



Report type	Phase 3 Remediation Options Appraisal
Date	10 February 2022
Client	PAG Developments Limited
Site address	Judy Cross Barn, Water Gate, Quadring, Spalding, PE11 4PY
Report prepared by	Mr Louis Turner BSc (Hons)
Supervised by	Mr Joseph Turner

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1. Introduction

The following document is a Phase 3 Remediation Options Appraisal carried out by Oakshire Environmental, commissioned by PAG Developments Limited, and includes details of the site, previous investigations, an evaluation of remediation options and an assessment of further investigations.

1.1 Project Overview

The client's proposed project involves the conversion of a barn into residential dwelling and associated works at Judy Cross Barn, Water Gate, Quadring, Spalding, PE11 4PY. A Phase 2 Intrusive Site Investigation has been carried out by Oakshire Environmental (October 2021). This assessment recommended that an appraisal of remediation options should be carried out. Oakshire Environmental have carried out a Phase 3 Remediation Options Appraisal, as described below.

1.2 Purpose of Investigation

The objectives of the Phase 3 Remediation Options Appraisal were to:

- Identify suitable remediation option(s).
- Provide a strategy for the implementation of suitable remediation option(s).
- Assess the requirement for a Phase 4 Verification Report.

1.3 Scope of Work

- Identify initial feasible options for remediation at the site, based on the costs involved and the practicality of their application. Remediation methods to be considered include civil engineering, biological, chemical, physical and thermal methods.
- Outline the potential constraints at the site and the generic remediation objectives.
- Conduct a detailed evaluation of selected remediation options, in order to determine which option(s) are most appropriate for the site and develop site-specific remediation objectives.
- Remediation option(s) have been used to update the Conceptual Site Model, produced as part of the Phase 2 Intrusive Site Investigation, to re-assess risks to end users of the site and the requirement for a Phase 4 Verification Report.
- Provide a strategy for the implementation of suitable remediation option(s).
- Supporting appendix includes photographs, maps and existing and proposed plans of the site.
- Options Appraisal has been carried out in accordance with the Environment Agency's Land Contamination: Risk Management (LC:RM) guidelines as updated from Environment Agency's Model Procedures for the Management of Land Contamination (CLR11) framework.

1.4 Limitations

Quantum Intelligent Trading Ltd is previously and hereafter referred to as "Oakshire Environmental" or "the company". Oakshire Environmental has exercised such professional skill, care and diligence as may reasonably be expected of a properly qualified and competent consultant when undertaking works of this nature. This report is only valid when used in its entirety and any information or advice contained within the report should not be relied upon until considered in the context of the whole report. Oakshire Environmental disclaims any responsibility to the client and others in respect of any matters outside the scope of this work. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate. This report has been prepared solely for the benefit of the client and any other party using or placing reliance upon any information contained in this report does so at their own risk. Oakshire Environmental accepts no responsibility or liability for the contents of this report being used for any purpose or project for which it was not commissioned. Oakshire Environmental accepts no liability whatsoever for any loss or damage arising from the interpretation or use of the information contained within this report. Furthermore, Oakshire Environmental does not accept any liability for the consequences of any legislative changes or the release of subsequent guidance documentation and following delivery of the report has no obligation to advise the client or any other party of such changes or their repercussions.

This report excludes consideration of potential hazards arising from any activities at the site other than normal use and occupancy for the intended land uses. Hazards associated with any other activities have not been assessed and must be subject to a specific risk assessment by the parties responsible for those activities. Oakshire Environmental does not warrant or guarantee that the site is free of hazardous or potentially hazardous materials or conditions. It should be noted that this report has been produced for environmental purposes only.

Oakshire Environmental cannot be held responsible for incorrect analysis of samples as the laboratory analysis presented in this report was carried out by Chemtech Environmental Ltd. The information and conclusions provided in this report are limited to, and representative of, the samples taken and cannot be extended to apply to the whole site, in addition, Oakshire Environmental cannot guarantee the accuracy of analysis for samples not taken at the source by the company or those which deviate due to exceedance of holding time or inappropriate sampling practises. The findings and/or recommendations of this report do not take into account any conditions that may be present but have hitherto not been encountered and as such further investigation and/or a reconsideration of the findings of this report should be undertaken if such conditions are subsequently encountered or an alternative development plan or land use is subsequently proposed.

2. Site

The following section provides a description of the site, location and previous investigations, utilising information obtained from the client and publicly available sources.

2.1 Site Description and Location

The site is located on the corner of Water Gate and Green Lane to the north east of the village of Quadring in South Holland and is approximately 1,350m². There is a brick barn building at the south of the site with a pile of crushed limestone to the west of this building and a concrete base with some wooden pallets to the north. The barn building is unused and contains some old wood and metal products, broken concrete and brick rubble. Adjacent to the building is a water tank and some concrete blocks. The remainder of the site is covered by grass and shrubs.

The site is bordered by an agricultural field to the north and east, Water Gate to the south and Green Lane to the west. A land drain curtails the south and west boundaries of the site. The surrounding area is predominantly agricultural with some residential dwellings in the vicinity, including just south of Water Gate and 150m east of the site. There are no woodlands, ancient monuments or archaeological sites within 500m of the site.

National Grid Reference: 523345 333676

2.2 Previous Investigations

A Phase 1 Preliminary Assessment has been carried out by Oakshire Environmental in August 2021. This assessment considered there to be a low to moderate risk to human health from contamination potentially present at the site due to its past use as a corn mill. The assessment recommended further investigation in the form of a Phase 2 Intrusive Site Investigation to include sampling of shallow soil for a suite of contaminants including heavy metals and hydrocarbons. A Phase 2 Intrusive Site Investigation was carried out by Oakshire Environmental in October 2021. The findings of this investigation are summarised below.

This assessment identified shallow made ground at the north east and south west of the site comprising brick fragments. Arsenic, Lead and PAH (*Dibenz(ah)anthracene*) contamination was identified at a depth of 0.3m at the north west of the site and Beryllium contamination was identified at 0.3m at the south west. These are areas of proposed lawn and soft landscaping.

Based on the above findings, the Phase 2 Intrusive Site Investigation considered there to be a moderate risk to residential end users, through ingestion and/or inhalation of soil dust, dermal contact with soil and ingestion of homegrown produce. It was noted that the exceedances of screening values were minor and there is only considered to be a risk to residents in areas of soft landscaping.

The Phase 2 Intrusive Site Investigation, therefore, recommended that a Phase 3 Remediation Options Appraisal should be carried out in order to identify the most appropriate remediation option(s) for the site. As per the recommendations of the Phase 2 Intrusive Site Investigation, Oakshire Environmental has carried out a Phase 3 Remediation Options Appraisal to include an assessment of the feasible remediation options available.

3. Remediation Options

The Environment Agency's Land Contamination: Risk Management guidance for the development of an options appraisal requires the initial identification of feasible options for remediation at a site, based on the costs involved and the practicality of their application. There are a number of remediation methods available including civil engineering, biological, chemical, physical and thermal methods. Some methods may not be appropriate to a particular site as some can only be used on certain types of media and some may not be cost effective. Other site specific constraints such as time and access can also determine the feasibility of a particular remediation option. The following section outlines the generic remediation objectives for the site, taking into account potential constraints, and includes a selection of feasible remediation options.

3.1 Site Context and Objectives

The site was previously a mill and has most recently been used for the storage of various materials. The proposed development involves the renovation of the existing agricultural building at the south of the site and conversion to a residential dwelling. The existing grass areas of the site will become the garden of the proposed dwelling. This report, therefore, considers the feasibility of redeveloping the site for residential use.

3.2 Potential Constraints

Given the size of the site and its location, there is not likely to be significant limitations with regards to space or access for machinery from Water Gate. Given the relatively small scale of the development, cost will likely be a limiting factor and the relatively localised nature of contamination at the site will most likely not require an extensive remediation option. There are no sensitive human receptors bordering the site or on-site, as it is not currently in use. The on-site contamination is not expected to be ongoing so there are no specific time constraints with regards the implementation of remediation. The client has expressed a desire to minimise the extent of further investigation or verification testing, therefore, this will also be considered.

3.3 Generic Remediation Objectives

The following table outlines the generic objectives of remediation at the site.

Table 1: Summary of Generic Remediation Objectives

Remediation Objective	Objective Type
Enable the site to be redeveloped for residential end use	General
Enable development of a remediation strategy that meets regulatory requirements	Management
Enable development of a remediation strategy that meets the developers requirements	Management
Avoid unacceptable environmental impacts from implementation of remediation strategy	Management
Avoid long term monitoring requirements	Management

3.4 Feasible Remediation Options

Contamination risks from inorganic and organic contaminants, in shallow soil and made ground has been identified at the site, therefore, a number of remediation options have been discounted as they are inappropriate for the site and the identified contamination risk.

Soil flushing, soil washing and hydraulic binders are likely to be too costly and unnecessarily extensive for the site given the relatively localised contamination and minimal material expected to require remediation. Contamination is not likely to have impacted groundwater or surface water, which was not encountered during ground investigation works, so remediation will only need to consider soil contamination. Therefore, the following remediation options are considered appropriate for the site and will be subject to a more detailed evaluation in the following section.

Table 2: Summary of Feasible Remediation Options

Remediation Option	Method	Linkage Element Addressed
Excavation and Disposal	Civil Engineering	Source Management
Containment - Cover System	Civil Engineering	Pathway Interruption
Amendment of Development Proposal	Behaviour Modification	Pathway Interruption

4. Evaluation of Remediation Options

Following the identification of feasible remediation options, a detailed evaluation of options, including development of site-specific remediation objectives, is required to determine which option(s) are most appropriate for the site.

Table 3: Summary of Site-Specific Remediation Objectives

Remediation Objective	Objective Type	Evaluation Criteria
Enable the site to be redeveloped for residential end use without risk to human health	General/Technical	Concentrations of Heavy Metals and PAHs in shallow soils on site to be below relevant screening values after remediation and the ingress of ground gases into the building to be negligible
Enable development of a remediation strategy that meets regulatory requirements	Management	Remediation strategy to be agreed with Local Authority and carried out in accordance with relevant regulations
Enable development of a remediation strategy that meets the developers requirements	Management	Remediation strategy to be agreed with developer
Avoid unacceptable environmental impacts from implementation of remediation strategy	Management	Compliance with regulations on the control of noise, dust odour, traffic and generation of waste
Utilise remediation option with a proven track record	Management	Selected option to have proven success on sites with similar contamination issues
Avoid long term monitoring requirements	Management	No site-specific evaluation criteria

4.1 Excavation and Off-Site Disposal and Containment

Excavation and off-site disposal of contaminated soil at the west of the site could be carried out to remove the source of contamination. Containment should then be carried out, through placement of imported clean material, to interrupt the contamination pathway, protect against residual contamination risks and re-instate site levels. Site-won material from the east of the site could be utilised, however, this material would require additional laboratory testing and analysis to ensure it is suitable for re-use.

Results of soil testing from the Intrusive Site Investigation suggest that sampled soil from the site would be classified as Non-Hazardous, with an EWC code of 17 05 04, for off-site disposal.

Given the low volatility of contaminants identified in the soil, a 'cover system' is considered to be appropriate for the site. This should include a layer of topsoil above a layer of subsoil to a sufficient depth to allow for the growth of vegetation and protect the health of residential end users. The thickness of the capping layer will also need to account for disturbance of the soil, which is unlikely to exceed 0.6m in a typical garden.

This remediation option meets all the relevant objectives outlined in this report and is considered to be appropriate for the site. There are not likely to be excessive environmental nuisances, such as noise and dust, in addition, excavation and containment are very common remediation techniques, successfully used on multiple sites with similar contamination issues, and is not likely to need extensive post-remediation verification work.

4.2 Amendment of Development Proposal

An alternative remediation method would be to amend the development proposal to replace any soft landscaping from the west of the site with hardstanding. Given the low volatility of the identified contamination on-site, this would sufficiently interrupt the contamination pathway between the contamination source and the sensitive on-site receptors.

This remediation option will meet most of the objectives outlined in this report, as it is likely to be the most cost effective feasible remediation option and will cause minimal environmental nuisances, such as noise and dust. This is also a common remediation technique, successfully used on multiple sites with similar contamination issues and will not require any post-remediation verification work.

However, the placement of hardstanding may increase the risk of surface water flooding at the site, so this option may not meet regulatory requirements. It should be noted that a flood risk assessment has been carried out for the site which identified a very low risk of flooding at the site, therefore, flooding is not likely to be an issue, provided surface runoff is appropriately managed. Due to the replacement of soft landscaping with hardstanding, this option may not meet developer requirements.

Following a detailed evaluation of feasible remediation options, excavation, off-site disposal and containment is considered to be the most suitable remediation option.

5. Recommendations

Based on the detailed evaluation of feasible remediation options in this report, the most appropriate remediation option is considered to be via source management and pathway interruption by way of excavation and off-site disposal of contaminated soil and made ground and containment through the placement of a clean cover layer. The details regarding this remediation are outlined below.

5.1 Remediation Strategy

Soil from the west of the site should be excavated to a depth of at least 0.3m and disposed of off-site. Excavation should extend approximately halfway across the site from the west boundary, approximately 10m from the south boundary and to the invert of the land drain at the west boundary, to maintain the integrity of the land drain. This is likely to equate to a total area of approximately 350m² - 450m², depending on the extent of proposed hardstanding. Sampled soil from the site is classified as Non-Hazardous and should be disposed of accordingly, however, Waste Acceptance Criteria (WAC) testing may also be required for materials that are to be disposed of to landfill. Excavations should be carried out by a suitability qualified groundworks contractor and a photographic record of the excavation works should be kept, including the base and faces of each excavation.

A cover layer of clean imported material should then be placed in excavated areas, to a depth of at least 0.6m, including 0.15m of topsoil and 0.45m of subsoil. Imported soil to be utilised as clean cover material must be shown to be uncontaminated and compliant with British Standards 3882:2015 (topsoil) and BS 8601:2013 (subsoil). Site-won material from the east of the site may be used, however, this would require verification testing once in-situ. Oakshire Environmental does not warrant or guarantee that the site is free of localised hazardous or potentially hazardous materials or conditions and, as such, site-won soils should not be used if visible signs of contamination are identified during excavation.

Photographic evidence of the depth of cover is required to verify that the required depth of cover has been implemented.

It should be noted that any areas of proposed hardstanding, such as proposed driveway or patio, will not require excavation or placement of clean cover.

If unforeseen visible or olfactory evidence of contamination is identified during excavations at the site, work should cease in order to allow further investigation to be carried out.

5.2 Further Investigation

Following the implementation of remediation, verification will be required to ensure remediation has been successful and the site is safe for its proposed use, and should include the following.

Imported topsoil should be compliant with BS3882:2015, while subsoil will need to be compliant with BS8601:2013. Both topsoil and subsoil will also need to be shown to be uncontaminated and test certificates will need to be kept as evidence of this. Waste transfer notes and delivery tickets will also need to be obtained to confirm the appropriate disposal of on-site soil and source of imported soil. Further in-situ testing of cover soil is not considered necessary.

Photographic evidence of the depth of excavation and clean cover will be required, to verify that the required depth of cover has been implemented. This should be carried out through the use of a tape measure or staff clearly showing the full depth.

If soil from the east of the site is to be used as cover, this would be classified as 'brownfield' soil, due to the previous development on the site and would require a minimum of 6 verification samples to be tested for Metals (As, Be, Cd, Co, Cu, Fe, Hg, Pb, Ni, Mn, Se, V, Zn), Chromium (III & VI), PAHs (16 USEPA speciation), TPH (CWG banded), Asbestos, pH and Organic Matter in a UKAS accredited laboratory. Borehole logs would need to be produced as part of the sampling process to assess ground conditions encountered at the site, with photographic evidence taken throughout. Results of laboratory testing would need to be assessed with reference to LQM/CIEH Suitable 4 Use Levels (S4ULs) and CL:AIRE Category 4 Screening Levels (C4SLs), to assess the risk to human health and the environment.

The findings of this verification assessment should be used to update the Conceptual Site Model, produced as part of the Phase 2 Intrusive Site Investigation, to identify contaminant linkages at the site, in order to determine the efficacy of remediation and the requirement for any further investigations or remediation work.

6. References

BRE Group, 2004. *Cover systems for land regeneration - thickness of cover systems for contaminated land.* BR456.

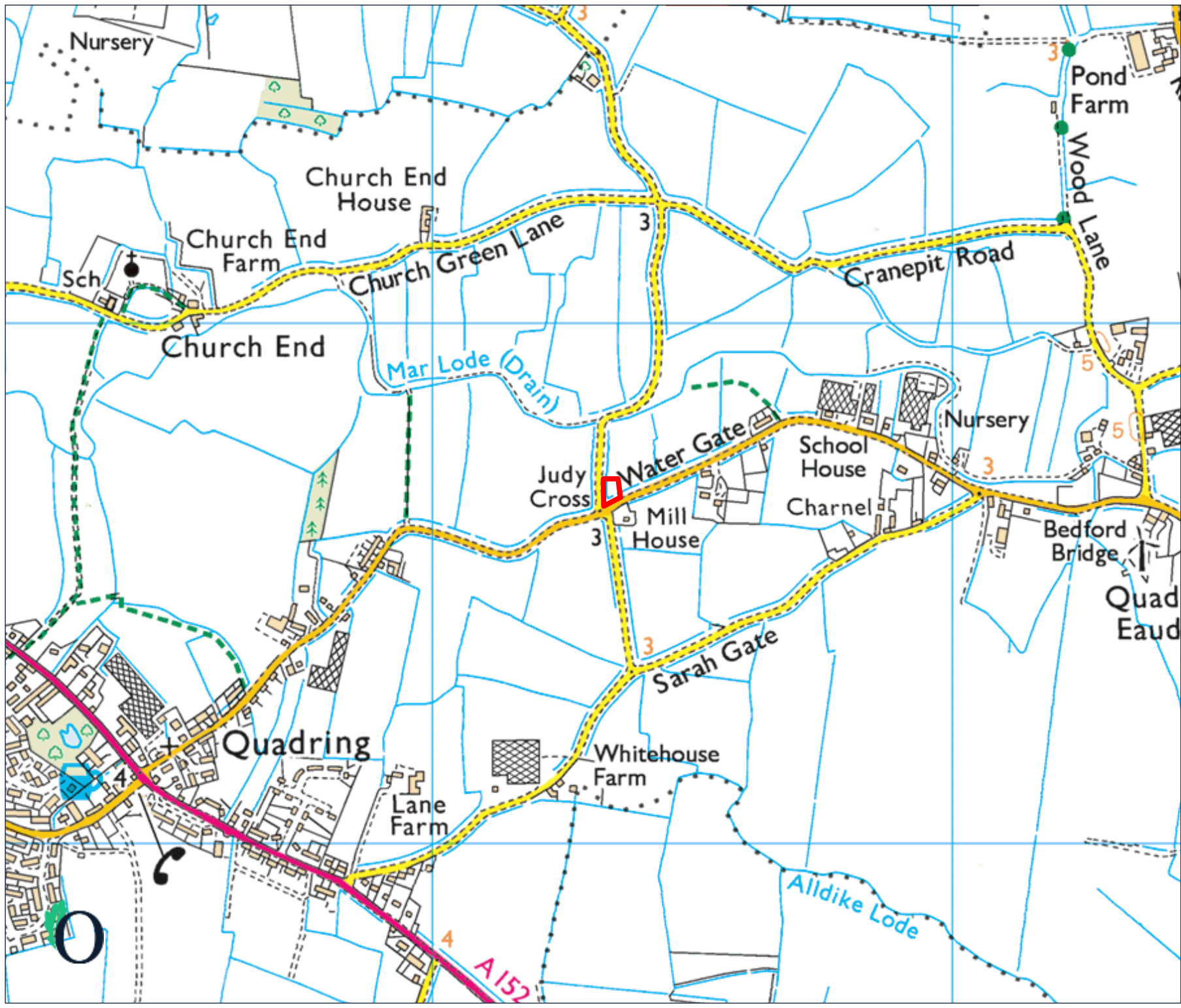
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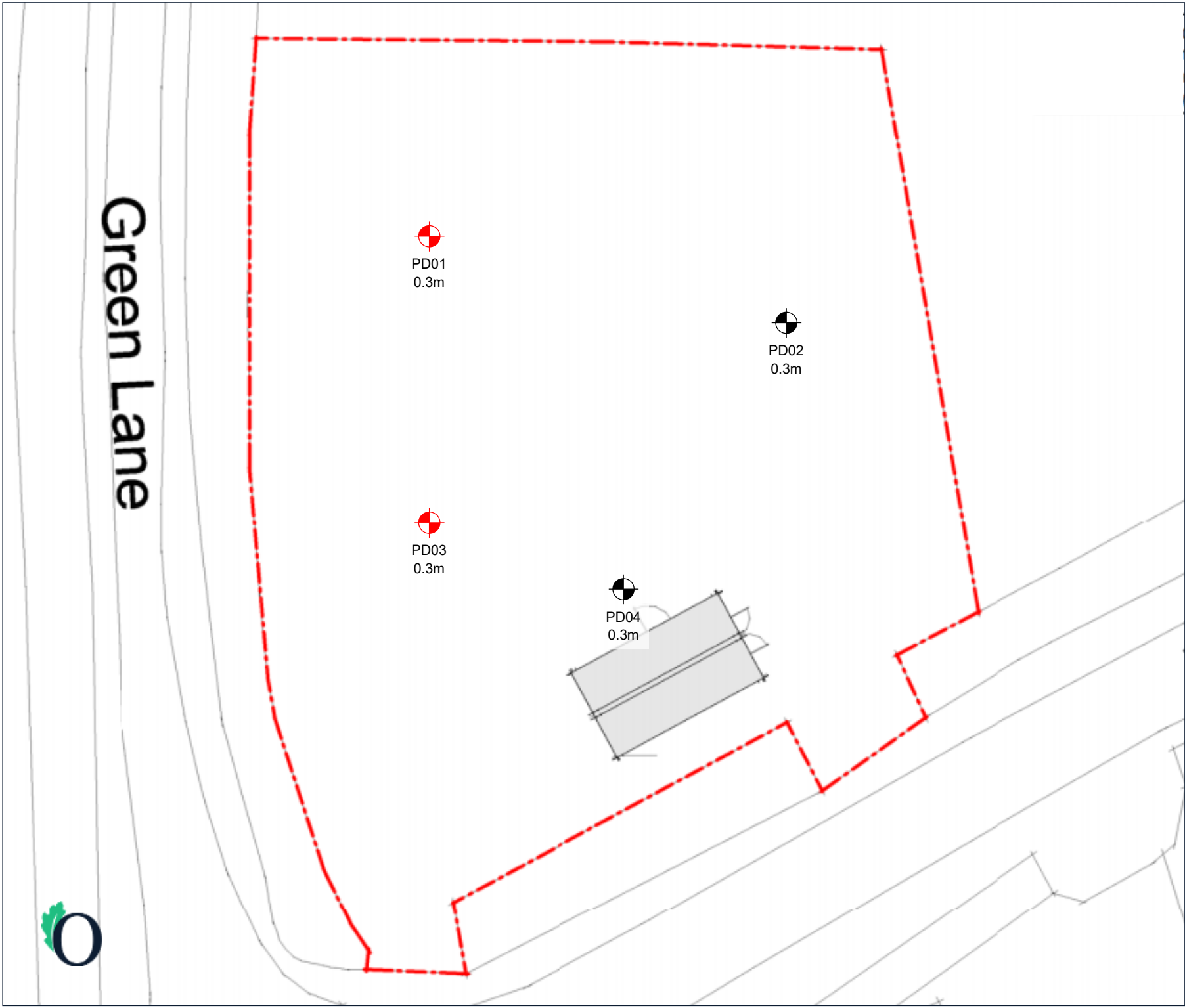
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Yorkshire and Lincolnshire Pollution Advisory Group (2021). *Technical Guidance for Developers, Landowners and Consultants - Verification Requirements for Cover Systems.*



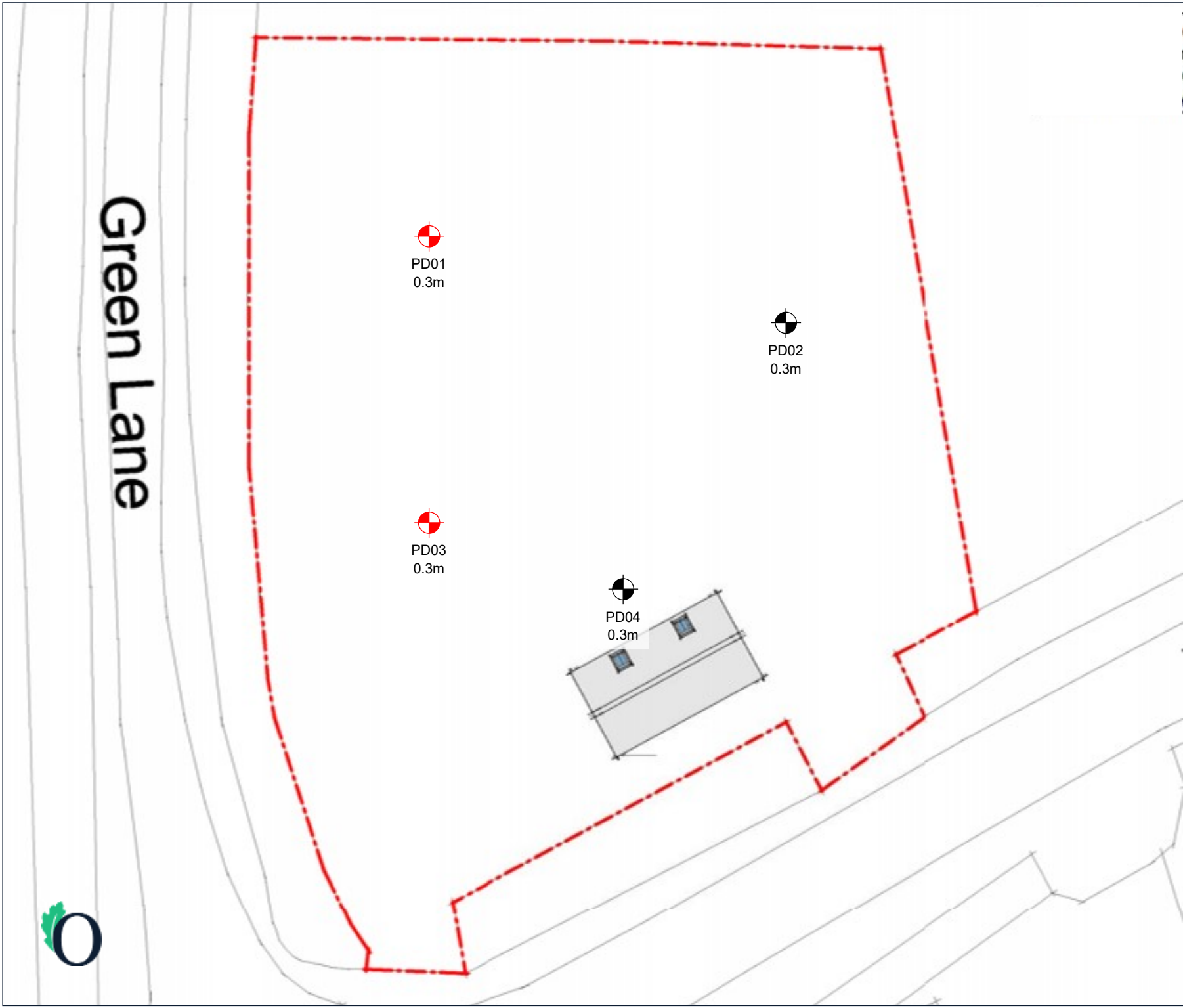
Appendix A - Site Maps & Plans	
Description	
OS location plan	
Sources	
Contains OS data © Crown copyright and database rights 2021	
Key	
	Site boundary
Name	Figure 1





Appendix A - Site Maps & Plans	
Description	
Existing block plan, showing samples from Phase 2 Intrusive Site Investigation	
Sources	
Remway Design Ltd	
Key	
	Site boundary
	Sample location
	Contaminated sample
	
	
	
	
	
	
Name	Figure 2





Appendix A - Site Maps & Plans

Description

Proposed block plan, showing samples from Phase 2 Intrusive

Sources

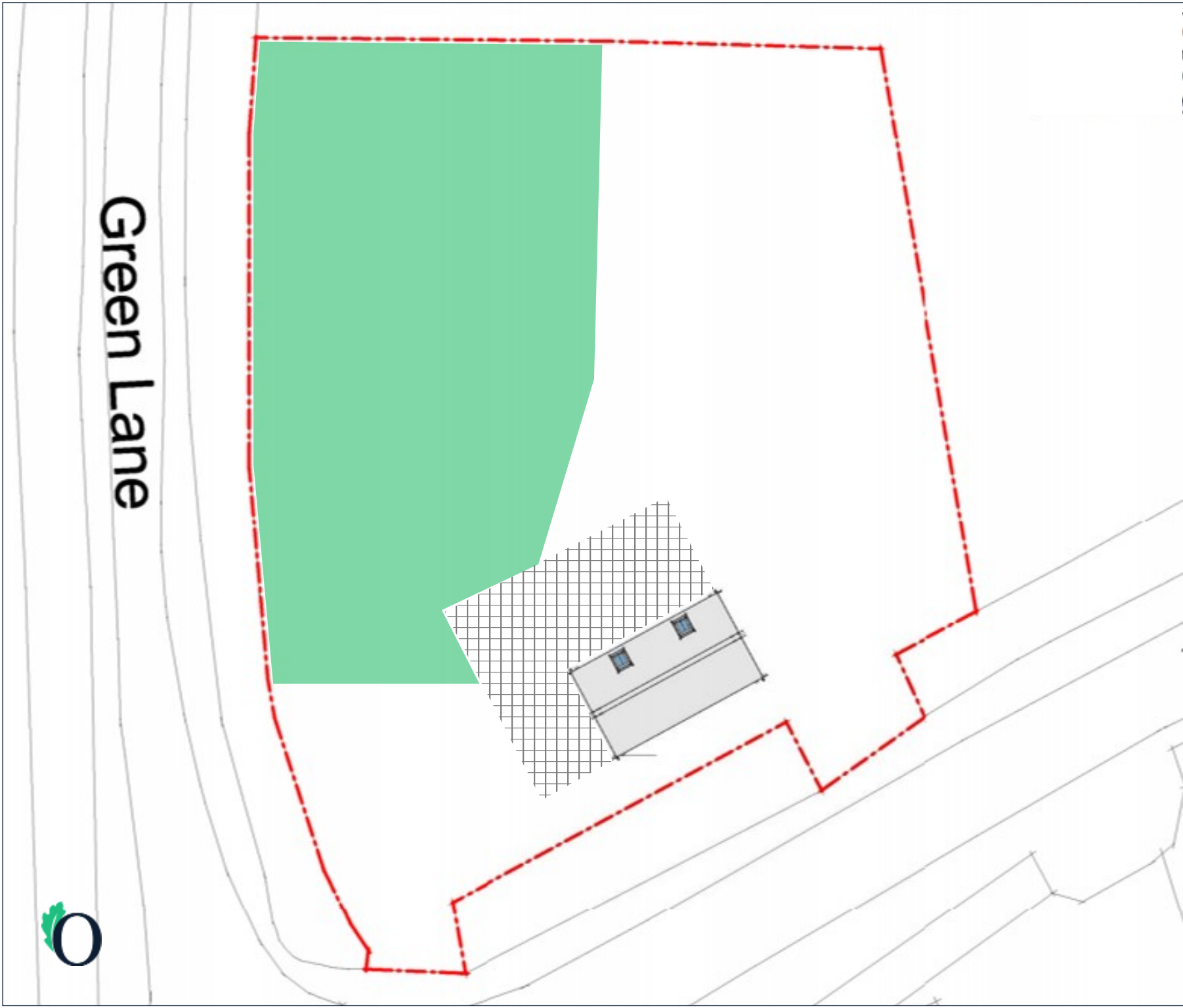
Remway Design Ltd

Key

	Site boundary
	Sample location
	Contaminated sample

Name

Figure 3



Appendix A - Site Maps & Plans

Description

Proposed block plan, showing indicative extent of excavation and clean cover

Sources

Remway Design Ltd

Key

	Site boundary
	Approximate extent of excavation and clean cover
	Example area of hardstanding

Name

Figure 4

