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PHASE II – LAND CONTAMINATION INTRUSIVE INVESTIGATION REPORT

Site: Land at Landvue, Rosudgeon, Penzance, Cornwall. TR20 9PA.

NGR: SW 5543 2965

Client: Miss K Trevorrow, Landvue, Rosudgeon, Penzance, Cornwall.

Planning Ref: PA18/01650

Date: 6th December 2019

Author: Miss C L Cauldwell, MSc PIEMA Environmental Scientist

Our Ref: CLC/CLC/SS/4513.f.SS

EXECUTIVE SUMMARY

Cornwall Consultants Ltd was commissioned by Miss K Trevorrow (client) to undertake a soil and human health risk assessment.

The client proposes to develop the site with a residential dwelling, associated gardens and parking. Cornwall Consultants Ltd carried out a Phase I – Land Contamination Desk Study (ref: AMR/AMR/SS/4513.b) in March 2018 and a Phase II - Intrusive Investigation Report was recommended. The Phase I Desk Study identified historic mining activity in the area and the natural strata as potential sources of contamination.

The site currently forms part of a residential garden. It is proposed to construct a residential dwelling with soft landscaped gardens and hard standing parking.

This survey constitutes a Phase II - Intrusive Investigation Report. The Phase II investigation has been conducted in order to assess the ground conditions and potential contaminants as identified in the Phase I report in March 2018. The Phase II Investigation involved the collection of ten soil samples taken from the proposed soft landscaped areas. Samples were collected on 4th September 2019 and sent to the laboratory for analysis. The analysis comprised a general suite of metallic elements and pH.

Elevated concentrations of arsenic were recorded within the topsoil. A hotspot (elevated concentration of arsenic) was also recorded within one sample. The risk to the future end users is considered moderate. Further testing in the form of arsenic bioaccessibility tests (UBM) were undertaken on the three samples (SS4, SS7 and SS8) which recorded the highest arsenic concentrations across the site. A site-specific assessment criteria (SSAC) was produced. The soil concentrations, with the exception of the hotspot are below the SSAC. The risk to the future end users, with the exception of the hotspot, is considered minimal. Remedial measures are not required across the majority of the site.

Further sampling and analysis were undertaken to delineate the hotspot area identified at sample location SS3. Six samples were taken around the hotspot sample and all recorded concentrations below the SSAC. The additional samples and analysis have provided a delineated area to be remediated, to protect the future end-users, as detailed within the report.

We recommend the above conclusion be confirmed in consultation with the Local Environmental Protection Officer at Cornwall Council. Once our recommendations have been approved and final plans for the development agreed a Phase III Remediation Method Statement will be required and submitted to Cornwall Council for approval prior to commencement of remedial measures. Finally a Phase IV Verification Report(s) will be formulated on completion of the remedial works and issued to Cornwall Council for approval.

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1.0 INTRODUCTION

1.1 Rationale

It is the aim of this investigation to carry out a Phase II - Intrusive Investigation Report on behalf of our client Miss K Trevorow. A Phase I – Desk Study was undertaken by Cornwall Consultants Ltd (ref: AMR/AMR/SS/4513.b.DS) in March 2018 and a Phase II was recommended.

The Phase I concluded that there are potential pollutant linkages and further assessment including soil sampling and chemical analysis is required. The Phase II assessment therefore should include an intrusive ground investigation (trial pits) and associated laboratory analysis to assess the potential risks to the end-user.

The client proposes to develop a residential garden with a residential dwelling and associated infrastructure. The proposed end-use will include soft landscaped gardens, parking area and hard landscaping. A plan of the site to be developed is included in Appendix A.

1.2 Objectives

The client's specific instructions were to undertake the recommended Phase II - Intrusive Investigation Report to accompany a planning application PA18/01650. The main objectives of the Phase II assessment are:

- Carry out an intrusive investigation involving collection/analysis of soil samples,
- Determine based on the results of the analysis if there is a significant risk to the identified receptors,
- Prepare a revised conceptual model from an understanding of the site; and
- Design a suitable remediation scheme that incorporates a risk based and proportionate approach-recognising that action to deal with soil must be practicable.

2.0 PHASE I ASSESSMENT

2.1 Summary of Phase I Desk Study

The Phase I report carried out by Cornwall Consultants Ltd identified the following potential sources of contamination;

- Elevated contaminants associated with the natural strata; and
- Historic mining activity in the immediate area

Intrusive sampling was recommended, which will constitute a Phase II risk assessment. Recommended laboratory analysis includes a suite of metallic elements and pH.

2.2 Initial Conceptual Site Model

The Phase I – Desk Study identified a number of pollutant linkages to formulate an initial Conceptual Site Model (CSM) as summarised below in Table 1.

Table 1: Pollutant Linkage Model

Source of Contamination	Pathway	Receptor	Risk
Potential elevated concentrations of contaminants associated with past mining activities in the area / Natural geology with elevated concentrations of metallic elements	Ingestion, dermal contact & inhalation	Humans & plant-life	Moderate
	Direct Contact	Built environment	Possible
	Migration	Environment	None

Possible pollutant linkages have been identified at the site as the pathway between the sources of contamination and the principal receptor.

3.0 SAMPLING AND ANALYSIS

This involved the collection of ten representative soil samples from the proposed garden areas. The analyses are discussed below and the full chemical analysis results are presented in Appendix B. The approximate location of the sample holes are illustrated on the plan presented in Appendix A.

The sample material from each point was a composite of the soil from surface to a maximum depth of approximately 300mm. The samples were taken at the site from the sidewalls of small hand dug holes. A fresh trowel was used to clean the face of the sidewall from which the sample was taken to ensure no cross contamination occurred. The samples were placed directly into pre-labelled sample pots, sealed, stored in cool conditions and then submitted for analysis the following working day.

3.1 Soil Observations

Samples 1 to 10 exhibited moderately compact dark brown / orange brown topsoil.

Groundwater

No groundwater was encountered across the site. However, only shallow hand dug pits to a maximum depth of 300mm were excavated.

Contamination

There were no obvious signs of contamination during the intrusive investigation.

Chemical analysis and soil sampling

The soil samples were analysed at Envirolab, Units 7&8, Sandpits Business Park, Mottram Road, Hyde, Cheshire, between 20th and 27th September 2019 for a suite of metallic elements and pH.

The laboratory is UKAS accredited, testing laboratory number 1247

3.2 Sampling Quality & Analysis

All sampling was undertaken by Cornwall Consultants Ltd working to standard department testing procedures.

4.0 DISCUSSION OF RESULTS

The Science Reports (SR) 'Updated Technical Background to the CLEA model' (SR3) and 'Human Health Toxicological Assessment of Contaminants in Soil' (SR2) both dated January 2009 have been used to assess the risks posed to human health.

Cornwall Consultants Ltd have adopted the Category 4 Screening Level (C4SL) as generic values to compare against recorded concentrations. A limited number of contaminants are currently available with more to be released in the near future.

In the absence of C4SL Cornwall Consultants Ltd have adopted the LQM (Land Quality Management*) CIEH (Chartered Institute of Environmental Health) S4UL's (suitable for use levels). Both the C4SL and LQM / CIEH S4UL's have been formulated using the CLEA software. For this site, where available, the default Suitable for Use Level (S4UL) for 'residential with home-grown produce' have been used.

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4.1 Statistical Analysis

Statistical analysis in accordance with the principals outlined in the SR guidance has been used to assess the chemical analysis test results. The statistical analysis has been carried out on one data set, topsoil. The statistical analysis spreadsheet is presented in Appendix C.

The Upper Bound Value with 95% confidence (US95) for the following contaminant exceeded the relevant LQM S4UL/C4SL:

Arsenic

US95 of 378.15 mg/kg exceeds the C4SL for residential land use with home-grown produce of 37mg/kg.

However, where the arsenic is either strongly bound to the surface of soil particles or present in an insoluble form, then its bioaccessibility may be less than 100% (bioaccessibility is the fraction that is soluble in the gastro-intestinal tract and is available for absorption by the human body). It may be possible to demonstrate that the proportion of arsenic available for absorption (expressed as a percentage) is less than 100%. This allows a Site Specific Assessment Criteria to be calculated which might remove the need for remediation. In our opinion, it is deemed appropriate to re-quantify through further testing. A decision was made to submit three samples to be analysed by the Unified BARGE Method (UDM) to ascertain a SSAC which **may** alleviate the need for remediation. The arsenic bioaccessibility test results are presented in Appendix B.

The US95 for all other contaminants tested for where the distribution is similar are below the LQM S4UL or C4SL calculated action levels.

The pH of the soil varies with values recorded between 7.6 and 8.3 this is classified as slightly alkaline.

4.2 Analysis of Soil Outlier Data

The statistical assessment of the test results revealed the following outlying values (potential hotspots) indicating that the data is unlikely to have originated from the same population:

Hotspot of arsenic SS3 (698mg/kg)

Hotspot of copper SS3 (243mg/kg)

The above copper hotspot does not exceed the LQM S4ULs value. However, the arsenic concentration exceeds the C4SL of 37mg/kg for residential with homegrown produce within soil sample SS3. It should be noted that the hotspot concentrations for copper, was from the same sample, SS3. Remedial measures within the area around SS3 is required. Further assessment is required to delineate the hotspot area.

The red highlighted text within the statistical analysis spreadsheet (presented in Appendix C) has been re-calculated by removing the outlier data from the data set and re-running the statistical analysis. Therefore, the revised U595 once the hotspot has been removed is 278.95mg/kg, which still exceeds the C4SL for residential land use with home-grown produce of 37mg/kg.

4.3 Arsenic Bioaccessibility Results

Samples SS4, SS71 and SS8 were submitted for arsenic bioaccessibility tests, using the Unified BARGE Method (UBM), as they recorded the three highest concentrations of total arsenic across the site. The UBM is an *in vitro* test which aims to replicate the human digestive process to determine what percentage of a potential toxic metal is absorbed in the human digestive system. The analysis is a complex process including extraction using simulated solutions of saliva gastric fluid, intestinal fluid and bile. Typically, the test consists of two stages:

- Stage 1 – mimics the conditions in the stomach at a pH of 2.5 using saliva and gastric fluid. Samples are normally taken after 1 hour.
- Stage 2 – mimics the conditions of the small intestine. Following an adjustment to pH 7.0 duodenal fluid is added and a sample is taken after a further 2 hours.

The bioaccessibility of an element is reported as mg/kg and calculated as a percentage of the total arsenic in the concentration.

Table 3: Arsenic Bioaccessibility Test Results

Sample Location	SS4		SS7		SS8	
Envirolab Ref. Number	19/08825/4		19/08825/7		19/08825/8	
	mg kg ⁻¹	RBA% [#]	mg kg ⁻¹	RBA% [#]	mg kg ⁻¹	RBA% [#]
Total Arsenic	200		140		240	
Stomach 60 mins*	1.0		0.7		0.9	
Intestine 180 mins*	1.8		1.1		1.4	
RBA%		0.9		0.79		0.58

*All times are from start of test.

[#]RBA% = Relative Bioaccessibility as percentage of total.

Sample SS4 produced the highest relative bioaccessibility value of 0.9% which will be used for the calculation of a SSAC.

4.4 CLEA UK Software

The CLEA UK software was used to create a Site-Specific Assessment Criteria (SSAC) using the arsenic bioaccessibility value of 0.9% and was compared against the US95 of 279mg/kg. The CLEA UK spreadsheet is presented in Appendix D.

Using the 'residential with homegrown produce' land use scenario and 0.9% bioaccessibility, the CLEA software produced a SSAC for the dermal and oral exposure pathway of 438mg/kg and for the inhalation pathway 526mg/kg. The US95 arsenic concentration of 279mg/kg is below the revised SSAC's of 438mg/kg and therefore the risk is reduced to minimal. Remedial measures are not required across the majority of the site. Remedial measures are required around the hotspot.

4.5 Hotspot Delineation

Further sampling around the hotspot located at sample location SS3 was undertaken. Six samples were taken and sent for chemical analysis. The results are presented in Appendix B. All six samples recorded concentrations below the SSAC, of 438 mg/kg. Therefore, the area to be remediated is around SS3 as highlighted on the plan presented in Appendix A.

4.6 Summary of Risk to End Users

The risk to the end users across the majority of the site is considered minimal based on the recorded concentrations of the topsoil and bioaccessibility testing.

The further sampling and analysis around the hotspot area have confirmed an area around SS3 that requires remedial measures.

4.7 Risks to the Environment

The principal pathway to the Secondary A Aquifer includes leaching of contaminants and vertical migration. However, no significant sources of contamination have been identified and it is considered that there is no risk or identified pollutant linkages.

4.8 Risks to the Built Environment

The primary built environment receptors are water pipes and buried concrete. Water Suppliers sometimes request sampling and specific chemical analysis within the proposed trenched excavations of water pipes to identify the most appropriate pipe material. No sources of organic contaminants were identified and therefore any water pipe material will be suitable for this site. Based on the findings of our desk study, intrusive investigation and the guidance provided by Water UK, (Contaminated Land Assessment Guidance) dated January 2014, no further assessment should be requested. We would recommend contacting your Water Supplier to confirm.

Buried concrete can be effected by the insitu oxidation of pyrite and other sulphide minerals found in mining waste in Cornwall. As the site is within a mining area this is considered a possible risk. Therefore, we would advise you discuss with your structural engineer and /or architect to confirm the type of concrete to be used for new foundations.

5.0 PHASE II CONCEPTUAL MODEL

5.1 Potential Source – Pathway – Receptor

The intrusive investigation has revealed that the majority of the topsoil across the site recorded concentrations below the relevant threshold level of SSAC for the residential with home-grown produce.

A hotspot area has been delineated around the hotspot at sample location SS3 and remedial measures are required to reduce the risk to the end users to minimal.

The proposed development is for the construction of a single residential dwelling with associated parking and garden.

Considering the above, it is considered that the majority of the site poses a minimal risk to end users. The hotspot area requires remedial measures to reduce the risk to minimal.

The revised pollutant linkage model is illustrated below. A visual revised conceptual model is illustrated in Appendix E.

Table 2: Revised Pollutant Linkage Model

Source of Contamination	Pathway	Receptor	Solution
Hotspot - recorded elevated concentration of arsenic	Ingestion, dermal contact & inhalation	End-users & plant-life	Remedial measures in garden and soft / hard landscaped areas

6.0 REMEDIAL MEASURES / FURTHER WORK

Based on the assessment undertaken to date and the recorded levels of contamination the majority of the site will not require remedial measures. Depending on the proposed finished surface the following remediation will be required:

- Soft landscaped area – soil capping of clean imported soil,
- Hardstanding patio / pathways – compacted 803 type material over a geotextile; and
- Brick pavers / tarmac parking areas – to industry standard - no remediation required.

It is considered that the use of a soil capping system within proposed soft landscaped areas to break the source-pathway-receptor linkage would represent a suitable form of remediation.

In summary the soil capping system should provide a clean capping layer comprising a single brightly coloured geotextile and 600mm thickness of imported clean subsoil/topsoil. The objective is to remove and replace the topsoil, thereby removing the pollutant linkage for any metallic contaminants. A capping detail is presented in Appendix F.

All hard standing surfaces should be constructed to industry standard. A geotextile should first be laid on the ground with a minimum of 150/200mm of compacted 803 cover. A final finish of stone paving slabs / stone chippings etc can then be laid over the compacted 803. A capping detail is presented in Appendix F.

All drive-ways and parking / turning areas (to industry standard and a tarmac or brick paver finish) will form a physical barrier between the soil and end user thus removing the contaminant pathway in these areas and therefore negating the need to remediate.

Prior to any importation of topsoil, validation testing (chemical analysis) would need to be undertaken in order to establish if the soil is suitable for the proposed end-use. Alternatively, if the soil supplier can provide a test certificate, it is recommended that this be forwarded to Cornwall Consultants Ltd to ensure that the material is suitable prior to purchase. In addition, adequate information on the former use of the topsoil's original location should be provided by the supplier. The test certificate or validation testing should be for a suite of contaminants based on the topsoil's original location and past use. Once soil has been imported to site, soil samples will then be taken from site for compliance testing.

In the case of arsenic, it is anticipated that in this area of the UK it will be very difficult to obtain a topsoil meeting the arsenic C4SL for the proposed use. Therefore, it is proposed that soils with arsenic levels higher than the C4SL could be used if bioaccessibility testing confirms suitability. These criteria will be used as the remediation targets.

In the event that soil is to be sourced from multiple sites then soil testing of each site will be required. The results of any analyses will be referred to the Environmental Protection Officer for approval.

If the imported topsoil is to be stored at the development site then precautions will need to be in place to prevent mixing with contaminated material. It is preferable to import the soil directly to its final destination.

Hard Standing Areas

All hard standing areas are to be constructed to industry standard. A geotextile should first be laid on the ground. If using, paving slabs / patio slabs / brick pavers etc, as the finished surface layer, a minimum of 150mm of compacted clean 803 type material should be laid over the geotextile. If using decorative gravel, wood / bark chippings or wooden decking etc, as a final finish layer a minimum thickness of 200mm of compacted clean 803 type material should be laid over the geotextile.

It is required that any variations to the remediation scheme or the discovery of any potential sources of contamination (not already identified) during the construction phase, be immediately referred to Cornwall Consultants Ltd.

6.1 Monitoring and Verification Requirements

It is necessary to monitor and verify that the above recommendations have been adhered to. Cornwall Consultants Ltd are required to provide the local authority with two separate documents:

- Phase III - Remediation method statement; and
- Phase IV - Verification report

The method statement needs to be submitted to the local authority once the proposed plans have been finalised for the development. The following information is required to produce the method statement document:

- Confirmation of finalised plans for the development detailing both areas of soft landscaping (including gardens) and hard landscaping (i.e. patios, driveways etc),

- Details of the proposed source of imported topsoil,
- A copy of the topsoil test certificate to verify suitability prior to purchase,
- If a certificate is unavailable samples need to be taken at source (prior to purchase) to confirm suitability for use on site,
- Confirm that appropriate precautions are to be taken if any imported soil is to be stored on site; and
- Confirm geotextile to be used including make and manufacturer.

Once the method statement has been submitted and agreed with the Environmental Protection Officer remediation can commence.

Cornwall Consultants are required to make inspections at certain phases of the development to:

- Inspect that the soil has been removed to the specified depth,
- Inspect that a brightly coloured geotextile has been placed at the specified depth,
- Inspect that a geotextile below the hardstanding is in place,
- Inspect that imported soil has been placed to the specified depth,
- Take samples of the imported topsoil and chemically analysis to confirm suitable for the end-use; and
- Confirm that appropriate precautions are taken if any imported soil is to be stored on site.

Following the completion of the above remediation works Cornwall Consultants will submit a verification report to the local authority, confirming that the remediation has been completed to the above specification. The following information will need to be submitted by the client to Cornwall Consultants to complete the verification report:

- Proof of purchase of geotextile and imported topsoil,
- Test certificate (if not already provided as part of the Phase III – Remediation Method Statement) or validation chemical analysis of imported topsoil,
- Photographic record of site remediation from soil removal, capping detail to importation of soil; and
- Documentation to confirm that topsoil has been removed to a suitably licensed waste facility.

Prior to purchasing the topsoil, the following should be provided to Cornwall Consultants Ltd:

- Test certificate provided by the supplier or validation chemical analysis undertaken by Cornwall Consultants Ltd; and
- Adequate information on the former use of the topsoils original location should be provided by the supplier.

Note: It is the client's responsibility to ensure all movement of waste including excavated soil, both onto site and off site is in line with current waste management legislation.

It is proposed to submit a brief verification report to Cornwall Council on completion of works, confirming that the remediation has been completed to the above specification.

7.0 CONCLUSIONS

This Phase II - Intrusive Investigation Report has shown that the site is likely to be suitable for the proposed development, assuming compliance with all the recommendations and remedial measures contained within this report.

A copy of this report should be submitted to the Planning Department of Cornwall Council for review, if planning conditions exist for this site.

When using any Guideline Values, (be they generic assessment criteria, site specific assessment criteria or the set Soil Guideline Values,) in this report we must be satisfied that they are relevant to the judgement of whether the effects of the pollution linkage in question could constitute a significant possibility of significant harm. Also that the assumptions underlying the derivation of any numerical values, (for example, soil conditions, the behaviour of certain pollutants, the land-use patterns), are relevant to the circumstances of the pollution linkage in question. The report must bear in mind any other conditions relevant to the use of guideline values have been observed, such as number of samples taken, and that appropriate adjustments have been made where necessary to allow for the differences between the circumstances of the land in question and any assumptions or other factors relating to guideline values. Any decisions must be based on an assessment of the risks according to relevant, appropriate authoritative and scientifically based guidance.

8.0 LIMITATIONS

The Phase II - Intrusive Investigation Report undertaken on this property was in respect of contamination only and the observations reported do not purport to constitute a full survey of ground conditions and should not be used as a basis for foundation or other structural design. The investigated area is defined as the block of ground surrounding and beneath the proposed dwelling(s)/building(s), which has been covered by the samples taken. The report is based specifically on information provided by the client at the time of the site visit. Any amendments to the development plan must be reported immediately for this may result in changes to the conclusions of this report. This report is confidential to the client and the client's solicitor and/or mortgage lender. It may not be reproduced or further distributed without the permission of Cornwall Consultants Limited. We shall not be under any liability to any person who has not been party to the commissioning and fee paid for this report. The report may be reissued to a new client by ourselves, on payment of an appropriate fee, but will not be reissued within 28 days without approval from the current client.

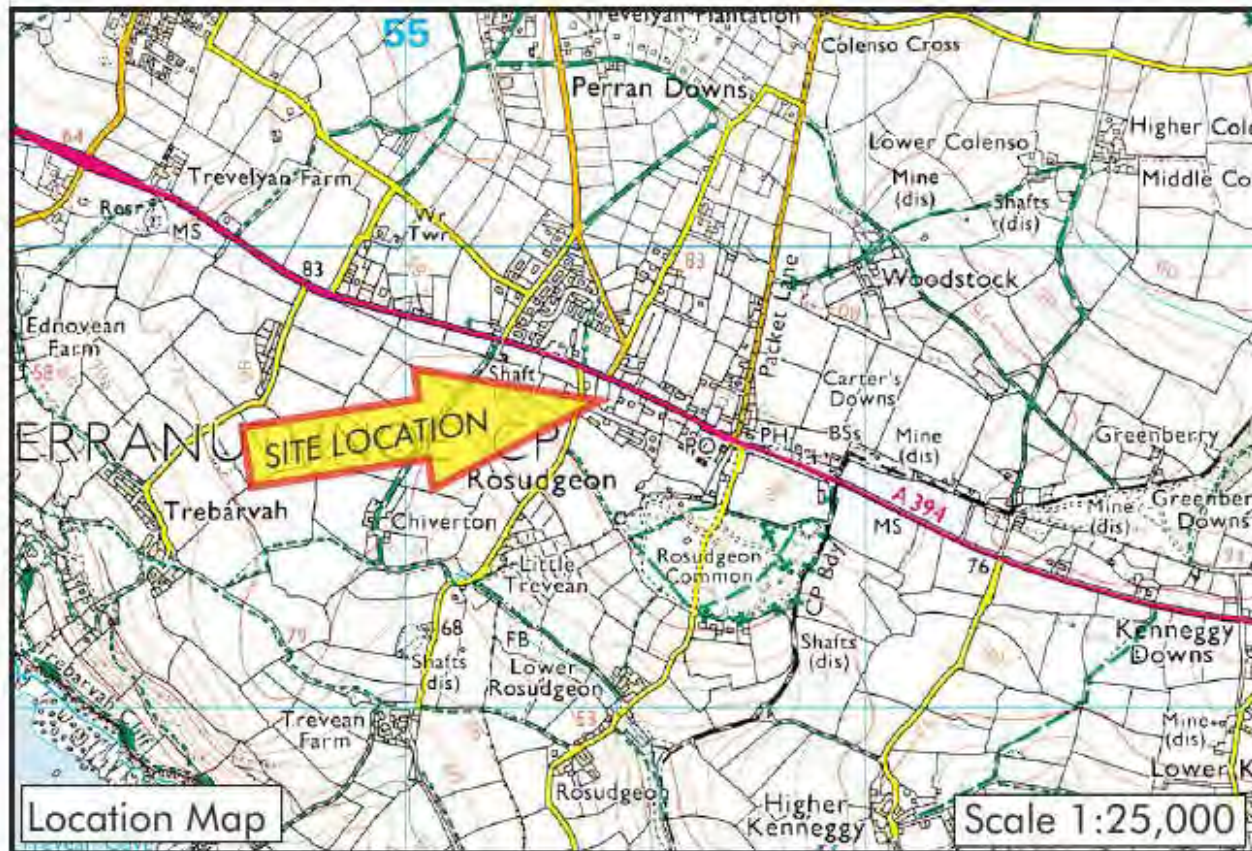
We trust that this report is to your satisfaction. If you have any further queries please do not hesitate to contact us.

Yours faithfully
for **Cornwall Consultants Limited**

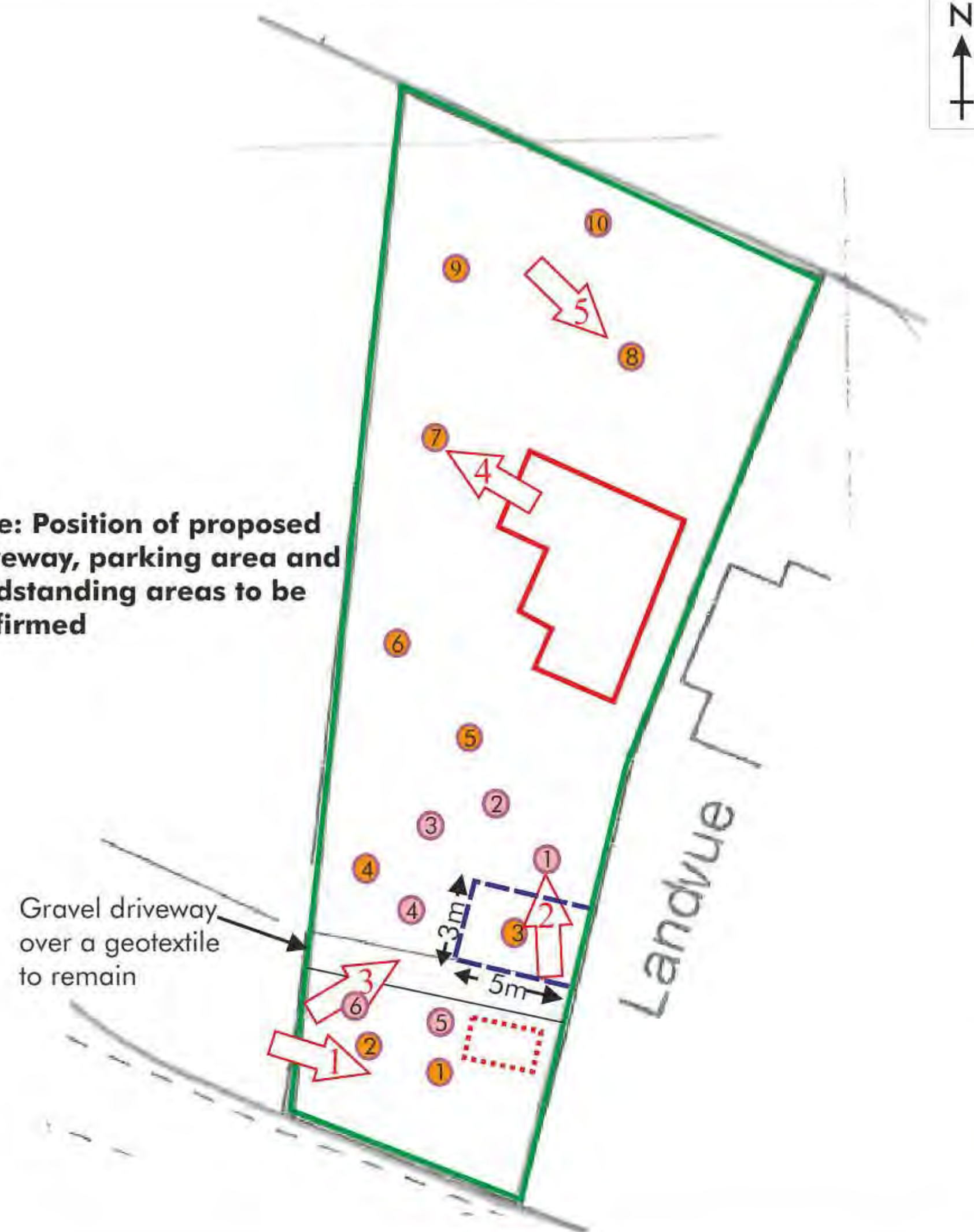


Miss C L Cauldwell MSc AIEMA
Senior Environmental Scientist

APPENDIX A: Location, Site and Sample Location Plan



Note: Position of proposed driveway, parking area and hardstanding areas to be confirmed



Key:

- | | |
|---|--|
| — Boundary of proposal (as supplied) | - - - - - Existing shed |
| — Boundary of proposed dwelling | - - - - - Hotspot area to be remediated |
| ➔ Photograph location and number | 1 Sample number and location |
| | 1 Additional sample number and location |



This plan applies to the shown/named property only, it must not be used for neighbouring properties as any mining features described are only those pertinent to the specific property and any adjacent mining features may have been omitted for clarity. This information is confidential to the client designated in the attached report and must not be further distributed without our permission. The approximate position of buried services must not be relied upon for any further excavations; refer to service providers.

APPENDIX B: Chemical Analysis Results

FINAL ANALYTICAL TEST REPORT SUPPLEMENT TO TEST REPORT 19/08825/1

Amendments: Request for Additional Analysis

Envirolab Job Number: 19/08825
Issue Number: 2

Date: 04 November, 2019

Client: Cornwall Consultants Ltd
Parc Vean House
Pac Vean
Coach Lane
Cornwall
TR15 2TT

Project Manager: Aly Rapo/Clare Cauldwell
Project Name: Landvue
Project Ref: SS4513
Order No: SS4513
Date Samples Received: 06/09/19
Date Instructions Received: 20/09/19
Date Analysis Completed: 04/11/19

Prepared by:



Sophie France
Admin Assistant

Approved by:



Danielle Brierley
Client Manager

Envirolab Job Number: 19/08825

Client Project Name: Landvue

Client Project Ref: SS4513

Lab Sample ID	19/08825/1	19/08825/2	19/08825/3	19/08825/4	19/08825/5	19/08825/6	19/08825/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SS1	SS2	SS3	SS4	SS5	SS6	SS7			
Depth to Top	0.30	0.30	0.30	0.30	0.30	0.30	0.30			
Depth To Bottom										
Date Sampled	04-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Sample Matrix Code	4AE	4AE	4AE	4AE	4AE	4AE	6AE			
% Stones >10mm _A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	% w/w	0.1	A-T-044
pH _D ^{AM}	8.15	7.66	8.11	8.03	8.13	8.21	8.19	pH	0.01	A-T-031s
Arsenic _D ^{ME}	235	228	698	284	238	193	162	mg/kg	1	A-T-039s
Cadmium _D ^{ME}	1.4	1.2	1.3	1.5	1.2	0.8	<0.5	mg/kg	0.5	A-T-039s
Copper _D ^{ME}	95	98	243	139	118	77	57	mg/kg	1	A-T-039s
Chromium _D ^{ME}	32	28	31	36	32	23	17	mg/kg	1	A-T-039s
Chromium (hexavalent) _D	<1	<1	<1	<1	<1	<1	<1	mg/kg	1	A-T-040s
Chromium (trivalent)	32	28	31	36	32	23	17	mg/kg	1	Calc
Lead _D ^{ME}	98	127	193	275	82	53	206	mg/kg	1	A-T-024s
Mercury _D	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	mg/kg	0.17	A-T-039s
Nickel _D ^{ME}	15	13	19	20	15	13	11	mg/kg	1	A-T-024s
Selenium _D ^{ME}	<1	<1	<1	1	<1	1	<1	mg/kg	1	A-T-024s
Zinc _D ^{ME}	177	217	119	126	135	80	57	mg/kg	5	A-T-024s

Envirolab Job Number: 19/08825

Client Project Name: Landvue

Client Project Ref: SS4513

Lab Sample ID	19/08825/1	19/08825/2	19/08825/3	19/08825/4	19/08825/5	19/08825/6	19/08825/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SS1	SS2	SS3	SS4	SS5	SS6	SS7			
Depth to Top	0.30	0.30	0.30	0.30	0.30	0.30	0.30			
Depth To Bottom										
Date Sampled	04-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Sample Matrix Code	4AE	4AE	4AE	4AE	4AE	4AE	6AE			
Arsenic BARGE										
Arsenic (Subcon Chemtest) _D	-	-	-	200	-	-	140	mg/kg	1	Subcon Chem D+G
As BARGE Stomach Phase _D	-	-	-	1.0	-	-	0.7	mg/kg	0.1	Subcon Chem D+G
As BARGE Stomach + Intestinal Phase _D	-	-	-	1.8	-	-	1.1	mg/kg	0.1	Subcon Chem D+G
As BARGE Bioaccessible Fraction	-	-	-	0.90	-	-	0.79	%	0.1	CAN-no stones

Envirolab Job Number: 19/08825

Client Project Name: Landvue

Client Project Ref: SS4513

Lab Sample ID	19/08825/8	19/08825/9	19/08825/10					Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SS8	SS9	SS10							
Depth to Top	0.30	0.30	0.30							
Depth To Bottom										
Date Sampled	04-Sep-19	04-Sep-19	04-Sep-19							
Sample Type	Soil	Soil	Soil							
Sample Matrix Code	6AE	4AE	6AE							
% Stones >10mm _A	<0.1	<0.1	<0.1					% w/w	0.1	A-T-044
pH _D ^{AM}	8.34	8.27	8.31					pH	0.01	A-T-031s
Arsenic _D ^{AM}	362	257	237					mg/kg	1	A-T-039s
Cadmium _D ^{MP}	1.5	1.0	0.9					mg/kg	0.5	A-T-039s
Copper _D ^{MP}	92	74	69					mg/kg	1	A-T-039s
Chromium _D ^{MP}	29	30	33					mg/kg	1	A-T-039s
Chromium (hexavalent) _D	<1	<1	<1					mg/kg	1	A-T-040s
Chromium (trivalent)	29	30	33					mg/kg	1	Calc
Lead _D ^{MP}	63	57	63					mg/kg	1	A-T-024s
Mercury _D	<0.17	<0.17	<0.17					mg/kg	0.17	A-T-039s
Nickel _D ^{MP}	17	12	13					mg/kg	1	A-T-024s
Selenium _D ^{MP}	1	<1	<1					mg/kg	1	A-T-024s
Zinc _D ^{MP}	142	66	87					mg/kg	5	A-T-024s

Envirolab Job Number: 19/08825

Client Project Name: Landvue

Client Project Ref: SS4513

Lab Sample ID	19/08825/8	19/08825/9	19/08825/10					Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SS8	SS9	SS10							
Depth to Top	0.30	0.30	0.30							
Depth To Bottom										
Date Sampled	04-Sep-19	04-Sep-19	04-Sep-19							
Sample Type	Soil	Soil	Soil							
Sample Matrix Code	6AE	4AE	6AE							
Arsenic BARGE										
Arsenic (Subcon Chemtest) _D	240	-	-					mg/kg	1	Subcon Chem D+G
As BARGE Stomach Phase _D	0.9	-	-					mg/kg	0.1	Subcon Chem D+G
As BARGE Stomach + Intestinal Phase _D	1.4	-	-					mg/kg	0.1	Subcon Chem D+G
As BARGE Bioaccessible Fraction	0.58	-	-					%	0.1	CAN-no stones

REPORT NOTES

General

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The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts.

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve.

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client:	Cornwall Consultants Ltd , Parc Vean House, Pac Vean, Coach Lane, Cornwall, TR15 2TT	Project No:	19/08825
Project:	Landvue	Date Received:	20/09/2019 (am)
Clients Project No:	SS4513	Cool Box Temperatures (°C):	14.9

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 19/11076
Issue Number: 1

Date: 29 November, 2019

Client: Cornwall Consultants Ltd
Parc Vean House
Pac Vean
Coach Lane
Cornwall
TR15 2TT

Project Manager: Clare Cauldwell
Project Name: Land at Landvue, Rosudgeon, Prnzance, Cornwall
Project Ref: SS4513
Order No: SS4513
Date Samples Received: 21/11/19
Date Instructions Received: 21/11/19
Date Analysis Completed: 29/11/19

Prepared by:



Melanie Marshall
Laboratory Coordinator

Approved by:



Richard Wong
Client Manager

Envirolab Job Number: 19/11076

Client Project Name: Land at Landvue, Rosudgeon,
Prnzance, Cornwall

Client Project Ref: SS4513

Lab Sample ID	19/11076/1	19/11076/2	19/11076/3	19/11076/4	19/11076/5	19/11076/6		Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SS1	SS2	SS3	SS4	SS5	SS6				
Depth to Top	0.30	0.30	0.30	0.30	0.30	0.30				
Depth To Bottom										
Date Sampled	18-Nov-19	18-Nov-19	18-Nov-19	18-Nov-19	18-Nov-19	18-Nov-19				
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil				
Sample Matrix Code	5A	5A	5AE	5AE	5AE	5AE				
% Stones >10mm _A	2.6	2.3	10.1	8.3	6.9	5.4		% w/w	0.1	A-T-048
pH _D ^{MP}	7.66	7.59	7.34	7.24	6.88	7.28		pH	0.01	A-T-031s
Arsenic _D ^{MP}	241	208	200	268	202	266		mg/kg	1	A-T-024s
Cadmium _D ^{MP}	1.0	0.9	0.8	0.8	0.9	0.9		mg/kg	0.5	A-T-024s
Copper _D ^{MP}	99	101	80	98	92	166		mg/kg	1	A-T-024s
Chromium _D ^{MP}	43	42	33	32	29	40		mg/kg	1	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1	<1	<1	<1		mg/kg	1	A-T-040s
Chromium (trivalent)	43	42	33	32	29	40		mg/kg	1	Calc
Lead _D ^{MP}	77	158	78	109	127	149		mg/kg	1	A-T-024s
Mercury _D	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17		mg/kg	0.17	A-T-024s
Nickel _D ^{MP}	20	20	16	17	18	18		mg/kg	1	A-T-024s
Selenium _D ^{MP}	2	2	2	<1	<1	<1		mg/kg	1	A-T-024s
Zinc _D ^{MP}	158	151	118	127	317	237		mg/kg	5	A-T-024s

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All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

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Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client:	Cornwall Consultants Ltd , Parc Vean House, Pac Vean, Coach Lane, Cornwall, TR15 2TT	Project No:	19/11076
Project:	Land at Landvue, Rosudgeon, Prnzance, Cornwall	Date Received:	21/11/2019 (am)
Clients Project No:	SS4513	Cool Box Temperatures (°C):	6.0

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

APPENDIX C: Statistical Analysis Spreadsheet

Confidence Level Required = **95** %

Type of Land Use (Enter No) **1**

- 1 = Residential with homegrown produce
- 2 = Residential without homegrown produce
- 3 = Allotments
- 4 = Commercial/Industrial
- 5 = Public Open Space - Resi
- 6 = Public Open Space - Park

MEAN VALUE TEST						OUTLIER TEST					
	Arithmeti c Mean	Standard Deviation	t Value	Upper Bound Value	Upper Bound Value < Guideline Value for Type of Land Use?	Arithmetic Mean of Logs of Analytical Data	Standard Deviation	Outlier Test	Outlier Test < the 10% Critical	Outlier Test < the 5% Critical Value?	
	x	s	t	US		y	Sy	T			
Arsenic	289.400	153.096	1.833	378.147	No	2.424	0.174	2.412	No	No	Arsenic
Arsenic*	244.000	56.391	1.860	278.954	No	2.377	0.098	1.850	Yes	Yes	Arsenic*
Cadmium	1.130	0.327	1.833	1.319	Yes	0.033	0.149	0.961	Yes	Yes	Cadmium
Chromium	29.100	5.466	1.833	32.269	Yes	1.456	0.095	1.066	Yes	Yes	Chromium
Copper	106.200	53.767	1.833	137.367	Yes	1.988	0.180	2.211	No	No	Copper
Copper*	91.000	25.554	1.860	106.840	Yes	1.944	0.120	1.658	Yes	Yes	Copper*
Lead	121.700	77.211	1.833	166.458	Yes	2.013	0.259	1.644	Yes	Yes	Lead
Mercury	0.165	0.005	1.833	0.168	Yes	-0.783	0.014	0.949	Yes	Yes	Mercury
Nickel	14.800	3.011	1.833	16.545	Yes	1.162	0.086	1.613	Yes	Yes	Nickel
Selenium	0.996	0.005	1.833	0.999	Yes	-0.002	0.002	0.775	Yes	Yes	Selenium
Zinc	120.600	50.524	1.833	149.888	Yes	2.046	0.187	1.553	Yes	Yes	Zinc
pH	8.140	0.193	1.833	8.252							pH

* recalc with outlier data removed

APPENDIX D: CLEA UK Spreadsheet

CLEA Software Version 1.071

Page 1 of 11

Report generated

05-Nov-19

Report title

Created by



Environment
Agency

RESULTS

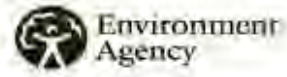
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[illegible]


[illegible]

[illegible]

[illegible]



	Average Daily Exposure ($\text{mg kg}^{-1} \text{ bw day}^{-1}$)	Distribution by Pathway (%)
	Direct soil ingestion Consumption of homegrown produce and attached soil Dermal contact with soil and dust Inhalation of dust Inhalation of vapour Background (oral) Background (inhalation)	Direct soil ingestion Consumption of homegrown produce Dermal contact with soil and dust Inhalation of dust Inhalation of vapour (indoor) Inhalation of vapour (outdoor) Background (oral) Background (inhalation)
21		
22		
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29		
30		



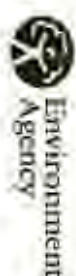
 Environment

 Agency

1	Arsenic (CASL child)	ID	Oral Health Criteria Value ($\mu\text{g kg}^{-1}$ BW day $^{-1}$)	ID	Inhalation Health Criteria Value ($\mu\text{g kg}^{-1}$ BW day $^{-1}$)	NR	Oral Mean Daily Intake ($\mu\text{g day}^{-1}$)	NR	Inhalation Mean Daily Intake ($\mu\text{g day}^{-1}$)	NR	Air-water partition coefficient (K_{aw}) ($\text{cm}^3 \text{cm}^{-3}$)	NR	Coefficient of Diffusion in Air ($\text{m}^2 \text{s}^{-1}$)	NR	Coefficient of Diffusion in Water ($\text{m}^2 \text{s}^{-1}$)	NR	$\log K_{oc}$ ($\text{cm}^3 \text{g}^{-1}$)	NR	$\log K_{ow}$ (dimensionless)	0.03	Dermal Absorption Fraction (dimensionless)	0.5	Soil-to-dust transport factor (g g^{-1} DW)	1	Sub-surface soil to indoor air correction factor (dimensionless)	0.01	Relative bioavailability via soil ingestion (unitless)	1	Relative bioavailability via dust inhalation (unitless)
2																													
3																													
4																													
5																													
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17																													
18																													
19																													
20																													

21	Oral Health Criteria Value ($\mu\text{g kg}^{-1} \text{ BW day}^{-1}$)
22	Inhalation Health Criteria Value ($\mu\text{g kg}^{-1} \text{ BW day}^{-1}$)
23	Oral Mean Daily Intake ($\mu\text{g day}^{-1}$)
24	Inhalation Mean Daily Intake ($\mu\text{g day}^{-1}$)
25	Air-water partition coefficient (K_{aw}) ($\text{cm}^3 \text{ cm}^{-3}$)
26	Coefficient of Diffusion in Air ($\text{m}^2 \text{ s}^{-1}$)
27	Coefficient of Diffusion in Water ($\text{m}^2 \text{ s}^{-1}$)
28	$\log K_{oc}$ ($\text{cm}^3 \text{ g}^{-1}$)
29	$\log K_{ow}$ (dimensionless)
30	Dermal Absorption Fraction (dimensionless)
	Soil-to-dust transport factor ($\text{g g}^{-1} \text{ DW}$)
	Sub-surface soil to indoor air correction factor (dimensionless)
	Relative bioavailability via soil ingestion (unitless)
	Relative bioavailability via dust inhalation (unitless)

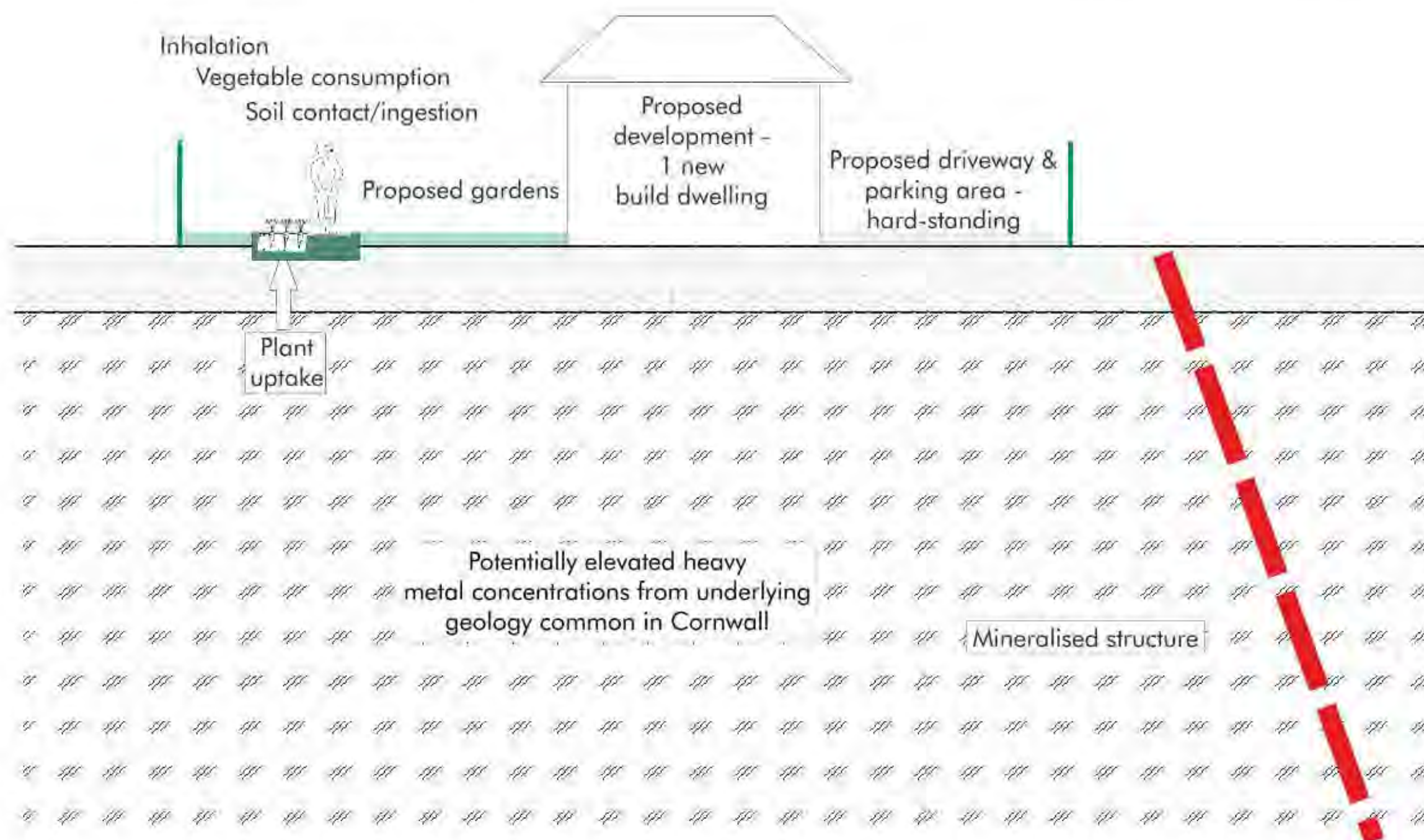
[illegible]

[illegible]

APPENDIX E: Revised Conceptual Site Model

Hotspot area only - Removal of contaminated soil and replacement with clean soil capping

- Direct soil and dust ingestion,
- Consumption of homegrown produce,
- Consumption of soil adhering to homegrown produce,
- Dermal contact with soil and indoor dust; and
- Inhalation of indoor and outdoor dust.



CORNWALL CONSULTANTS LTD
Helping protect property from the ground up

PHASE II - Land Contamination Intrusive Investigation
Land at Landvue, Rosudgeon, Penzance, Cornwall.

Reference: SS/4513.b.DS

Date: 06/12/2019

Scale: NOT TO SCALE

Initial Conceptual Model

APPENDIX F: Capping / Hardstanding Details

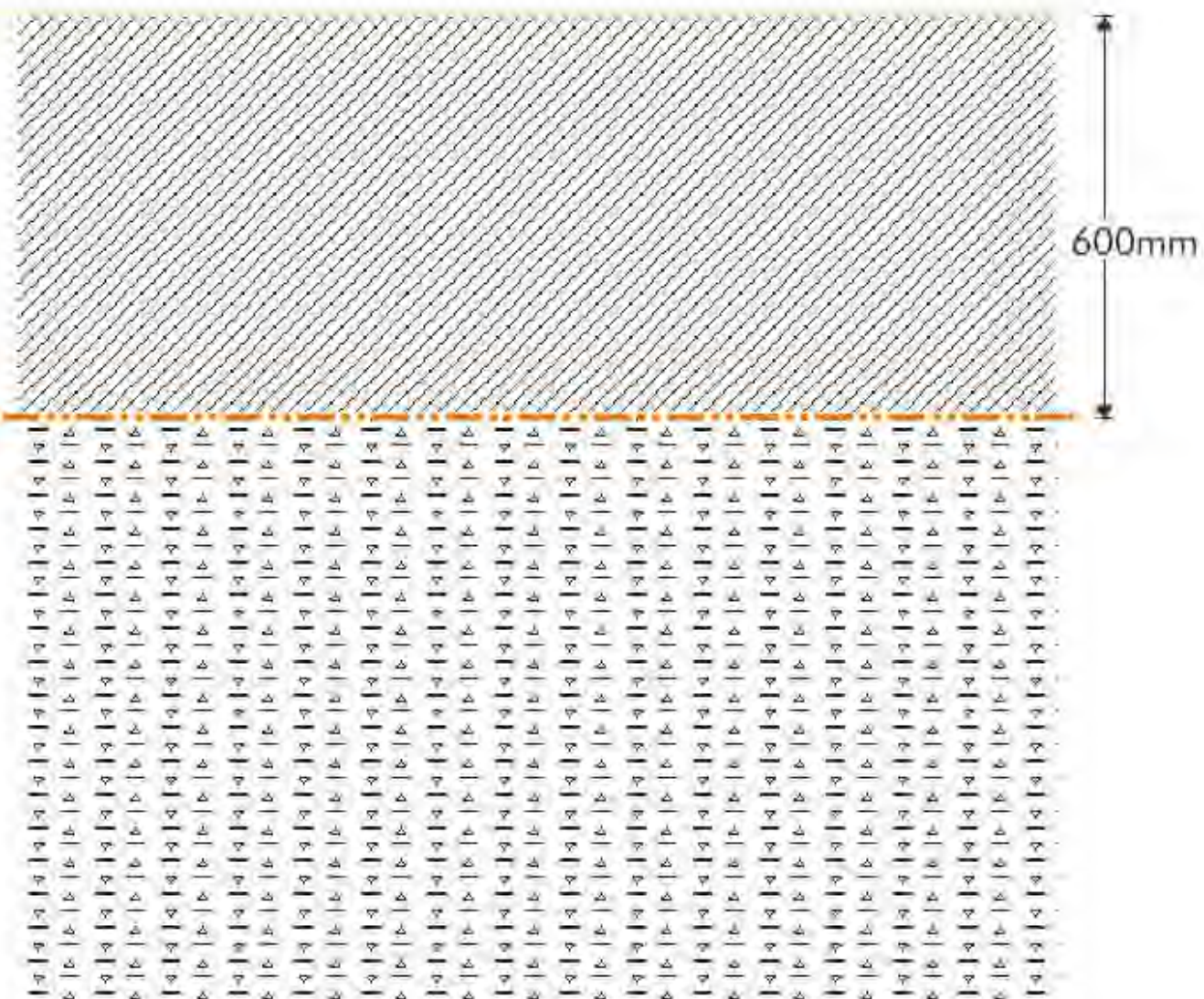
Original surface level

Clean imported topsoil

Original contaminated soil to be removed to a depth of 600mm

Geotextile (prevent migration of fines into clean imported topsoil)

Natural (potentially contaminated) ground



Notes

Geotextile: Brightly coloured Geotextile



CORNWALL CONSULTANTS LTD
Helping protect property from the ground up

Land at Landvue, Rosudgeon,
Penzance, Cornwall

Reference: SS/4513.f.SS

Date: 06/12/2019

Scale: Not to scale

PHASE II - Land Contamination
Intrusive Investigation
Capping Detail

