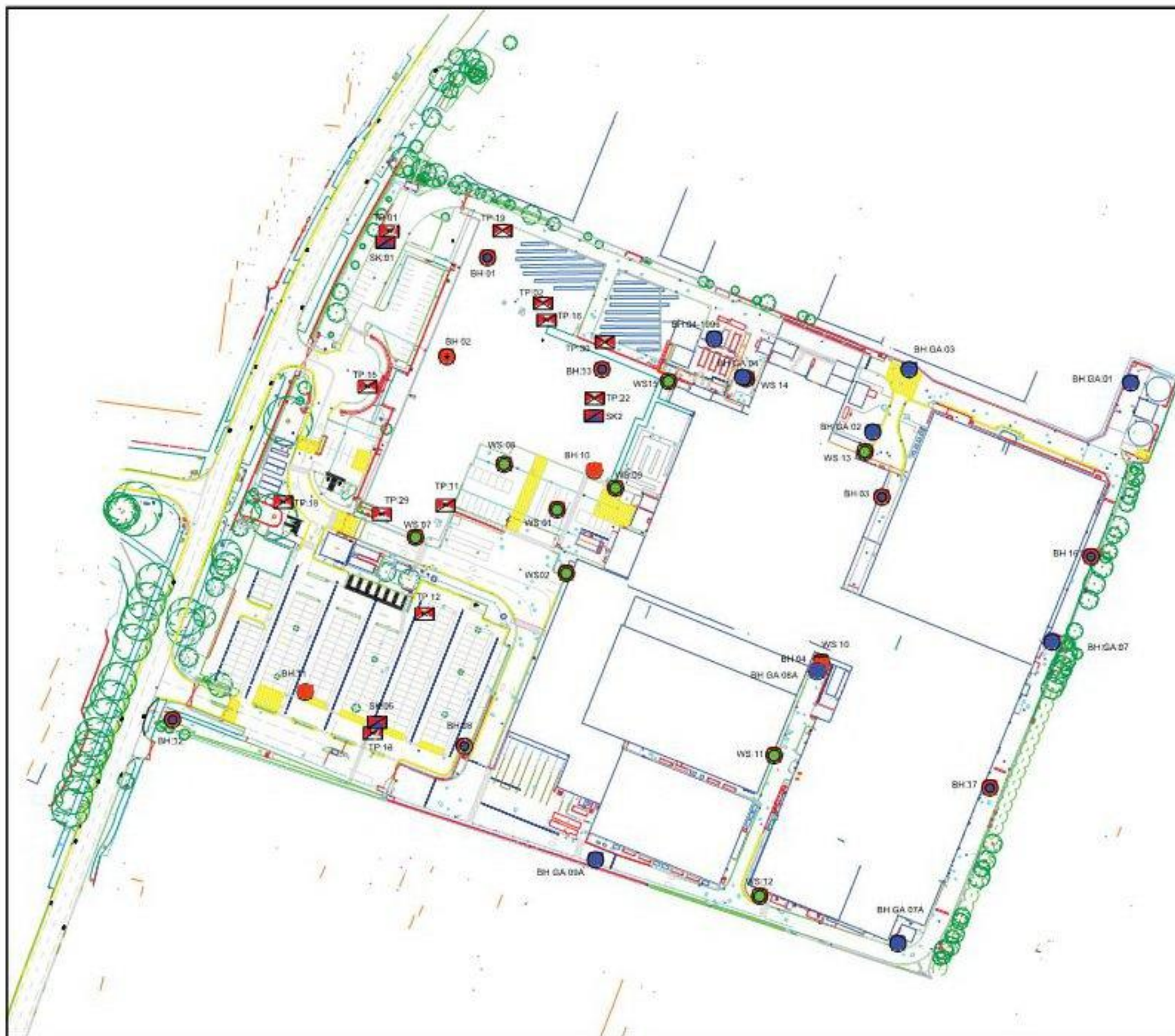
Drawn By: MJ

Approved By: SB

Job No: UK20.5052c

Dwg No: 32NewLane/ 0321/ 03

Date: March 2021



KEY:

-  Trial Pit
-  Borehole (Geotechnical)
-  Borehole (Monitoring Well)
-  Gas well
-  Soakaway Test (Trial Pit)
-  Borehole (Existing Monitoring Well)

Fig No: 4

Title: Borehole & Trial Pit Location Plan

Project: Pfizer, 32 New Lane, Havant

Scale: NTS, For Illustration purposes only
 Drawn By: M
 Job No: UK20-5052
 Drawn By: Havant 0321/04
 Date: March 2021



TABLES

Table 1a – Laboratory Testing Schedule (Environmental - Soil)

Sample ID	Sample Depth (m bgl)	EPS Mini Suite	EPS TPH Suite	EPS Waste Suite	VOC & SVOC	PCB	Ammonical Nitrogen	pH and Water Soluble Sulphate	Asbestos Screen
BH1	2.5	-	-	-	-	-	-	1	-
BH1	2.5-3.0	1	1	-	1	-	-	-	-
BH1	10.0-10.45	-	-	-	-	-	-	1	-
BH02	3.5-4.0	1	1	1	1	1	1	-	-
BH03	0.0-0.8	1	1	-	1	1	1	-	-
BH3	2.95-3.0	-	-	-	-	-	-	1	-
BH03	3.0-4.0	1	1	-	1	-	1	-	-
BH3	12.45-12.5	-	-	-	-	-	-	1	-
BH04	0.5	1	1	-	1	1	1	-	-
BH4	5.5-5.95	-	-	-	-	-	-	1	-
BH4	14.95-15	-	-	-	-	-	-	1	-
BH4	17.5-17.95	-	-	-	-	-	-	1	-
BH6	1.15-1.2	-	-	-	-	-	-	1	-
BH6	3.95-4.0	-	-	-	-	-	-	1	-
BH6	9.45-9.5	-	-	-	-	-	-	1	-
BH8	0.8	1	1	-	1	-	-	-	-
BH8	2.5-3.0	1	1	-	1	-	-	-	-
BH8	11.95-12	-	-	-	-	-	-	1	-
BH10	2.5-3.0	-	-	-	-	-	-	1	-
BH10	7.0-9.0	1	1	-	1	-	1	-	-
BH10	10.45-10.5	-	-	-	-	-	-	1	-
BH11	0.0-0.5	1	1	-	1	1	1	-	-
BH11	3.6-4.0	-	-	-	-	-	-	1	-
BH11	11.5-11.95	-	-	1	-	-	-	1	-
BH12	0.0-0.5	1	1	-	1	1	1	-	-
BH12	2.5-3.0	1	1	-	1	-	-	1	-
BH12	7.45-7.5	-	-	-	-	-	-	1	-
BH13	1	1	1	-	1	1	1	-	-
BH13	4.95-5.0	-	-	-	-	-	-	1	-
BH13	6.0-6.5	1	1	-	1	1	1	-	-
BH13	8.95-9.0	-	-	-	-	-	-	1	-
BH16	2.95-3.0	-	-	-	-	-	-	1	-
BH16	4.9-5.0	-	-	-	-	-	-	1	-
BH16	6.5	1	1	-	1	-	1	-	-
BH16	11.95-12.0	-	-	-	-	-	-	1	-

BH17	0.4-0.8	-	-	-	-	-	-	-	-
BH17	3.95-4.0	-	-	-	-	-	-	1	-
BH17	5.95-6.0	-	-	-	-	-	-	1	-
BH17	8.95-9.0	-	-	-	-	-	-	1	-
WS2	0.3-0.5	1	1	1	1	1	1	-	-
WS7	0.5-0.7	1	1	-	1	1	1	-	-
WS8	0.9-1.0	-	-	1	-	-	-	-	-
WS9	0.6-0.8	1	1	-	1	1	1	-	-
TP01	0.5	-	-	-	-	-	-	-	1
TP02	0.5	-	-	-	-	-	-	-	1
TP11	0.5	-	-	-	-	-	-	-	1
TP11	1.5	1	1	-	1	1	1	-	-
TP12	0.2-0.4	-	-	-	-	-	-	-	1
TP12	2.1	1	1	-	1	1	1	-	-
TP13	0.2-0.25	1	1	-	1	-	1	-	-
TP15	0.3-0.7	1	1	-	1	1	1	-	-
TP15	1	1	1	-	1	-	1	-	-
TP16	1.6	1	1	-	1	-	1	-	-
TP18	1.2-1.3	-	-	-	-	-	-	-	-
TP19	0.5	-	-	-	-	-	-	-	1
TP22	0.5	-	-	-	-	-	-	-	1
TP22	1.2	1	1	-	1	-	1	-	-
TP29	0.5	-	-	-	-	-	-	-	1
TP30	1.8	1	1	-	1	1	1	-	-

Notes:

mbgl

1

-

EPS Mini Suite

EPS TPH Suite

EPS Waste Suite

VOC

SVOC

PCB

meters below ground level

Sample Taken

Sample Not Analysed

Organic Matter, Cyanide, Metals, PAH's, Phenols, Asbestos, pH, sulphates

TPH CWG, BTEX, MTBE

Waste Characterisation Suite

Volatile Organic Compounds

Semi-Volatile Organic Compound

Polychlorinated Biphenyls

Table 1b – Laboratory Testing Schedule (Environmental - Groundwater)

Sample ID	EPS Mini Suite	EPS TPH Suite	Ammoniacal Nitrogen	VOC & SVOC	PCB	Ferrous Iron
BH1	1	1	1	1	1	1
BH3	1	1	1	1	1	1
BH8	1	1	1	1	1	1
BH12	1	1	1	1	1	1
BH16	1	1	1	1	1	1
BH17	1	1	1	1	1	1
BH04 1996	1	1	1	1	1	1
BHGA01	1	1	1	1	1	1
BHGA02	1	1	1	1	1	1
BHGA03	1	1	1	1	1	1
BHGA04	1	1	1	1	1	1
BHGA07	1	1	1	1	1	1
BHGA07A	1	1	1	1	1	1
BHGA08A	1	1	1	1	1	1
BHGA09A	1	1	1	1	1	1

Notes:

mbgl

1

-

EPS Mini Suite

EPS TPH Suite

VOC

SVOC

meters below ground level

Sample Taken

Sample Not Analysed

Organic Matter, Cyanide, Metals, PAH's, Phenols, Asbestos

TPH CWG, BTEX, MTBE

Volatile Organic Compounds

Semi-Volatile Organic Compound

Table 1c – Laboratory Testing Schedule (Environmental – Soil Gas)

Sample ID	TO15 List + TICs	Ground Gases	Hydrogen Sulphide	THP	Limonene
WS01	1	1	1	1	
WS02	1	1	1	1	
WS07	1	1	1	1	
WS08	1	1	1	1	
WS09	1	1	1	1	
WS10	1	1	1	1	
WS11	1	1	1	1	
WS12	1	1	1	1	
WS13	1	1	1	1	
WS14	1	1	1	1	
WS15	1	1	1	1	

Notes:

mbgl

1

-

Ground Gases

meters below ground level

Sample Taken

Sample Not Analysed

Carbon Dioxide, Methane, Oxygen, Nitrogen, Carbon Monoxide

Table 2 – Laboratory Testing Schedule (Geotechnical)

Sample ID	Sample Depth (m bgl)	Moisture Content	Liquid / Plastic Limits	Particle Size Distribution	Undrained Triaxial	Oedometer Consolidation
BH1	4.5-5.0	-	-	1	-	-
BH1	12.0-12.5	1	1	-	-	-
BH3	2.0-2.5	-	-	1	-	-
BH3	5.0-5.45	-	-	-	1	-
BH3	12.0-12.45	-	-	-	1	-
BH4	3.5-4.0	1	1	-	-	-
BH4	11.5-11.95	-	-	-	1	1
BH4	19.0-19.45	-	-	-	1	1
BH6	1.2-1.65	-	-	1	-	-
BH6	9.0-9.45	-	-	-	1	-
BH8	2.5-3.0	-	-	1	-	-
BH8	8.5-8.95	-	-	-	1	-
BH8	10.0-10.45	1	1	-	-	-
BH8	14.5-14.95	-	-	-	1	-
BH10	1.5-2.0	1	1	-	-	-
BH10	3.5-4.0	-	-	1	-	-
BH10	5.5-5.95	-	-	-	1	1
BH10	5.95-6.0	1	1	-	-	-
BH10	14.5-14.95	-	-	-	1	1
BH11	2.5-3.0	-	-	1	-	-
BH11	13.0-13.45	-	-	-	1	1
BH11	13.45-13.5	1	1	-	-	-
BH11	17.5-17.95	-	-	-	1	1
BH12	1.1-2.0	-	-	1	-	-
BH12	6.20	-	-	1	-	-
BH12	7.0	-	-	-	1	-
BH12	10.0	-	-	-	1	-
BH13	2.0-2.45	-	-	1	-	-
BH13	5.95-6.0	1	1	-	-	-
BH13	12.0-12.45	-	-	-	1	-
BH16	3.9-4.0	1	1	-	-	-
BH16	5.0-5.45	-	-	-	1	-
BH16	6.95-7.0	-	-	1	-	-
BH16	9.95-10.0	1	1	-	-	-
BH16	12.0-12.45	-	-	-	1	-



BH17	3.5-4.0	-	-	1	-	-
BH17	6.95-7.0	-	-	1	-	-
BH17	12.0-12.45	-	-	-	1	-

Notes:

mbgl

1

-

meters below ground level

Sample Taken

Sample Not Analysed

Table 3 - Groundwater Monitoring Parameters (18/02/2021)

Location	Depth to water (m bgl)	pH	Dissolved Oxygen (ppm)	Temperature (°C)	Redox	Electrical Conductivity (uS/cm)	Product Thickness
BH1	3.03	7.21	2.10	11.3	36.2	688.0	n/ a
BH3	2.55	7.48	1.80	11.6	111.7	561.0	n/ a
BH8	2.13	7.43	2.98	10.7	141.8	520.4	n/ a
BH12	2.20	7.12	0.83	11.5	6.86	1088	n/ a
BH13	3.05	7.40	2.64	11.2	141.8	622.7	n/ a
BH16	2.27	7.72	4.0	11.1	127.7	669.7	n/ a
BH17	2.80	7.11	0.41	12.2	1.5	744.0	n/ a
BHGA01	3.40	7.37	3.32	11.7	94.1	879.0	n/ a
BHGA02	2.61	7.87	6.10	9.5	122.6	577.5	n/ a
BHGA03	2.85	7.33	4.74	12.3	143.6	584.0	n/ a
BHGA04	2.16	7.65	6.47	11.5	148.9	569.0	n/ a
BHGA07	2.78	7.33	0.56	12.3	-69.0	654.4	n/ a
BHGA07A	2.83	7.19	4.0	11.3	104.5	1128	n/ a
BHGA09A	2.50	6.96	0.27	11.7	-64.3	1140	n/ a
BH08A	2.47	7.08	3.38	10.6	93.7	620.0	n/ a
BH-04-1996	2.30	7.58	7.63	10.6	171.5	538.9	n/ a

Notes

n/ a – not any

m bgl – metres below ground level

ppm – parts per million

Table 4 - Ground Gas Monitoring Data

(25/02/2021)

Sample ID	WS01	WS02	WS07	WS08	WS09	WS10	WS11	WS12	WS13	WS14	WS15
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
O ₂ (%)	20.7	20.4	20.8	20.7	20.6	20.6	20.4	20.6	20.5	20.6	20.5
Flow Rate (l/ hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Readings collected on 25th February 2021 at an atmospheric pressure of 1025-1026 (rising).

(05/03/2021)

Sample ID	WS01	WS02	WS07	WS08	WS09	WS10	WS11	WS12	WS13	WS14	WS15
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
O ₂ (%)	20.7	20.5	20.5	20.4	20.4	20.4	20.1	19.9	20.3	20.2	20.2
Flow Rate (l/ hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Readings collected on 5th March 2021 at an atmospheric pressure of 1029-1030 (rising).

(09/03/2021)

Sample ID	WS01	WS02	WS07	WS08	WS09	WS10	WS11	WS12	WS13	WS14	WS15
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
O ₂ (%)	20.8	20.7	20.7	20.5	20.6	20.5	20.4	20.5	20.5	20.5	20.7
Flow Rate (l/ hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
VOC	<.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Readings collected on 9th March 2021 at an atmospheric pressure of 1020-1020 (steady).

APPENDICES

APPENDIX A

Selected Site Photographs



— Approximate Site Boundary

① Approximate Photo Location

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Title: Photograph Location Plan

Project: 32 New Lane, Havant

Appendix A

Scale: NTS

Drawn By: MJ

Approved By: SB

Job No: UK20.5052c

Dwg No: 32NewLane/0321/A

Date: March 2021

Photo 1: View looking west at the northwest corner of the site.



Photo 2: View looking southeast across the site.



Photo 3: View looking north along the eastern edge of the site, with BH17 under the yellow cover.



Photo 4: View looking northeast, from the southwest corner of the site.



Photo 5: View looking west at the southwest corner of the site, with BH12 underway.



Photo 6: View looking south across the gravelled area in the west of the site.



Photo 7: TP12



Photo 8: TP1



APPENDIX B

Detailed Site Layout

