



Remediation Strategy

**Clifton Slips, West Street,
Gravesend, Kent, DA11 0BW**



Report

Ecologia 
experts on the ground

Remediation Strategy

**Clifton Slips, West Street,
Gravesend, Kent, DA11 0BW**

Prepared for: Quinn Estates Ltd.

Reference: EES 18.376.6

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Building 711 & 712
Kent Science Park
Sittingbourne
Kent ME9 8BZ UK

Tel: +44 (0)1795 471611

Fax: +44 (0)1795 430314

E-mail: info@ecologia-environmental.com

Website: www.ecologia-environmental.com

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				<i>L. Cammack</i>	

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EXECUTIVE SUMMARY

Site Location	Clifton Slips (the 'Site') is located at West Street, Gravesend, Kent, DA11 0BW.
Objective	This Remediation Strategy is intended to support discharge of planning conditions reference 20191122, Condition No.5 part 3, for the redevelopment of the Site and ensure that the required remedial work is undertaken to a standard suitable for a residential end use (without private gardens) with soft landscaping and public open space areas.
Site Setting	The Site is 0.55 hectares and is irregular in shape comprising two (2No.) parcels of land, split by West Street (Area 1 known as 'West Street' is located to the north adjacent the River Thames and Area 2, known as 'Stuart Road' is to the south of West Street). The Site is situated in a predominantly residential and retail / commercial area in the centre of Gravesend. Site area north of West Street currently comprises mostly concrete hardstanding and is generally flat with a derelict pier extending out into the River Thames. The Pier is approximately 2.50-3.00m higher than surrounding ground level. The Site south of West Street and west of Stuart Road, comprises open scrubland / vegetation and has a steep gradient across the Site, differing in ground levels from approximately 10.00m AOD in the south to 5.75m AOD in the north adjacent to West Street. Underlying ground conditions comprise Made Ground up to depths of 4.50m below ground level (bgl) in the north and 8.10m bgl in the south. Made Ground typically comprised dark brown mottled white, sandy, gravelly clay with chalk, flint, concrete, brick and tile, with occasional boulders of concrete. Structureless Seaford Chalk Formation (classified as a Principal Aquifer) is present below Made Ground. The nearest surface water feature is the River Thames, which borders the Site to the north. During investigation work groundwater was encountered between 3.00m and 4.00m bgl. Groundwater underlying the Site is likely to be in hydraulic continuity with the river, and is estimated to flow in a north east direction towards the River Thames.
Historical Setting	Historically the site has been utilised predominantly for industrial purposes, including a coal wharf, timber yard, connecting viaduct with railway lines and travelling crane, and subsequently as building merchant with storage facilities. The combined Site areas formed the Gravesend West Station which was a terminus for boat trains connecting with passenger ferries crossing the Thames and the Channel. The southern part (Area 2) contained the station buildings and platforms. From 1999, storage units were present across the Site and is understood to have been used for building materials, shipping containers and boats. By 2007, the pier was closed to the public and the viaduct was removed; both areas were cleared and the Site has remained derelict.
Previous Investigation Findings	<u>Made Ground Soil</u> Laboratory results of soils samples were compared against Generic Assessment Criteria (GAC's) for a residential end use (without home grown produce). The analysis of underlying soils has confirmed the majority of elevated contaminants appears to be primarily in Made Ground soils of West Street Area 1; contamination included exceedances for metals, PAHs and asbestos. Some asbestos fragments were also identified on the ground surface, with positive identification in Made Ground soils. Asbestos fibres in soil (Area 1) reported a maximum value of <0.084% with visual cement sheeting identified at ground level. Asbestos fibres in soil (Area 2) reported a maximum value of <0.001% in one area. Soil leachate analysis for Area 1, indicated predominantly low concentrations with some exceedances for PAHs and heavy metals (namely, copper, nickel, lead, zinc, and chromium VI) in all samples when compared to current Environmental Quality Standards (EQS), protective of surface waters, which are particularly stringent. When compared against current Drinking Water Standards (DWS), protective of the underlying aquifer, only minor PAH exceedances were identified. For Area 2, leachate laboratory analysis revealed minor exceedances for heavy metals (namely copper and lead) when compared to EQS. No exceedances were identified when compared against DWS. <u>Groundwater</u> Moderate to low exceedances were identified from groundwater laboratory analysis, however, the majority were low and did not appear to be significant. <u>Ground Gas</u>

	Four ground gas monitoring visits were completed and encountered low to negligible concentrations of carbon dioxide and negligible concentrations of methane. Gas flow rates were also found to be negligible.
Conceptual Site Model & Risk Assessment	Findings of the intrusive Site investigation works, and initial risk assessment identified the following potential risks: • Potential moderate to high risks identified to future site users via direct, dermal contact, inhalation and ingestion from impacted Made Ground soils. • Potential moderate risks to groundwater and surface water from leaching of contaminants from impacted Made Ground soils and migration to controlled waters. • Potential moderate risks to surface water in relation to contaminant migration via surface water run off / drainage pathways to surface waters. • Potential low to moderate risks to future site users and buildings from accumulation of ground gas. • Deep piling foundations have been deemed to be required to sustain the proposed high-rise buildings. As such, there is the potential for the creation of preferential pathways for the migration of contamination from the surface. Following assessment and taking into consideration the proposed development, the Relevant Contaminant Linkages (RCLs) require mitigation / remediation to reduce identified risks: • Elevated contaminants in the underlying Made Ground soils posing potential risks to human health (current and future Site users) via vapour, dust inhalation, ingestion, dermal and ingestion via water supply pipes. • Elevated contaminants in the underlying Made Ground soils posing potential risks to controlled water (principal aquifer and surface waters) via leaching, dissolution and migration via groundwater / drainage. • Migration of contamination via groundwater and / or preferential pathways such as drainage / piling posing potential risks to controlled water (principal aquifer and surface waters).
Remediation Strategy	The Remediation Strategy will comprise: • Contamination watching brief / Discovery Strategy to be in place during all works to identify any potential sources of contamination. • Installation of cover system across the Site comprising: ○ For areas of soft landscaping and communal garden the clean cover system will comprise imported soil that has been subject to validation testing. The clean cover will act as a barrier to protect users from coming into direct contact with the identified contaminants and is recommended to be 450mm thick. ○ Areas of buildings and hard landscaping (including roads, public paved areas etc.) are expected to act as a physical barrier and cover system in their own right. • Completion of a piling risk assessment (if piling is required) during development works. • Groundwater monitoring during piling phase (depending on pile solution employed and potential for piles to affect groundwater migration). • Decommissioning of groundwater monitoring wells. • Consultation with the water supply authority regarding suitable potable water supply pipe materials. • Provision of an appropriate Materials Management Plan (MMP) to enable potential re-use of site-won materials should this be required. In accordance with CL:AIRE Definition of Waste Code of Practice (DoWCoP). • Off-site disposal of any unsuitable materials off-site under the appropriate duty of care. • Completion of a Verification Report to demonstrate the effectiveness of the approved remediation carried out, prior to occupation.

1. INTRODUCTION

Ecologia has been commissioned by Quinn Estates Ltd. (the 'Client') to prepare a Remediation Strategy in relation to the redevelopment of land known as Clifton Slips (the 'Site') located at West Street, Gravesend, Kent, DA11 0BW.

This document sets out the Remediation Strategy required to allow the safe development of the Site for a residential end use and to ensure the necessary supervision and validation procedures are implemented to control the works.

1.1 Objectives

This Remediation Strategy (RS) is intended to support discharge of planning conditions reference 20191122, Condition No.5 part 3, for the redevelopment of the Site and ensure that the required remedial work is undertaken to a standard suitable for a residential end use (without private gardens) with soft landscaping and public open space areas.

This Strategy should be read in conjunction with the following previous assessments:

- Ecologia Environmental Solutions Phase 1 and 2 Geo-Environmental Assessment, Clifton Slips, West Street, Gravesend, Kent, DA11 0BW (reference: 18.376.3, dated 20th June, 2019).

The above Phase 1 and 2 Geo-environmental Report was submitted as part of the planning application.

1.2 Proposed Development

Gravesham Borough Council granted planning permission for the restoration and development of the historic pier; Clifton Slipways in July 2020 (planning Ref.2019112). The planning permission is for 227No. new 1 and 2-bed homes, spread across two sites: West Street and Stuart Road with restoration of the pier creating public and private amenity space and business units. The development will include areas of landscaping, public open space and communal garden.

The proposed development as detailed in the planning application comprises:

The erection of two buildings to provide a total of 227no. dwellings with associated vehicle parking, cycle storage, highway works, and landscaping. Building 1 comprises the erection of a 23 storey tower on the north side of West Street to provide 121no. dwellings with 1no. business Unit (B1a) comprising 90 sqm of floor space at ground floor level; and Building 2 from four storeys to 12 storeys on the south side of West Street which will provide 106no. dwellings. The proposal includes the restoration and adaptation of the existing pier structure to provide public and private amenity space to include the erection of 16no. Business(B1a) units comprising a total of 510 sqm of floor space; and a cafe (A1/A3) comprising up to 60 sqm of floor space.

Initially the re-development was granted by Gravesham Borough Council under planning permission ref: 20160046, however, following submission of a revised description, the development is approved with planning reference 20191122.

The redevelopment layout plans including landscaping masterplan are included as [Appendix I.](#)

1.3 Report Structure

This Remediation Strategy report has been prepared with due consideration to the guidance for Land Contamination Risk Management guidance (EA, 2020) and provides the following information:

- **Site Setting:** summarising the Sites environmental setting and historical development ([Section 2](#)).

- **Previous Assessments:** summarising the various phases of works across the Site and previous works undertaken ([Section 3](#)).
- **Conceptual Site Model:** identifying sensitive receptors and sources of impactation, and any Relevant Contaminant Linkages from a review of all available data ([Section 4](#)).
- **Remediation Options Appraisal:** ([Section 5](#)).
- **Remediation Objectives & Strategy:** identifying objectives which define the framework for remediation works and the overall approach in order to break the identified pollutant linkages ([Section 6](#)).
- **Verification Plan:** detailing the sampling and laboratory requirements and the lines of evidence required to demonstrate the effectiveness of remediation works ([Section 7](#)).
- **Implementation of Strategy:** considering the various construction requirements in order to implement the remediation strategy ([Section 8](#)).

2. SITE SETTING

This section draws on available sources of information, to provide a summary of the Site's environmental setting and previous industrial / historic land uses.

2.1 Site Description

The Site address is Clifton Slips, West Street, Gravesend, Kent, DA11 0BW.

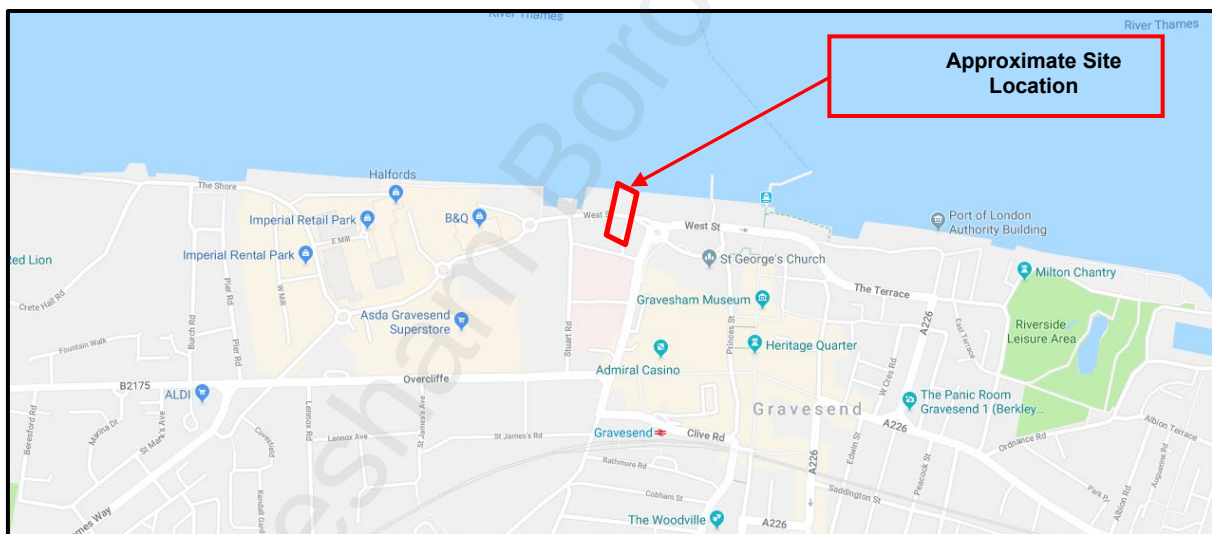
The Site is irregular in shape and comprises two (2No.) parcels of land, split by West Street, Area 1 (also known as 'West Street') and Area 2 (also known as 'Stuart Road'). The Site is situated in a predominantly residential and retail / commercial area in the centre of Gravesend.

The combined site comprises approximately 0.55 hectares.

Area 1 north of West Street currently comprises mostly concrete hardstanding and is generally flat (surface level recorded between 4.75m AOD and 5.25m AOD), with a derelict pier extending out into the River Thames. The Pier is approximately 2.50-3.00m higher than surrounding ground level. The pier is not in use / currently derelict and is constructed of a cast iron and wrought iron structural frame with three levels of timber decking supported on piles.

Area 2, south of West Street and west of Stuart Road, comprises open scrubland / vegetation and has a steep gradient across the Site, differing in ground levels from 10.00m AOD in the south to 5.75m AOD in the north adjacent to West Street.

The location of the site is shown in Plan 1 and is approximately centred at grid reference 564391, 174435. The approximate site area is shown in Plan 2 (outlined in red).



Plan 2. Site Location (Source: Google Maps).



Plan 3. Approximate Proposed Development Area (Source: Google Earth).

2.2 Environmental Setting

2.2.1 Geology

A review of readily available information from British Geological Survey (BGS) website and the published BGS Dartford 271 (1998, 1:50,000) Solid and Drift edition has been undertaken.

The BGS records superficial deposits to be underlying the very northern edge of Area 1 comprising Tidal River or Creek Deposits (Clay and Silt); with no superficial deposits reported in Area 2. Bedrock geology underlying the Site is reported as comprising the structureless Seaford Chalk Formation.

The below ground conditions have been reported with reference to the previous site investigation undertaken on Site:

- **Made Ground:**

- Made Ground was encountered across the Site at varying depths from Ground Level (GL) 4.5m below ground level (m bgl) in Area 1 and up to 8.10 meters bgl in Area 2.
- Made Ground typically comprised dark brown mottled white, sandy, gravelly clay with chalk, flint, concrete, brick, plastic, wood, tile with occasional boulders of concrete.

- Groundwater was struck within the Made Ground at depths of between 3.00m bgl and 4.00m bgl.
- **Seaford Chalk Formation:**
 - Below the Made Ground, the Seaford Chalk Formation was encountered at between 4.00m bgl and 8.10m bgl.
 - The Seaford Chalk Formation was recovered as a gravelly silt with occasional fine to coarse angular flint gravel.
 - The Seaford Chalk Formation was encountered to the maximum explored depth of 25.00m bgl.

2.2.2 Hydrogeology and Hydrology

The [MAGIC](#) website indicates the Site is located over:

- Principal Aquifer associated with the Seaford Chalk Formation bedrock deposits.

Principal Aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

The Site is not within a Source Protection Zone (SPZ) or a Drinking Water Protected Area (DrWPA), however, the Groundwater Vulnerability is classified as Major Aquifer High.

There are no recorded Groundwater abstractions within 1km of the Site.

The nearest surface water feature is the River Thames, which borders the Site to the north. Groundwater underlying the Site is likely to be in hydraulic continuity with the river, and is estimated to flow in a north east direction towards the River Thames.

One (1No.) Zone 2 floodplain (Fluvial/Tidal Models) and one (1No.) Zone 3 floodplain (Fluvial Models) have been identified onsite. A further Zone 3 floodplain has been identified 220m west of the site.

The Risk of Flooding from Rivers and the Sea (RoFRaS) identifies a High (1 in 30 or greater) chance of flooding in any given year for the area closest to the Thames. The RoFRaS for the remainder of the site is Very Low (annual chance of flooding of less than 0.1%) chance of flooding in any given year.

Flood defences are recorded as being present on Site.

2.3 Site History

Historically the site has been utilised predominantly for industrial purposes, including a coal wharf, timber yard, connecting viaduct with railway lines and travelling crane, and subsequently as building merchant with storage facilities. The combined Site areas formed the Gravesend West Station which was a terminus for boat trains connecting with passenger ferries crossing the Thames and the Channel. The southern part (Area 2) contained the station buildings and platforms.

From the earliest historic map, dated 1863, shows the wharf on West Street was occupied by two buildings, labelled as a coal wharf. The two parcels of land were separated by West Street, and the Stuart Road Area 2 land was occupied by houses and a timber yard. In 1897, several railway lines traversed through the western part of Area 2 and continued onto the pier, supported underneath by a viaduct that crossed West Street. A railway station is present on the southern Site and adjacent to south west. For the next 30 years, the Site remained relatively unchanged. A travelling crane was added to the northern end of the pier by 1933, indicating that the pier served cargo ships as well as passenger ferries. The railway tracks were eventually removed in 1975, however, the viaduct still remained. From 1999, storage units were present across the Site

and is understood to have been used for building materials, shipping containers and boats. By 2007, the pier was closed to the public and the viaduct was removed; both areas were cleared and the Site has remained derelict.

3. PREVIOUS ASSESSMENTS

3.1 STATS Ltd 'Geotechnical and Geo-environmental Report; Dated 23rd March 2007, report reference 35486-001

A previous site investigation was undertaken by STATS Ltd in 2007 and consisted of:

- Four (4No.) deep boreholes to a maximum depth of 20.00 metres below ground level (m bgl) and seven (7No.) shallow boreholes to a maximum depth of 5.00m bgl;
- Six (6No.) borehole installations for subsequent monitoring (1No. round of ground gas monitoring and 1No. round of groundwater monitoring);
- Seven (7No.) trial pits, including three (3No.) excavated by hand to a maximum depth of 0.60 bgl and four (4No.) excavated by mechanical excavator to a maximum depth of 4.90 mbgl; and,
- Six (6No.) In-situ Dynamic Cone Penetrometer (DCP) tests in the Made Ground.

Results of the investigation identified the following:

- Made Ground in Area 1 was reported to be up to 6m thick and consisted of a reinforced concrete slab over sandy gravelly clay with flint, brick rubble and tarmac. A slight hydrocarbon odour was noted in WS2 (located in Area 1).
- Substructures associated with old viaduct abutments, brick walls and sheet pile river walls were exposed in all trial pits in Area 1.
- Made Ground in Area 2 was reported to be up to 6.50m thick and consisted of sandy gravelly clay with flint, brick rubble and tarmac, with rare clinker, roots, concrete and glass. A slight hydrocarbon odour was noted in BH3 and WS7 (central and southern Area 2). Some decomposing organic matter was encountered in WS6 (central Area 2).
- One (1No.) round of gas monitoring indicated the site may be classified as Characteristic Situation 1 and would not require any special precautions or protective measures. However, additional monitoring is required to enable a full range of conditions to be established, including any tidal influence.
- One (1No.) round of groundwater monitoring did not reveal any exceedances when compared against the controlled water standards at the time of investigation. However, when compared to updated standards, potential exceedances for Polycyclic Aromatic Hydrocarbons (PAHs) were identified.
- Overall, limited contamination was noted across the samples scheduled for analysis; albeit, the investigation was limited in terms of chemical suites and quantity. However, no leachate analysis was undertaken to determine risks of migration to controlled waters.

3.2 Ecologia – 'Phase 1 & Phase 2 Geo-Environmental Assessment' (reference 18.376.3, dated 20/06/19)

Site Investigation works were undertaken in February and April 2019 to support the initial planning application granted in 2016 (ref: 20160046) and to provide further detailed assessment of the underlying ground conditions. Works comprised eighteen (18No.) trial pits and four (4No.) boreholes installed with dual monitoring pipes enabling supplementary ground gas and groundwater monitoring to be completed.

The exploratory hole locations completed by Ecologia in 2019 is included as Figure 1, Appendix II.

3.2.1 Ground Conditions

Ground conditions were confirmed as Made Ground ranging from 4.50m thick in Area 1 and up to 8.10m thick in the south of Area 2, directly overlying structureless Seaford Chalk Formation. No superficial deposits encountered.

Underground obstructions were identified on Area 1, including a concrete wall extending from TP1 and TP6 at a depth of 0.60m below ground level (bgl) to the base. A metal obstruction was encountered at the base of TP6 (at 2.10m bgl). Concrete was identified at the base of TP7 (depth of 1.90m bgl) with a thin concrete layer encountered in TP8 at 1.25m bgl (0.20m thick). Brick walls were identified in the central section of the plot visible from ground level and extending down to 1.00m bgl in TP9 and TP7.

Three (3No.) groundwater monitoring rounds were completed, the average groundwater depths varied between 1.393m AOD and 0.960m AOD in Area 1 and between 1.311m AOD and 1.070m AOD in Area 2. The depth of the groundwater varied slightly during the monitoring visits indicating some tidal influence from the adjacent Thames Estuary. No visible free product was identified or detected and no visual or olfactory evidence of contamination noted in groundwater during monitoring.

Groundwater flow direction is inferred in a north east direction towards the River Thames.

Four (4No.) rounds of ground gas monitoring were completed, data recorded identified carbon dioxide (CO₂) concentrations ranged between 0.0% and 1.4%; methane (CH₄) concentrations were 0.0% in all monitoring rounds; carbon monoxide (CO) concentrations ranged between 0ppm and 6ppm; and, hydrogen sulphide (H₂S) concentrations ranged between 0ppm and 1ppm.

3.2.2 Contamination Observations

In Area 1, hard standing was encountered across all intrusive locations, over Made Ground (up to 4.50m thick). Made Ground consisted of brown / blackish sandy gravelly clay. Gravels comprised brick, concrete, bituminous material and flint. Some deleterious materials were also noted, including plastic, tiles and glass. Small fragments of asbestos cement sheeting were identified on the surface ground level and in the soils of trial pits TP1 and TP4. Railway sleepers were noted in TP1, TP3 and TP6.

In Area 2, Made Ground was identified in all intrusive locations up to 8.10m thick and consisted of brown / blackish sandy gravelly clay. Gravels comprised brick, concrete, bituminous material and flint. Some deleterious materials were also noted, including plastic, tiles and glass.

Abundant rubbish was present in the southwest corner of Area 2, resulting from squatters on site. In general, 'fly-tipped' rubbish was observed around the boundaries of each area, generally alongside the road / pathways.

3.2.3 Findings & Assessment

Made Ground Soil

Laboratory results of soils samples were compared against Generic Assessment Criteria (GAC's) for a residential end use (without home grown produce). The analysis of underlying soils has confirmed the majority of elevated contaminants appears to be primarily in Made Ground soils of West Street Area 1; contamination included exceedances for metals, PAHs and asbestos. Some asbestos fragments were also identified on the ground surface, with positive identification in Made Ground soils. Asbestos fibres in soil (Area 1) reported a maximum value of <0.084% with visual cement sheeting identified at ground level. Asbestos fibres in soil (Area 2) reported a maximum value of <0.001% in one area.

Soil exceedances identified are denoted on Figure 2, Appendix II.

Soil leachate analysis for Area 1, indicated predominantly low concentrations with some exceedances for PAHs and heavy metals (namely, copper, nickel, lead, zinc, and chromium VI)

in all samples when compared to current Environmental Quality Standards (EQS), protective of surface waters, which are particularly stringent. When compared against current Drinking Water Standards (DWS), protective of the underlying aquifer, only minor PAH exceedances were identified.

For Area 2, leachate laboratory analysis revealed minor exceedances for heavy metals (namely copper and lead) when compared to EQS. No exceedances were identified when compared against DWS.

Groundwater

Moderate to low exceedances were identified from groundwater laboratory analysis, although, the majority were low and did not appear to be significant. However, it was noted that further monitoring and risk assessment may be required.

Ground Gas

Four ground gas monitoring visits were completed and encountered low to negligible concentrations of carbon dioxide and negligible concentrations of methane. Gas flow rates were also found to be negligible. The monitoring data and risk assessment suggests a classification in accordance with CIRIA C665 of Characteristic Situation 1. Therefore, no special ground gas protection measures are considered to be required on site.

Radon Affected Areas

Previous environmental search data indicated the Site not to be located in a radon affected area as less than 1% of properties are above the Action Level. The UK Health Security Agency (UKHSA) and the British Geological Survey (BGS) have recently published an updated radon potential map for Great Britain (in December 2022). The Site is now classified as being located within a radon affected area with estimated probability of the property being above the Action Level for radon is 1-3%. However it is considered that no radon protection measures are required in new builds or commercial developments, as described in publication BR211 by the Building Research Establishment.

4. CONCEPTUAL SITE MODEL & RISK ASSESSMENT

This Conceptual Site Model (CSM) has been developed cognisant of the 'Land Contamination Risk Management' (LCRM) and follows the principle of the identification of the Source-Pathway-Receptor (S-P-R).

For a potential risk to be realised all three components must be identified and a potential contaminant linkage established.

4.1 Summary of S-P-R

The results of the previous Site investigation identified the following sources and corresponding pathways and receptors:

4.1.1 Sources

- Elevated contaminants within Made Ground soils underlying the Site.
- Asbestos in Made Ground soils underlying the Site.
- Marginal elevated contaminants within the soil leachate and groundwater underlying the Site.
- Potential ground gas generation associated with Made Ground soils.

4.1.2 Pathways

Potential Human Health exposure pathways comprise:

- Direct contact, vapour, fibre and / or dust inhalation and ingestion of contaminated soil / dust.
- Permeation of plastic water supply pipework of volatile organic compounds and tainting drinking water supply.
- Leaching, dissolution, and vertical / lateral migration of contaminants or migration via preferential pathways (such as drainage, piling).
- Lateral migration of contaminants via groundwater.
- Migration of ground gasses via granular strata and ingress to buildings leading to a build-up in confined spaces.

4.1.3 Receptors

- Future site users (residential without home grown produce).
- Construction workers, groundworkers and off-site residents.
- Controlled Waters (Principal Aquifer and River Thames).
- Buildings and infrastructure.

4.2 Risk Assessment

Previous investigation work and initial risk assessment identified the following:

- Potential **moderate to high risks** identified to future site users via direct, dermal contact, inhalation and ingestion from impacted Made Ground soils.
- Potential **moderate risks** to groundwater and surface water from leaching of contaminants from impacted Made Ground soils and migration to controlled waters.

- Potential **moderate risks** to surface water in relation to contaminant migration via surface water run off / drainage pathways to surface waters.
- Potential **low to moderate risks** to future site users and buildings from accumulation of ground gas.
- Deep piling foundations have been deemed to be required to sustain the proposed high-rise buildings. As such, there is the potential for the creation of preferential pathways for the migration of contamination from the surface.

Construction, Groundworkers and off-site Residents

Short term human health risks during ground works as part of any redevelopment have been excluded from further consideration on the basis that risks of acute exposure can be addressed through the use of appropriate control measures, including dust suppression, careful stockpile management, good standard of hygiene practices, health and safety practices and Personal Protective Equipment (PPE).

Ground Gas

Four ground gas monitoring visits were completed during 2019 investigation works and encountered low to negligible concentrations of carbon dioxide and negligible concentrations of methane. Gas flow rates were also found to be negligible. The monitoring data and risk assessment suggests a classification in accordance with CIRIA C665 of Characteristic Situation 1. Therefore, no special ground gas protection measures are considered to be required on site.

Controlled waters

Overall soil leachate and groundwater contaminant concentrations were low and given the development will comprise mainly hardstanding reducing infiltration, risks to controlled waters are deemed to be low. However, given the sensitivity of controlled waters receptors, further monitoring maybe required during potential activities such as piling to monitor groundwater quality.

Proposed Development

The proposed development is for a residential end use in the form of apartments with business / retail units on the pier. Much of the Site will be covered by building and hardstanding, with some landscaping and a communal garden.

4.3 Relevant Contaminant Linkages

Taking into account the proposed development, the relevant contaminant linkages (RCL's) requiring further assessment or remediation are discussed below, and the RCLS's summarised in Table 4.1 overleaf.

Table 4.1: Relevant Contaminant Linkages (RCL)

RPL	Contaminant	Pathway	Receptor
RCL1	Contaminants present within the Made Ground soils these include heavy metals, PAHs and ACM.	Inhalation, ingestion and dermal contact with contaminants in soil and soil-derived dust	Future site users
RCL2		Infiltration of contaminants into drinking water supply pipes, followed by ingestion.	Future site users
RCL3		Leaching, dissolution followed by vertical and lateral migration of contaminants	Groundwater and Surface Waters
RCL4		Migration of contamination via groundwater and preferential pathways e.g., drainage, existing wells, and piled foundations.	Groundwater and Surface Waters

5. REMEDIATION OPTIONS APPRAISAL

5.1 Introduction

The identification of feasible remediation options and the options appraisal is undertaken in accordance with the requirements set out in Stage 2 'Options appraisal' of the EA LCRM guidance.

The moderate to high risks identified in the site conceptual model represent unacceptable risks to the identified receptors and will require appropriate further assessment and/or remedial actions to mitigate these risks.

5.2 Identification of Feasible Remediation Options

Feasible remediation options are identified to prevent, minimise, remedy or mitigate the effects of the identified unacceptable risks.

The remediation options are considered as 'feasible' if they can break the identified 'relevant contaminant linkages' or reduce risks. This objective can be achieved with the implementation of remediation actions capable of either:

- Remove or treat the source(s):
 - Reduction.
 - Removal.
 - Stabilisation.
 - Transformation / Destruction / Degradation.
- Remove or modify the pathway(s):
 - Breaking of the pathway (capping).
 - The destruction or removal of contaminants moving along a pathway.
- Remove or modify the behaviour of receptor(s):
 - Restricted access to certain areas for end users.
 - Health and safety requirements.

The remediation options to reduce and mitigate the potential risks to both future end users and controlled waters associated with contamination sources identified on Site are summarised in Table 5.1 overleaf.

Table 5.1: Feasible Remediation Techniques

Remediation Technique		Contaminants		
		Asbestos	PAHs	Heavy metals
Soil	Excavation & Disposal	✓	✓	✓
	Cover System	✓	✓	✓
	Bioremediation	x	✓	x
	Soil washing	x	✓	✓
	Stabilisation	x	✓	✓
	Soil Vapour Extraction	x	✓	x
	Containment – In-ground Barriers	x	✓	✓
Groundwater	Pump and Treat	x	✓	NA
	Air Sparging	x	✓	NA
	Chemical Treatment	x	✓	✓
	MNA	x	NA	NA
	Containment – Hydraulic Barriers	x	✓	✓

5.3 Assessment of Remediation Options

The role of the options appraisal is to establish, taking all the circumstances of the Site into account, which options (either singly or in combination) offer the best overall approach to remediation for the Site as a whole. Consideration is given to the identification of the remediation techniques which are:

- Applicable to treat the identified contamination.
- Effective in the encountered site conditions and future layout.
- Aligned with the construction programme of the proposed development.
- Are sustainable.

The following remediation techniques are shortlisted as feasible options:

1. Excavation & Disposal:

The excavation of contamination in the Made Ground soils in localised areas across the Site is considered a feasible remediation option, however, should be undertaken with sustainable approach and only undertaken if necessary (such as requirements for gross contamination source removal to mitigate risks to controlled waters and / or required as part of the development formation levels).

2. Cover System

The majority of the Site will be covered with hard landscaping, forming a cover system in its own right as part of the development.

The installation of a cover system over contaminated material will break the critical pathways for the relevant contaminant linkage RCL1 and RCL2.

This technique will comprise the installation of hardstanding ground cover within the footprint of buildings, roads and car parks and an engineered capping for soft landscaping / communal garden areas.

As the majority of the Site will be covered with hardstanding or buildings, this cover system will also limit infiltration and reduce leaching / vertical migration of contaminants (relevant to contaminant linkage RCL3 and RCL4).

3. Combination of both source removal and cover system to achieve the final remediated site.

The advantages of each of these methods are outlined in Table 5.2 overleaf.

5.4 Selection of Final Remediation Option

Based on this assessment, and the proposed cut requirements for the development and final layout, the most feasible remedial option for the Site is considered to be a cover system, with acknowledgement that some Made Ground soils will be removed as part of the development cut (but not necessary as a remediation measure).

The selected remediation option will break RCL1, RCL2, and reduce risks to RCL3.

5.5 Further Monitoring & Assessment

To reduce risks of RCL4 we would recommend the following:

- Groundwater monitoring is undertaken during certain activities such as piling to ensure contaminant migration does not occur and to monitor groundwater quality.
- Decommissioning of any existing groundwater monitoring boreholes.
- A piling risk assessment should be undertaken (not included in this remediation strategy) to ensure contamination to the underlying aquifer does not occur.
- Detailed procedures for managing unexpected contamination which may be uncovered during the works.

Table 5.2: Remediation Options Appraisal

Remediation Technique	Method	Advantages	Disadvantages	Feasibility
1. Excavation and off-site disposal	This can be undertaken to treat the contamination sources as they are localised. The removal of the hotspots of contamination can be carried out as part of the redevelopment works and as part of the cut across the site. The stream of waste generated by the source removal is disposed off-site to a licensed waste facility.	Short timescales. Effective source removal of contaminants, breaking human health receptor pathway. Shallow excavations are required to remove the identified superficial contamination. Reduction of risks to controlled waters.	Relatively high cost for off-site treatment and disposal. Production of additional waste. Generation of vehicle movements in the site area. Some disturbance to neighbouring site is expected during the excavation of contaminated soil. Possible Site constraints such as presence of underground services / obstructions. Management of perched water within excavation.	Although this option is very effective, it presents sustainability issues relating to the production of waste, generation of heavy plant movements and potential disturbance to the neighbours.
2. Clean capping / cover system	Capping involves placing a cover system over contaminated material. Such cover isolates contaminants removing exposure pathway and the contaminants remain in place to avoid the spread of contamination. This technique can comprise the installation of 1. Hardstanding ground cover within the footprint of buildings, roads and car parks. 2. An engineered capping for soft landscaping areas. This can provide protection from inhalation, ingestion and dermal contact with contaminants in soil, soil-derived dust and gas/vapour to the future site users and ingress into buildings.	Short timescales. Effective on breaking the pathways via inhalation, ingestion and dermal contact with contaminants in soil. Applicable to the proposed development, as the planned hardstanding and buildings will form the cover system, therefore, reducing cost import. Minimal disturbance to the neighbours. Minimal production of additional waste.	Capping does not destroy or remove contaminants. Does not improve groundwater quality, however, may reduce infiltration if majority impermeable hard standing. Future maintenance workers should be informed of the presence of contamination below the capping layers.	Considered to be feasible, sustainable and compatible with the layout of the new development.
3. A combination of the techniques presented in items 1 and 2.	These can be used to i. Protect the future site users from inhalation, ingestion and dermal contact with contaminants in superficial soil, soil-derived dust and gas / vapour. ii. Prevent ingress of gas/vapour into buildings. This can comprise of a capping system and the removal of localised hotspots.	Short timescales. Compatible with the construction programme. Effective on breaking human health pathways. Reduction of risks to controlled waters.	Same disadvantages as points 1 above, however, combination will reduce volume for off-site disposal.	Considered to be feasible, not as sustainable due to the production of the waste. However, it is likely that some Made Ground materials will be removed as part of the cut for development platform.

6. REMEDIATION STRATEGY

6.1 Remediation Objectives

The main objective of the remedial work is preparation of the Site for re-development to ensure that it is suitable for the future intended use. Although certain elements of the works required will be undertaken as part of development measures (e.g., provision of topsoil finishes) these are discussed herein as part of the overall approach.

The objectives of the remediation are as follows:

- To produce a strategy that can be agreed with all key stakeholders;
- To meet all regulatory requirements applicable to the development of the Site and to consider the views of key stakeholders on how unacceptable risks should be managed;
- To meet all regulatory requirements during the implementation of the remediation options;
- To avoid unacceptable health and safety and environmental impacts during remediation;
- To carry out remediation in accordance with good technical practice;
- Ensuring feasible mitigation measures taking into consideration factors such as the ground conditions, environment setting, and the phasing of the development; and
- Sustainability of the strategy in terms of how it fits other environmental objectives, e.g., use of natural resources and avoiding or minimising adverse environmental impacts, e.g., transportation, water, environment, air and landfill.

6.2 Remediation Requirements

- Contamination watching brief / Discovery Strategy to be in place during all works to identify any potential sources of contamination.
- Installation of cover system across the Site comprising:
 - For areas of soft landscaping and communal garden the clean cover system will comprise imported soil that has been subject to validation testing. The clean cover will act as a barrier to protect users from coming into direct contact with the identified contaminants and is recommended to be 450mm thick.
 - Areas of buildings and hard landscaping (including roads, public paved areas etc.) are expected to act as a physical barrier and cover system in their own right.
- Completion of a piling risk assessment (if piling is required) during development works.
- Groundwater monitoring during piling phase (depending on pile solution employed and potential for piles to affect groundwater migration).
- Decommissioning of groundwater monitoring wells.
- Consultation with the water supply authority regarding suitable potable water supply pipe materials.
- Provision of an appropriate Materials Management Plan (MMP) to enable potential re-use of site-won materials should this be required. In accordance with CL:AIRE Definition of Waste Code of Practice (DoWCoP).
- Off-site disposal of any unsuitable materials off-site under the appropriate duty of care.
- Completion of a Verification Report to demonstrate the effectiveness of the approved remediation carried out, prior to occupation.

The risks to construction / groundworkers are mitigated by the adoption of appropriate

construction protocols (further discussed in [Section 8](#)).

6.2.1 Soil Cover System (Soft Landscaping / Communal Garden)

In order to protect future site users, it is recommended that a clean cover system is applied in soft landscaping areas. The cover system should comprise suitable subsoil and topsoil to be validated to confirm material, thickness of layer and suitability against the relevant verification criteria ([Appendix III](#)) for imported material.

Placement of a cover system in soft standing areas across the Site as follows:

- A minimum of 450mm soil cover system which may comprise subsoil and topsoil.
- Soil cover system to be underlain by geotextile marker layers (such as terram).
- The cover system thickness should be maintained above drainage runs and services where these intersect landscaped areas.
- Cover system should not comprise Made Ground deleterious materials.
- Chemical validation of soils and verification of marker layer and thickness.

Areas of buildings and hard landscaping (including roads, public paved areas etc.) are expected to act as a physical barrier and cover system in their own right, therefore, no requirement for cover layer.

Chemical validation by the collection and analysis of representative soil samples – [Section 7](#)) of imported materials used as the cover layer across the soft landscaping areas is required. The materials used in the cover layer will need to be approved for use prior to importation or placement on-site. As part of this process, details of source and testing records will need to be provided. In addition, on site validation soil sampling and analysis of the material will be required once imported onto Site.

The thickness of the clean cover layer will require verification via test holes and supporting photographic evidence.

6.2.2 Piling Risk Assessment

If piled foundations or any other foundation design using penetrative methods are required, a Piling Risk Assessment maybe required prior to piling and may require approval from Regulators (this is usually set as a planning condition). As part of the piling risk assessment groundwater monitoring and sampling may be required prior, during and post piling works. If previously installed boreholes are no longer serviceable, additional boreholes will need to be installed for this purpose.

Consideration should also be given to the resulting pile arisings and appropriate disposal of waste under duty of care.

6.2.3 Drinking Water Supply Pipes

It is recommended that sub-surface water supply pipework shall either:

- Be placed in uncontaminated natural ground;
- Be placed in suitable uncontaminated fill in lined trenches; or,
- Utilise appropriate materials selected for water supply pipework in accordance with UKWIR guidance.

Consultation with water supply company regarding installation of water supply pipework for the development will be required.

6.2.4 Earthwork Excavations

As the development will comprise majority hardstanding, excavation of areas in which elevated concentrations of contaminants were encountered is not necessary.

As part of the development measures for the Site it is likely that an excavation cut of Made Ground soils will be required in parts of the Site to achieve the required formation platform for construction.

Excavated Made Ground soils will be stockpiled for re-use under areas of hard standing if suitable or removed from Site. If Made Ground soils are to be re-used, materials will need to be chemically and geotechnically suitable for use and only re-used below buildings and hardstanding areas.

Excavated materials should be stockpiled prior to sentencing based on the following visual assessment soil categories:

- Natural virgin soils likely to be classified as suitable for an inert disposal facility.
- Made Ground and other soils suspected of contamination, likely to be classified as suitable for a non-hazardous disposal facility.
- Grossly contaminated soil, if encountered, (including asbestos containing soils stockpiled separately) likely to be classified as suitable for a hazardous disposal facility.

Depending on depth of excavations, perched water or shallow groundwater may need managing as part of works. Water removed from excavations should either be treated on site with subsequent discharge to foul drainage (under consent from local sewage undertaker) or disposed of off-site to a suitable treatment facility.

6.2.5 Asbestos Containing Materials (ACMs)

Asbestos has been recorded in Made Ground soils tested from the Site, the presence of further ACMs should be assumed within areas not directly investigated and cannot be discounted at this time.

During the construction works there will be a risk from dust to on-site workers and people occupying adjacent properties. Appropriate risk assessments should be carried out by the contractor in accordance with the Control of Asbestos Regulations (2012) to allow appropriate controls for the mitigation of risk to health of construction workers to be put in place. This risk can be controlled to within acceptable limits by:

- Implementing the Asbestos Working Plan including control of dust generation;
- Workers wear suitable Personal Protective Equipment (PPE) and if necessary appropriate RPE;
- Adequate site hygiene facilities allowing staff to keep a good level of personal hygiene; and
- All ground workers should have been trained in asbestos awareness and should keep a look out for this being encountered during excavations.

6.2.6 Reuse of Suitable Materials

The cut and fill exercise for the development could require the re-use of materials onsite. Under the Waste Framework Directive, naturally occurring soils are not considered waste if reused on the site of origin for the purposes of development.

In accordance with the definition provided in the Waste Framework Directive, materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Thus, soils that are not of clean and natural origin, i.e., Made Ground (whether contaminated or not) and other materials such as recycled aggregate, do not become waste until the aforementioned criteria are met.

The Definition of Waste: Development Industry Code of Practice (CL:AIRE, 2011) (CoP) was developed in consultation with the Environment Agency and development industry to enable the re-use of materials under certain scenarios and subject to demonstrating that specific criteria are met. The current reuse scenarios covered by the CoP comprise:

- Reuse on the site of origin (with or without treatment);
- Direct transfer of clean and natural soils between sites; and,
- Use in the development of land other than the site of origin following treatment at an authorised Hub site (including a fixed soil treatment facility).

The importation of Made Ground soils (irrespective of contamination status) or crushed demolition materials is not permitted currently under the CoP and requires either a standard rules environmental permit or a U1 waste exemption.

In the context of excavated materials used on sites undergoing development, four factors are considered to be of particular relevance in determining if the material is a waste or when it ceases to be waste:

- The aim of the Waste Framework Directive is not undermined, i.e., if the use of the material will create an unacceptable risk of pollution of the environment or harm to human health it is likely to be waste;
- The material is certain to be used;
- The material is suitable for use both chemically and geotechnically;
- Only the required quantity of material will be used.

The CoP requires the preparation of a Materials Management Plan (MMP) that confirms the above factors will be met. This plan needs to be reviewed by a 'Qualified Person' (QP) who will then issue a declaration form to the EA. As the project progresses, data must be collated and on completion a verification report produced that shows the MMP was followed and describes any changes.

The MMP establishes whether specific materials are classified as waste and how excavated materials will be treated and/or reused in line with the CoP. The MMP is likely to form part of the site waste management plan.

As noted above, under the Waste Framework Directive naturally occurring soils are not considered waste and therefore arisings of clean natural soils, e.g., from foundation and drainage excavations, may be reused on the Site. However, it is important that these soils should be stockpiled separately and not become cross-contaminated with Made Ground / contaminated soils or construction wastes.

If it were proposed to import clean and naturally occurring soils direct from another site, the receiving site's MMP would need to be updated in advance of importation.

6.2.7 Decommissioning of Existing Groundwater Monitoring Wells

There may be a need to decommission the existing boreholes on Site in order to prevent potential preferential pathways to the aquifer.

Works should be undertaken in accordance with the publication of 'Good Practice for Decommissioning Redundant Boreholes and Wells'.

Detailed records of works should be taken and include:

- Groundwater level prior to decommissioning;
- Any removal of pipework or attempt to remove the pipework;
- The depth, position and nature of backfill materials; and

- Problems encountered during decommissioning.

6.2.8 Discovery Strategy

Despite the previous site investigation works undertaken, it remains possible that accidental or previously unexpected soil conditions may be encountered during the process of redevelopment.

Should unexpected contamination be encountered, the following course of action should be adhered to:

- Works in the area of the suspected contamination should cease immediately. The ground workers should report any suspected contamination immediately to the Client's site supervisor. The supervisor should contact the Environmental Consultant, who should visit the site to assess the extent of the 'contamination'.
- Where the conditions revealed differ from those previously anticipated, the Environmental Consultant shall take samples as deemed appropriate to be dispatched for appropriate chemical testing.
- Depending on the results of the testing either: 1) no further work will be required; and/or 2) localised specific remedial measures will be necessary.
- The local authority and Environment Agency shall be consulted if any substantially different conditions are encountered or modifications to the works are required.

Any unexpected contamination discovered will be included within the Verification Report.

6.2.9 Groundwater Monitoring

Groundwater monitoring may be required depending on the pile solution employed and the potential for piles to affect groundwater migration. This should be assessed as part of a piling risk assessment.

7. VERIFICATION PLAN & REPORTING

Demonstrating that the remediation objectives and criteria have been met should be achieved through the verification process in accordance with Environment Agency guidance including:

- Laboratory requirements;
- Compliance criteria; and,
- Verification report.

7.1 Compliance & Validation Criteria

Validation Generic Assessment Criteria (GAC) for 'Residential without Home Grown Produce' end use have been adopted ([Appendix III](#)) for the purposes of:

- Assessing the suitability of imported material for use as the soil cover system in soft landscaping areas.
- Assessing the suitability of materials, import for soft landscaping and site-won soil for re-use.
- Encountering unexpected contamination.
- Assessing the suitability of backfill materials (import and site won).

The analytical results will be screened assessment against the GAC values derived by using CLEA software v1.06 and supporting UK guidance. Where available, published soil guideline values (SGV) were used as the adopted GAC.

The chosen GACs are for a residential end use without home-grown produce, screening criteria will be dependent either 1%, 2.5% or 6% soil organic matter (SOM) criteria applied. The different SOM % criteria is provided due to the topsoil likely having a higher organic content (6% SOM).

Additionally the material should be:

- A suitable growing medium;
- Free from obvious contamination (i.e. staining / free product etc.);
- Not come from areas where Japanese Knotweed or other invasive or injurious plants are suspected to have been growing;
- Not odorous (could be considered a statutory nuisance); and
- Free from unsuitable material (e.g. bricks, brick, tiles, metal, timber and glass etc).

7.1.1 Verification Sampling Frequencies

The following sampling frequencies in Table 7.1 overleaf should be adopted.

Table 7.1: Sampling Frequencies

Imported Material (to be used in soil cover system)	1No. sample per 500m ³	Whichever is the greater In addition, source certification testing will be required
	3No. per source	
	Verification samples will be required prior to or following placement of soil including verification evidence of the clean cover thickness	
Site won materials for re-use	1No. sample per 500m ³	

7.1.2 Materials Failing GAC

Following receipt of laboratory results and confirmation of non-compliant concentrations elevated above the GAC these materials will be segregated for offsite disposal and / or further assessment.

7.1.3 Cover Layer Verification

The cover system should be validated to confirm material, thickness of layer, marker layer and suitability against the relevant GAC ([Appendix III](#)).

The following will be required:

- Verification and evidence that the designed thickness of material has been placed in both soft landscaping areas.
- Verification and evidence that the materials comprising the cover system are themselves not contaminated and do not comprise Made Ground deleterious materials, i.e. suitable for use.
- Verify the extent of hardstanding areas, which provide a barrier to migration pathways.

7.1.4 Laboratory Requirements

Each sample taken for laboratory chemical testing is to be placed in laboratory provided containers and kept under controlled temperature conditions prior to dispatch to the laboratory. Samples should be dispatched within 48hrs to ensure they do not deviate.

Chain of custody documentation should be completed and recorded for samples dispatched to the laboratory. Each batch of samples dispatched is traced via a sample progress record sheet retained for the Site.

An accredited UKAS / MCERTS Environmental Laboratory will carry out laboratory chemical testing of all samples.

7.2 Waste Disposal

All contaminated materials removed off-site shall be transported to an approved licensed waste management facility for treatment or final disposal. The contractor shall provide a full documentary record of this operation in accordance with the Duty of Care. This should include waste transfer notes and details of the receiving Site. Copies of the landfill documents shall be provided to the Environmental Consultant for inclusion in the verification report.

7.3 Verification Report

On completion of works a Verification Report is required. The report should incorporate the necessary information to demonstrate that the relevant remediation strategy has been undertaken and complied with lines of evidence including the following:

- A narrative summarising the works including any further investigation / assessments undertaken.

- Photographic record (to include placement and thickness of clean cover in soft standing areas).
- Laboratory analytical certificates from all testing carried out during the works.
- Any assessments undertaken of suitability of materials, including materials imported onto site demonstrating their suitability in relation to agreed chemical compliance criteria.
- Verification of imported materials including test results for pre-certified soils and validation testing.
- Verification of materials placement and thickness.
- Quantities of excavated and re-used materials.
- Any unexpected contamination encountered, and mitigation measures implemented.
- Records of imported material and off-site disposal (this is anticipated to be provided as part of any Materials Management Plan or similar).

The Verification report should be submitted to the regulatory authorities for approval and to assist in the discharge of the relevant planning conditions.

7.4 Maintenance and Monitoring Plan

As part of the Verification Report, any potential residual liabilities shall be identified and any ongoing requirements in consultation with the Environment Agency and / or Local Authority.

General information in relation to Health and Safety matters, including: site records, design specifications, duty of care information, and environmental monitoring records, should be collated separately as part of the Health and Safety Plan.

7.5 Responsibilities

The Principal Contractor will be responsible for implementing the requirements of this Remediation Strategy. The Principal Contractor may appoint a suitably qualified environmental consultant to monitor and verify the correct implementation of the Remediation Strategy.

8. IMPLEMENTATION

The following sections comprise an outline implementation plan for the Site. This plan may be improved / amended by the client / contractor to include detailed method statements for each of the activities comprising the mitigation/remediation works.

8.1 Enabling Works

Suitable fencing should be erected around the Site, if not already present, and should be maintained to prevent members of the public and any other unauthorised personnel from entering the Site.

8.2 Site Clearance

Previous fly tipping has been noted on the Site, any waste material should be removed off-site under the appropriate Duty of Care.

8.3 Waste Disposal

The principals of the waste hierarchy (reduce-reuse-recover-disposal) should be followed onsite with a dedication to reducing the amount of waste generated during the redevelopment works, reusing as much material as possible and recovering all allowable material / energy. Waste for disposal will, however, be generated onsite but it will be segregated into the various types, as is reasonably practicable, and transported to an approved licensed waste management facility for treatment or final disposal.

All offsite management of contaminated / unsuitable material should be undertaken in accordance with the Environmental Permitting Regulations (England and Wales) and Duty of Care for Waste.

The contractor should provide a full documentary record of this operation in accordance with Duty of Care. This must include waste transfer notes and details of the receiving Site. Copies of the landfill documents shall be provided to the Environmental Consultant for inclusion in the Verification Report.

The latest, edition of Technical Guidance WM3 requires that, within a mixed waste, the separately identifiable wastes be assessed separately. For instance, where waste soil contains identifiable pieces of asbestos (visible to the naked eye) the asbestos should, where feasible, be separated from the soil and classified / disposed separately.

Reuse of natural arisings onsite will be possible but re-use of Made Ground will only be possible if proven to be suitable for use and there is geotechnical suitability. All efforts will be made to minimise offsite disposal (using a Materials Management Plan) by retaining the highest % of material onsite as possible.

Classification of any material to be disposed to landfill shall be agreed in advance with the landfill operator(s), as appropriate. This may involve collecting samples for further analysis, including Waste Acceptance Criteria (WAC) analysis for landfill compliance criteria. Soils may also require an appropriate classification (Hazardous Properties Assessment) in accordance with waste management guidance (Environment Agency, 2015 as amended).

Should site works encounter ACM, appropriate mitigation measures should be employed in accordance with the requirements of HSG 247 – Asbestos: the licensed contractors guide, in particular with reference to the Control of Asbestos Regulations and good practice (CL:AIRE Joint Industry Working Group, 2016). This may comprise removal by a suitably qualified and licensed specialist.

8.4 Materials Tracking

As part of the preparation works for the development a Materials Management Plan (MMP) will be prepared and implemented in accordance with the Definition of Waste: Development Industry Code of Practice (CoP), if required.

The MMP will include a robust system for tracking the movement of materials from the point of excavation to the point of reuse, including the locations of temporary stockpiles. If necessary, the following registers should be maintained onsite as a real time record of materials management:

- Off-site disposal.
- Excavated soils.
- Levels surveys.
- Stockpile movement.
- Verification testing.
- Placement / re-use.

All laboratory analysis should be collated, and records maintained of any assessments.

A drawing register should be maintained in the project data management system to ensure all works are carried out to the latest revisions. Superseded drawings should be kept in a separate file.

As part of the MMP on completion of works a Verification Report will be required detailing material movement, verification process and volumes. This report is required to be submitted to CL:AIRE and the Environment Agency

8.5 Health and Safety

All construction method statements and risk assessments for site works should be prepared cognisant of the above mitigation measures.

Prior to work commencement, toolbox talks should be administered to site operatives to inform them of any potential land contamination issues relating to the Site and the appropriate action that should be taken (i.e. asbestos awareness training). A record should be maintained and kept onsite that details all toolbox talks undertaken and those operatives that have attended.

The Contractor should provide material for the main site induction regarding the scheme, for all personnel to ensure that everyone is aware of their individual responsibility in complying with legislation and the relevant contractual requirements. The Contractor should also deliver toolbox talks for site staff and operatives to emphasise the nature of the Site and their responsibility to stop work and report any issues e.g., if they suspect the presence of contaminated land or something which may have the potential to cause a pollution incident.

8.5.1 Personal Protective Equipment

The provision of appropriate Personal Protective Equipment (PPE) and cognisant of Health and Safety Executive (HSE), Health and Safety Guidelines, 'Protection of Workers and the General Public During Development of Contaminated Land' (HSG 66), including typically:

- Overalls (if required).
- Safety footwear.
- Safety gloves.
- Eye protection.

8.5.2 Construction Protocols

The adoption of best practice construction techniques (e.g., CIRIA R132 'A guide for safe working on contaminated sites'), including:

- The adoption of hygiene protocols and provision of appropriate facilities.
- Minimisation of the generation of particulates and dust.
- Appropriate measures in relation to entry to confined spaces and the provision of suitable respiratory equipment, if necessary.

Additionally, it is an offence to knowingly permit or cause pollution of Controlled Waters under the Water Resources Act (WRA) 1991; therefore, the following mitigation measures should be adopted during the construction phase:

- Site works should be managed in accordance with best practice construction techniques including Environment Agency (EA) Pollution Prevention Guidelines (PPG) where applicable, most notably:
 - PPG 1 (General guide to the prevention of pollution);
 - PPG 2 (Above ground oil storage tanks);
 - PPG 5 (Works and maintenance in or near water);
 - PPG 6 (Pollution prevention guidance for working at construction and demolition sites); and,
 - PPG 27 (Installation, decommissioning and removal of underground storage tanks) etc.

8.6 Environmental Monitoring

Environmental monitoring forms an integral part of the remediation strategy. This monitoring assesses the effects of the works on the site atmosphere and is a record of the effectiveness of any controls or precautions put in place. Environmental monitoring and management should include as a minimum dust, noise and odour.

General weather information including conditions, wind speed/direction, temperature and rainfall should be collected during the course of the remediation works.

8.7 Record Keeping, Reporting and Site Communication

8.7.1 Project Data Management System

A comprehensive quality controlled electronic project filing records system should be maintained, to satisfy the requirements of the project objectives, contract specification, the Health and Safety File and the final Verification Report to discharge the conditions of the Planning Consent and other regulatory requirements.

8.7.2 Project Diary

A daily diary of general information including site operations should be maintained by the site manager and / or engineer.

8.7.3 Register, Records and Drawings

If necessary, the following material registers should be maintained onsite as a real-time record of materials management:

- Offsite disposal register.
- Excavation validation register.

- Testing & laboratory screening register.

8.8 Permits & Licensing

Typically, these may include:

- Flood Risk Activity Permit (FRAP) due to proximity of work to River Thames and existing flood defences.
- Materials Management Plan in accordance with CL:AIRE DoWCoP.
- Quality Protocol for aggregates from inert waste (referred to as the WRAP protocol).
- Local authority mobile crushing plant permit (if crushing is undertaken onsite).
- Water discharge agreement / licence if perched water is removed during excavation works.
- Notification of Asbestos removal to the HSE (if required).

9. REFERENCES

9.1 Previous Assessments

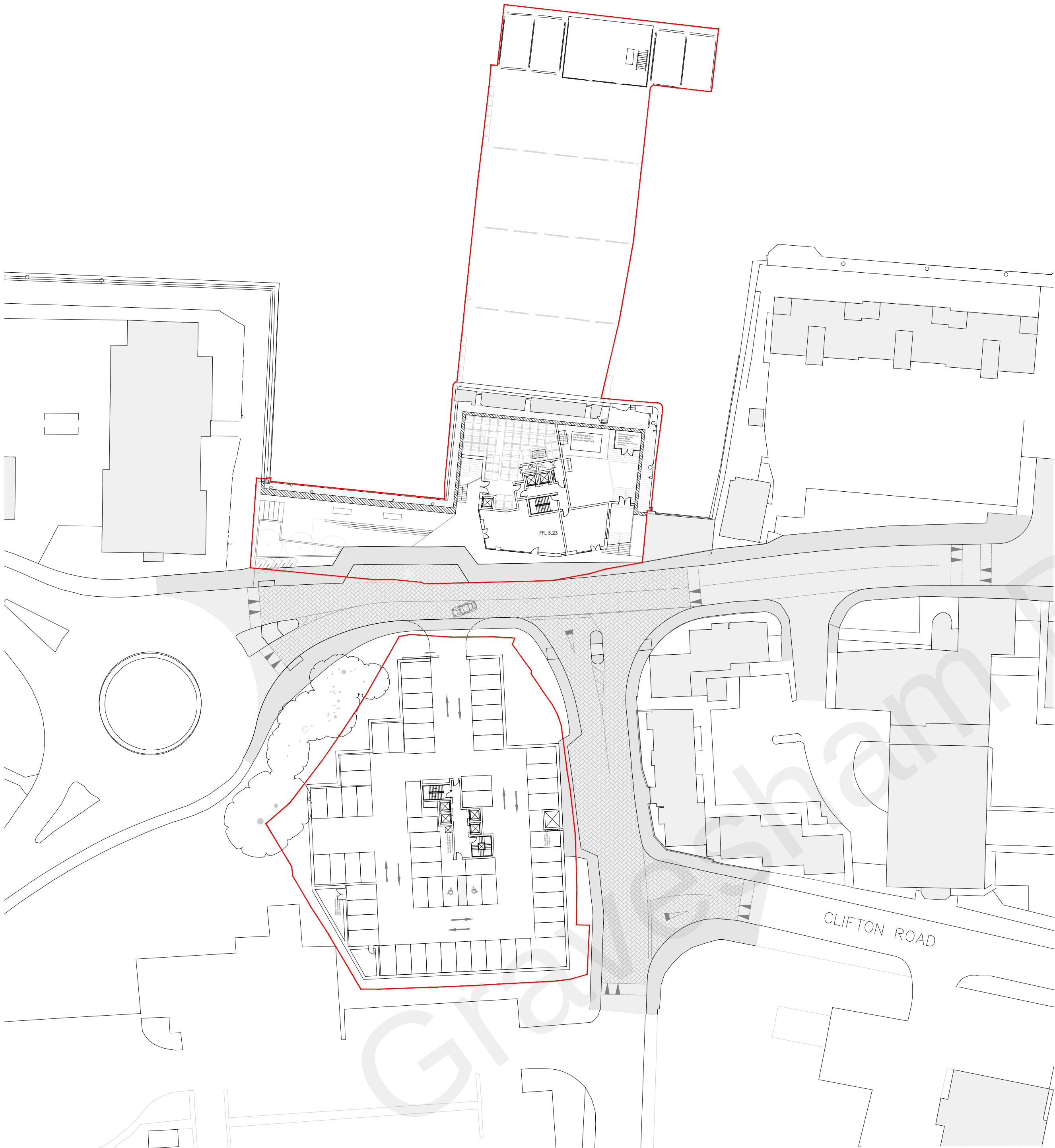
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APPENDIX I
SITE DEVELOPMENT PLANS

Gravesham Borough Council



SITE PLAN LEVEL -1



SITE PLAN LEVEL 1

0 5 10 20 30M

APPLICATION BOUNDARY

CLIFTON SLIPWAYS, GRAVESEND
SITE PLAN

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Revisions

Project | Clifton Slipways
Gravesend, Kent

Client | Quinn Estates

Title | Site Plan

Status | PLANNING

Scale@A1 | 1:500 Date | Aug 2019 Drawn | LC

Chkd | AR

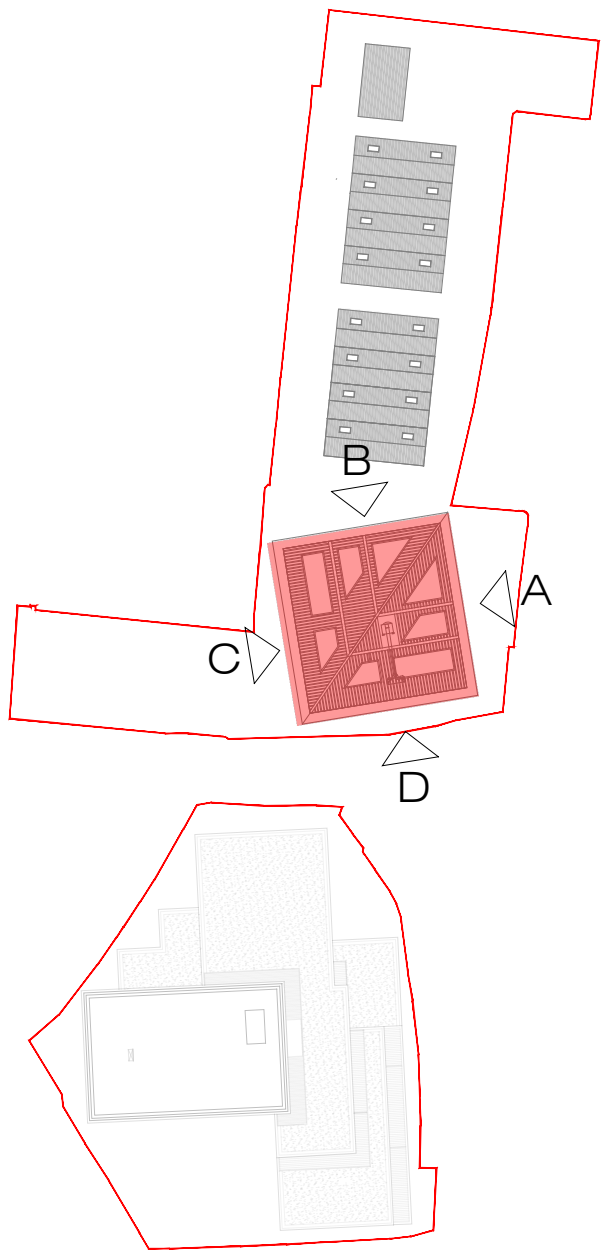
guy hollaway

London | Fourth Floor | 251 Pentonville Road | London | N1 9HG
T +44 (0) 20 7014 4900 | F +44 (0) 1303 260 214 | E london@guyhollaway.co.uk | W www.guyhollaway.co.uk

Kent | The Tramway Stables | Ramport Road | Hythe | Kent | CT21 5RG
T +44 (0) 1303 260 515 | F +44 (0) 1303 260 214 | E kent@guyhollaway.co.uk | W www.guyhollaway.co.uk

Project Number
18.137.100.03
Bin Number

Revision
P1



KEY PLAN
1:1000 SCALE

- 01+ Angled light grey brick slip cladding system. (Upper Levels)
- 02+ Dark grey brick slip cladding system. (Lower Levels)
- 03+ Aluminium window system. Powder coated (Colour TBC)
- 04+ Metallic feature vent panels.
- 05+ Fascia panels between windows to match window frames.
- 06+ Feature cill banding. Pressed aluminium fascia system.
- 07+ Aluminium louvres at roof level. (Colour TBC)
- 08+ Aluminium canopy with flashings/fascias etc. To match windows.

All internal layouts are shown for illustrative purposes only

All landscape shown indicatively

PROJECT MATERIAL PALETTE

06

04

01

05

03

02

+85.945AOD

Level + 23 FFL/SSL 79.3

Level + 22 FFL 76.28

Level + 21 FFL 73.23

Level + 20 FFL 70.18

Level + 19 FFL 67.13

Level +18 FFL 64.08

Level +17 FFL 61.30

Level +16 FFL 57.98

Level +15 FFL 54.93

Level +14 FFL 51.88

Level +13 FFL 48.83

Level +12 FFL 45.78

Level +11 FFL 42.73

Level +10 FFL 39.68

Level +9 FFL 36.630

Level +8 FFL 33.58

Level +7 FFL 30.53

Level +6 FFL 27.48

Level +5 FFL 24.43

Level +4 FFL 21.38

Level +3 FFL 18.33

Level +3 FFL 15.28

Level +1 FFL 11.63

Level +0 FFL 8.43

Level -1 FFL 5.23

BLOCK: West Street Tower

ELEVATION: A

0 1 2 3 4 5M

CLIFTON SLIPWAYS, GRAVESEND WEST STREET TOWER - ELEVATION A

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Revisions

Project | Clifton Slipways
Gravesend, Kent

Client | Quivini Estates

Title | West Street Tower - Elevation A

Status | PLANNING

Scale(s) | 1:100 Date | June 2019 Drawn | LC

Drawn | JAR

guy hollaway

London | Fourth Floor | 251 Pentonville Road | London | N1 9HG

T: +44 (0) 20 7014 4900 | F: +44 (0) 20 7014 4901 | E: info@guyhollaway.co.uk | W: www.guyhollaway.co.uk

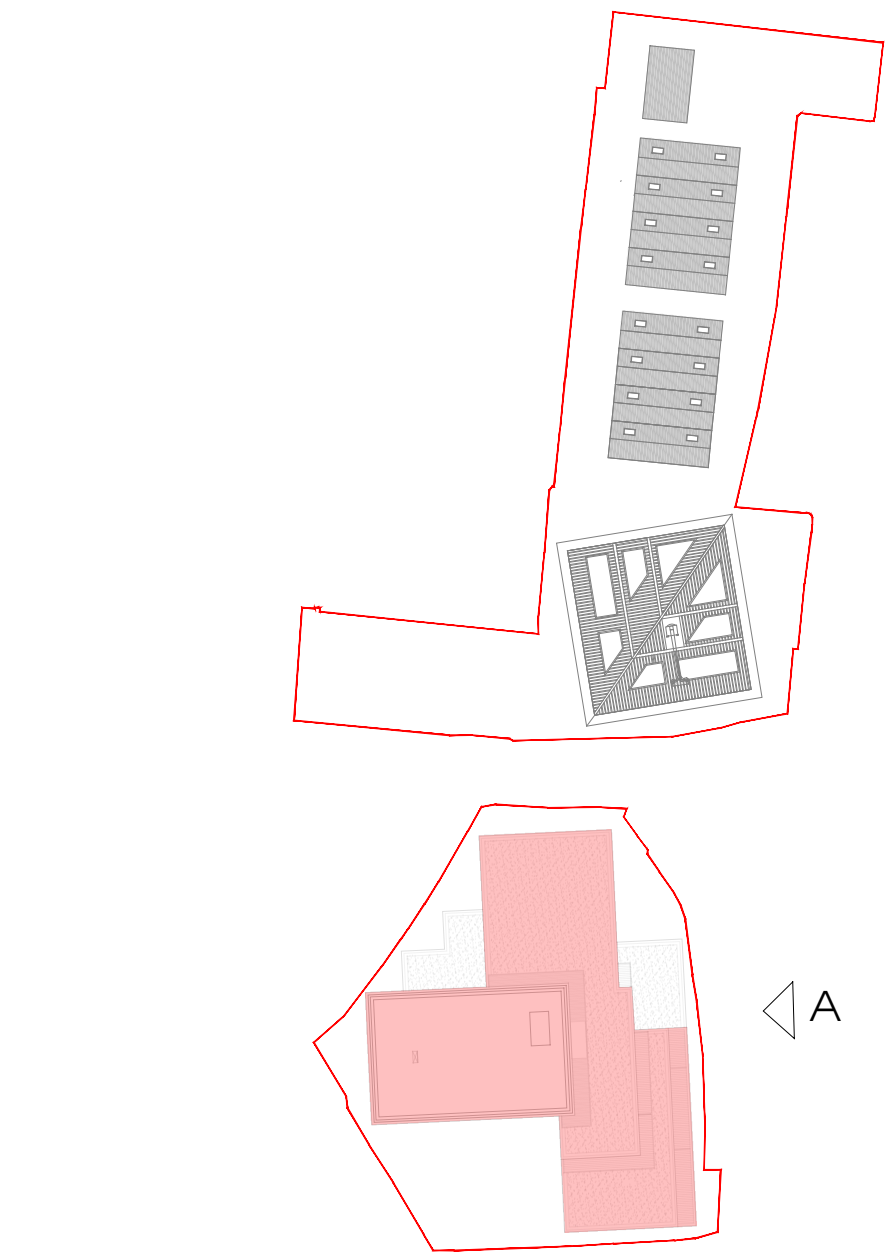
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T: +44 (0) 1853 200 910 | F: +44 (0) 1853 200 911 | E: kent@guyhollaway.co.uk | W: www.guyhollaway.co.uk

Project Number
18.137.210.00

Drawing Number

Revision
P1



KEY PLAN
1:1000 SCALE

- PROJECT MATERIAL PALETTE
- 01 Vertical Timber cladding.
 - 02 Light grey Brick.
 - 03 Buff Brick.
 - 04 Metallic coloured feature surround
 - 05 Hit and Miss brickwork to provide ventiation to car parking level.
 - 06 Angled buff brick slip cladding system.
 - 07 Metallic coloured Powder coated balustrade
 - 08 Glazed Balustrade.
 - 09 Metallic feature vent panels.

All internal layouts are shown for illustrative purposes only
All landscape shown indicatively

PROJECT MATERIAL PALETTE

BLOCK: Stuart Road Block
ELEVATION: A



0 1 2 3 4 5M

CLIFTON SLIPWAYS, GRAVESEND STUART ROAD BLOCK - ELEVATION A

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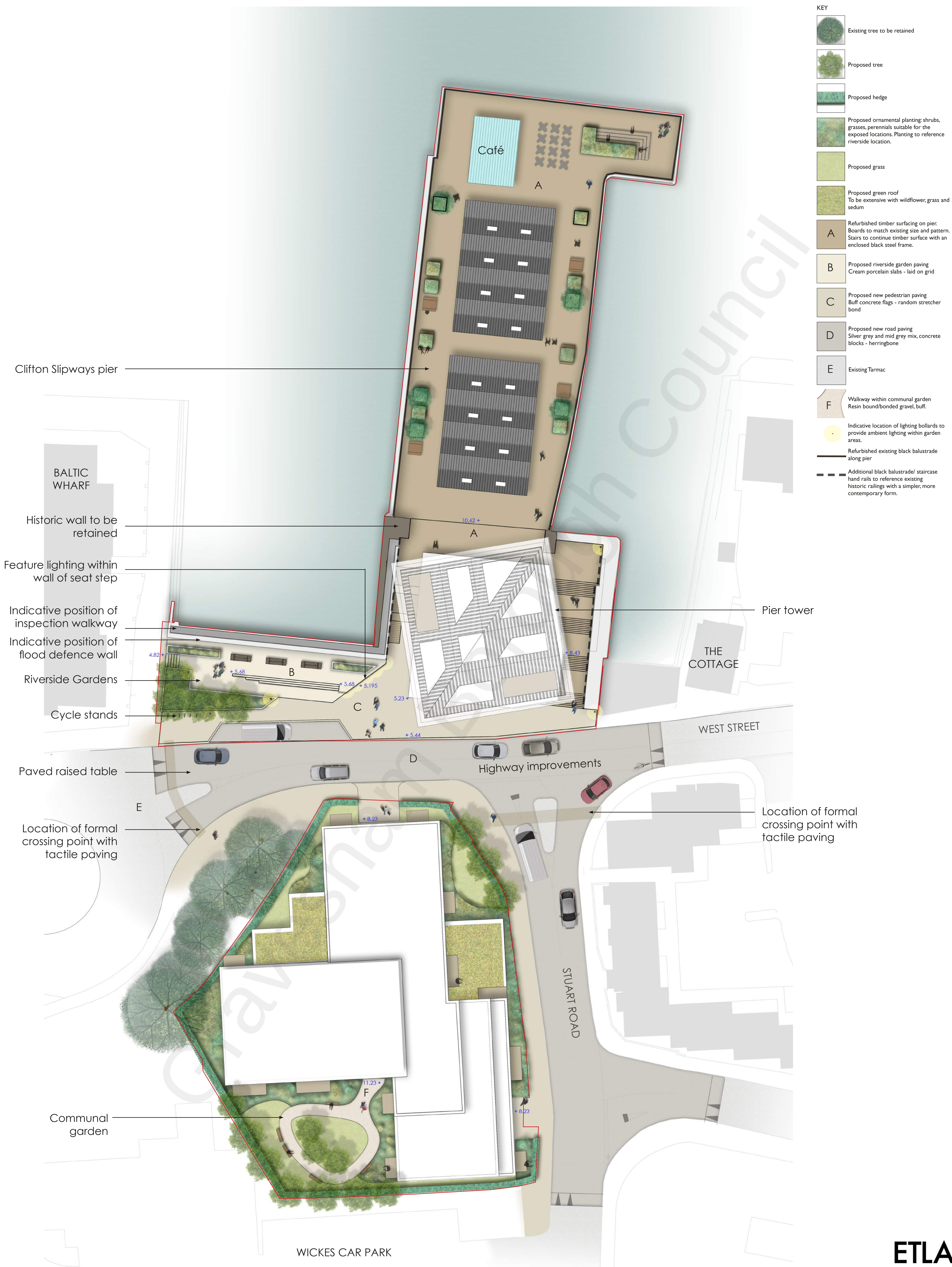
Revisions

Project | Clifton Slipways
Gravesend, Kent
Client | Quinn Estates
Title | Stuart Road Block - Elevation A
Status | PLANNING

Scale@A1 | 1:100 Date | June 2019 Drawn | LC Chkd | JAR

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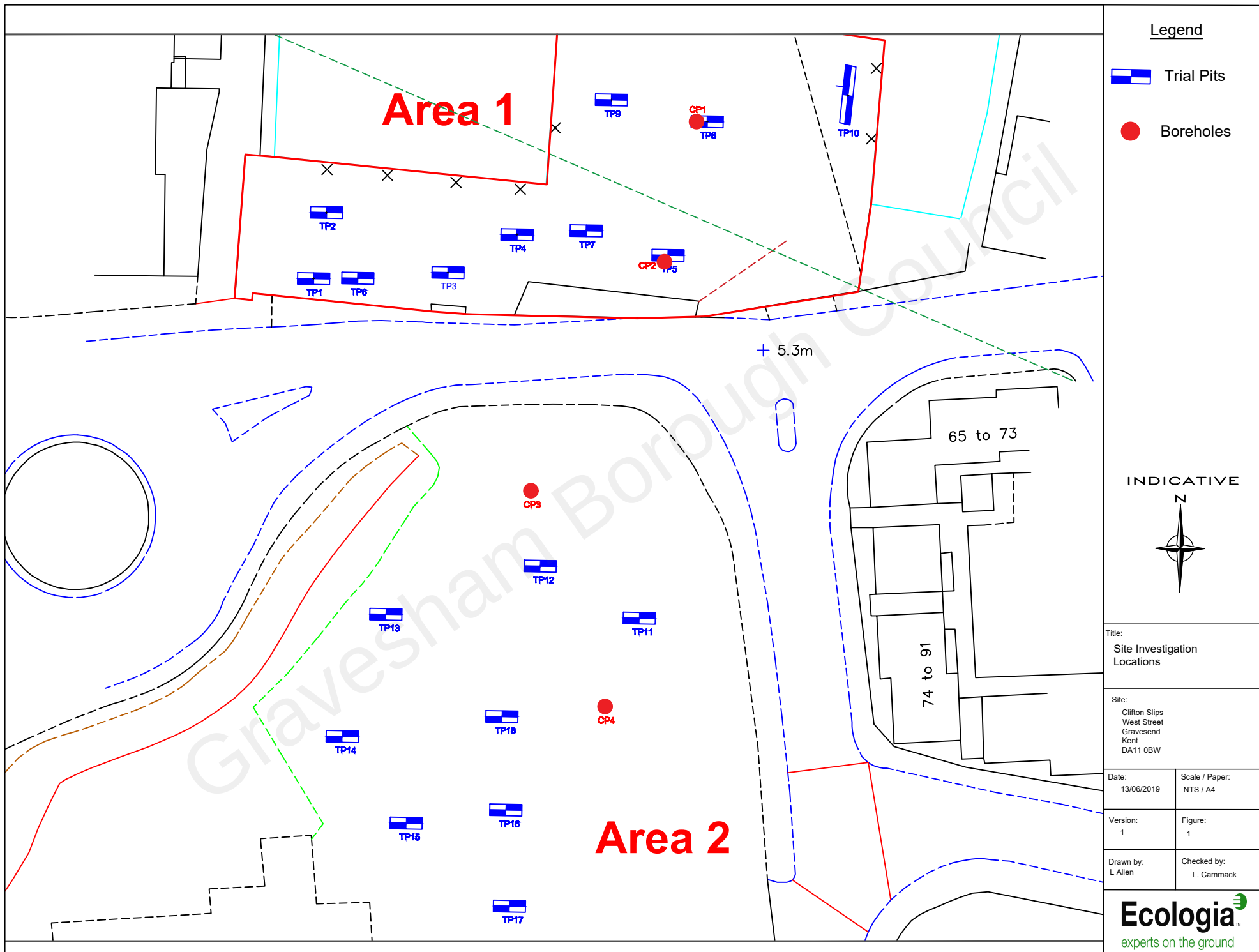
London | Fourth Floor | 251 Pentonville Road | London | N1 9HG
T +44 (0) 20 7014 4800 | F +44 (0) 1303 260 214 | E london@guyhollaway.co.uk | W www.guyhollaway.co.uk
Kent | The Tramway Stables | Ramport Road | Hythe | Kent | CT21 5BG
T +44 (0) 1303 260 515 | F +44 (0) 1303 260 214 | E kent@guyhollaway.co.uk | W www.guyhollaway.co.uk
Project Number Drawing Number Revision
18.137.310.00
Bin Number

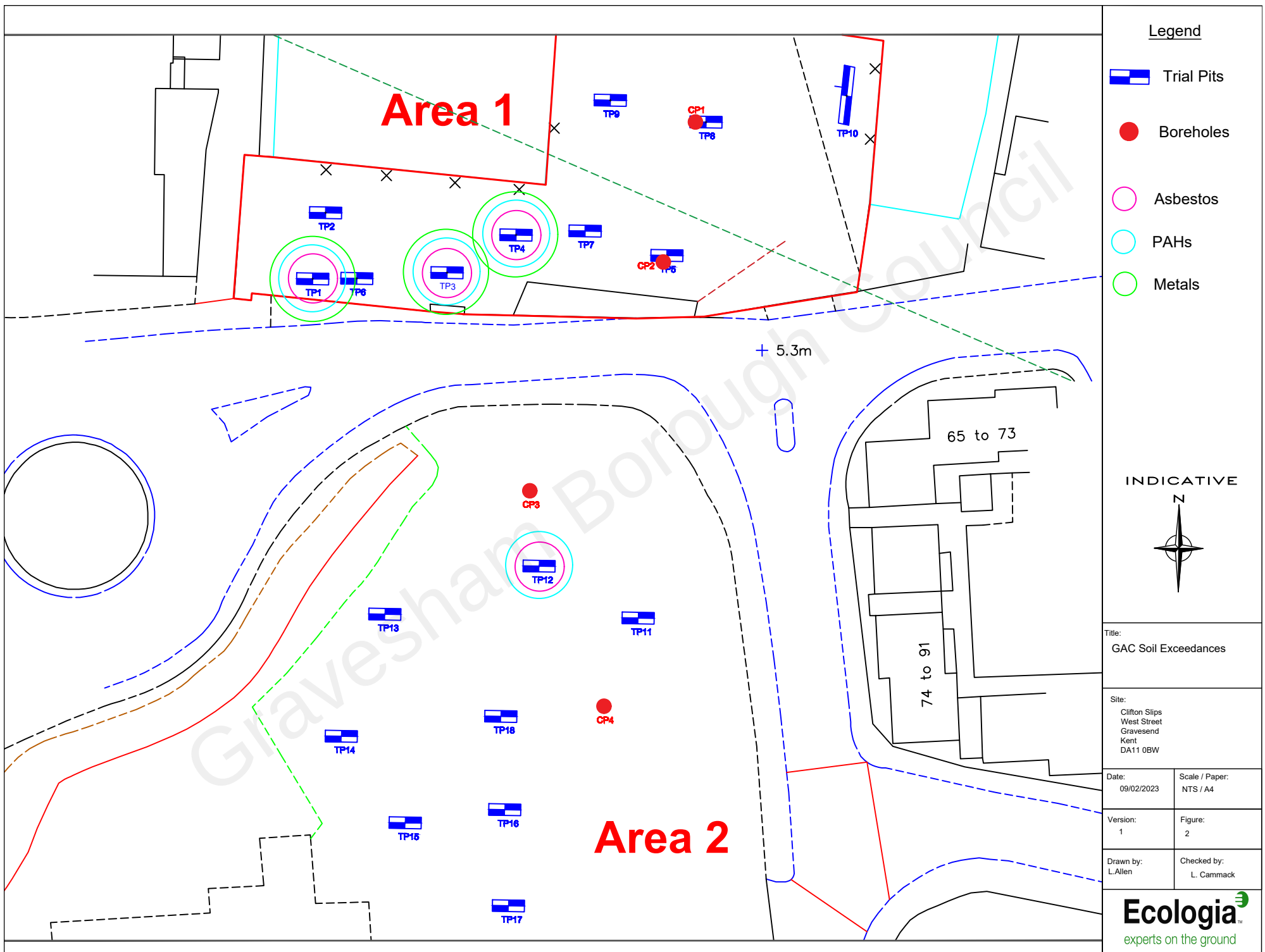


LANDSCAPE MASTERPLAN

APPENDIX II FIGURES

Gravesham Borough Council





APPENDIX III
VALIDATION GAC

Gravesham Borough Council

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITHOUT HOME-GROWN PRODUCE			
Human health generic assessment criteria for residential without home-grown produce			
Compound	SAC for Soil SOM 1% (mg/kg)	SAC for Soil SOM 2.5% (mg/kg)	SAC for Soil SOM 6% (mg/kg)
Metals			
Arsenic	40	40	40
Barium	1,300	1,300	1,300
Beryllium	1.7	1.7	1.7
Boron	11,000	11,000	11,000
Cadmium	149	149	149
Chromium (III) - trivalent	910	910	910
Chromium (VI) - hexavalent	21	21	21
Copper	7,100	7,100	7,100
Lead	310	310	310
Elemental Mercury (Hg ⁰)	0.2	0.6	1.2
Inorganic Mercury (Hg ²⁺)	56	56	56
Methyl Mercury (Hg ⁴⁺)	9	12	15
Nickel	180	180	180
Selenium	430	430	430
Vanadium	1,200	1,200	1,200
Zinc	40,000	40,000	40,000
Cyanide (free)	40	40	40
Volatile Organic Compounds			
Benzene	0.9	1.6	3.3
Toluene	900 (869)	1,900	3,900
Ethylbenzene	80	190	440
Xylene - m	80	190	450
Xylene - o	90	210	480
Xylene - p	80	180	430
Total xylene	80	180	430
Methyl tertiary-Butyl ether (MTBE)	100	170	320
Trichloroethene	0.02	0.04	0.08
Tetrachloroethene	0.2	0.4	0.9
1,1,1-Trichloroethane	9.0	18.4	40.4
1,1,1,2 Tetrachloroethane	1.5	3.5	8.2
1,1,2,2-Tetrachloroethane	3.9	8.0	17.2
Carbon Tetrachloride	0.026	0.056	0.128
1,2-Dichloroethane	0.009	0.013	0.023
Vinyl Chloride	0.0008	0.0010	0.0015
1,2,4-Trimethylbenzene	5.6	12.9	26.9
1,3,5-Trimethylbenzene	NR	NR	NR
Semi-Volatile Organic Compounds			
Acenaphthene	6,600 (57)	7,200	7,400
Acenaphthylene	6,600 (86)	7,200	7,400
Anthracene	31,000 (1.17)	35,000	37,000
Benzo(a)anthracene	11.0	13.6	15.0
Benzo(a)pyrene	5.3	5.3	5.3
Benzo(b)fluoranthene	4.0	4.0	4.1
Benzo(g,h,i)perylene	355	358	359
Benzo(k)fluoranthene	106	107	107
Chrysene	30	31	32
Dibenzo(a,h)anthracene	0.31	0.32	0.32
Fluoranthene	1,500	1,600	1,600
Fluorene	2,800 (31)	3,800 (77)	4,500 (183)
Indeno(1,2,3-cd)pyrene	45	46	46
Naphthalene	23	55	125
Phenanthrene	1,300 (36)	1,450	1,520
Pyrene	3,700	3,800	3,800
Phenol	440*	688	1,170
Total Petroleum Hydrocarbons			
Aliphatic hydrocarbons EC ₅ -EC ₆	42	78	161
Aliphatic hydrocarbons >EC ₆ -EC ₈	100	230	530
Aliphatic hydrocarbons >EC ₈ -EC ₁₀	27	65	155
Aliphatic hydrocarbons >EC ₁₀ -EC ₁₂	130 (48)	330 (118)	770 (283)
Aliphatic hydrocarbons >EC ₁₂ -EC ₁₆	1,100 (24)	2,400 (59)	4,400 (142)
Aliphatic hydrocarbons >EC ₁₆ -EC ₃₅	65,000 (8)	92,000 (21)	111,000
Aliphatic hydrocarbons >EC ₃₅ -EC ₄₄	65,000 (8)	92,000 (21)	111,000
Aromatic hydrocarbons >EC ₈ -EC ₁₀	47	115	269
Aromatic hydrocarbons >EC ₁₀ -EC ₁₂	300	600	1,200
Aromatic hydrocarbons >EC ₁₂ -EC ₁₆	1,800 (169)	2,300 (419)	2,500
Aromatic hydrocarbons >EC ₁₆ -EC ₂₁	1,900	1,900	1,900
Aromatic hydrocarbons >EC ₂₁ -EC ₃₅	1,900	1,900	1,900
Aromatic hydrocarbons >EC ₃₅ -EC ₄₄	1,900	1,900	1,900
Minerals			
Asbestos	Stage 1 test – No asbestos detected with ID; Stage 2 test - <0.001% dry weight (exceedance of either equates to an exceedance of the GAC) ¹		
Notes:			
¹ - Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.			
NR - SAC for 1,3,5-trimethylbenzene is not recorded owing to the lack of toxicological data, SAC for 1,2,4 trimethylbenzene may be used			
EC - equivalent carbon. SAC - soil assessment criteria.			
¹ LOD for weight of asbestos per unit weight of soil calculated on a dry weight basis using PLM, handpicking and gravimetry.			
The SAC for organic compounds are dependent on Soil Organic Matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58.			
1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.			
SAC for TPH fractions, PAHs naphthalene, acenaphthene and acenaphthylene, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3.			
(VALUE IN BRACKETS)			
Approach adopted for petroleum hydrocarbons in accordance with LQM/CIEH whereby the concentration modelled for each petroleum hydrocarbon fraction has been tabulated as the SAC with the corresponding solubility or vapour saturation limits given in brackets.			



Headquarters

Building 711 & 712
Kent Science Park
Sittingbourne
Kent
ME9 8BZ
TEL +44 (0)1795 471611
<mailto:info@ecologia-environmental.com>

Midland Office

4 Romford Road
Astonfields
Stafford
ST16 3DZ
TEL +44 (0)1785 878010
<mailto:midlandinfo@ecologia-environmental.com>

South West Office

Unit 1 Kingsgate Business Centre
Duchy Road
Heathpark Industrial Estate
Honiton
Devon
EX14 1YG
TEL +44 (0)1404 47714
<mailto:swinfo@ecologia-environmental.com>

Italian Subsidiary

Ecologia Environmental Solutions Srl
Via Irma Bandiera 6
Monte San Pietro (BO)
CAP 40050
Italia
TEL +39 051 754754
infoitaly@ecologia-environmental.it



www.ecologia-environmental.com