REPORT NO. D6135/RS
May 2015

Remediation Strategy
for land at

Park Avenue, Cleadon, South Shields
Prepared for
Bellway Homes

DUNELM
GEOTECHNICAL & ENVIRONMENTAL

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REMEDIATION STRATEGY
for land at
Bellway Homes

1 INTRODUCTION

Scope of this report

Dunelm Geotechnical & Environmental Limited (Dunelm) were instructed by Bellway Homes (the Client) to prepare a Remediation Strategy for land at Park Avenue, Cleadon, South Shields.

Procedures for management of Land Contamination in the UK are set out in the Environment Agency's guidance document *Model Procedures for the Management of Land Contamination*, Contaminated Land Report 11, 2004 (herein termed CLR11). The procedures in the above document have been followed in the assessment of this site.

This report describes the results of the Options Appraisal process described in CLR11 and outlines the remediation strategy adopted following this process. In addition to addressing pollutant linkages, remediation works are also required in respect of a number of other issues affecting the proposed development.

The objectives of the proposed remediation works are described in Section 3 together with an overview of the works required in Section 6. The Contractor appointed to undertake the remediation works shall provide a detailed Method Statement describing how the objectives set out in this Strategy are to be achieved.

2 RESULTS FROM PREVIOUS WORK

Contamination Risk Assessment

Dunelm issued a report entitled *Geoenvironmental Appraisal of land at Park Avenue, Cleadon, South Shields* Report No. D6135/1, dated April 2014. This report provided a Preliminary Risk Assessment and Generic Quantitative Risk Assessment in accordance with the requirements of CLR11.

Based on the above report, potentially unacceptable risks were identified in relation to contamination at the site; these are summarised below. Consequently an Options Appraisal was undertaken in which feasible remediation options in relation to relevant pollution linkages were identified and evaluated, and a Remediation Strategy developed. The Options Appraisal process is described in Section 5.

Conceptual Site Model

A Conceptual Site Model was determined during the above assessments and shows pollution linkages considered to be significant.

Following the site's redevelopment, significant receptors in terms of human health that could be affected by contamination will include future residents and plants. Ecosystem receptors include the underlying Principal Aquifer.

Hazardous Gas

The Geoenvironmental Appraisal identified the need for gas protection measures on site and recommended Amber 1 protection measures were installed.

Contamination Sources

Potentially unacceptable risks have been identified in relation to the following contamination sources.

The topsoil was found to contain elevated PAH compounds and phytotoxic copper and zinc (copper and zinc are elevated when compared to the plant growth thresholds values but fall below human

health guideline values). The near-surface made ground at the site was found to contain elevated concentrations of PAH. In addition, both topsoil and made ground contained fragments of ash, glass, plastic, tile and brick which are considered undesirable in near surface deposits.

3 REMEDIATION OBJECTIVES

Remediation Objectives - Contamination

Based on the summary of contamination in the preceding Section, the objectives of the remediation works in respect of contamination are as follows:

- Removal of pathways between inorganic contamination and plants
- Removal of pathways between organic contamination and future residents.

Possible remedial options to achieve the above objectives are discussed in the following Section.

4 REMEDIAL OPTIONS

Categories of remedial option

A wide variety of remedial treatment options is available. Remedial technologies can be considered in terms of the three categories below, based on the way in which the method works:

A Immobilization of contaminants

B Destruction or alteration of contaminants

C Extraction or separation of contaminants from environmental media

A brief overview of the commonly used remedial options is set out in the following sections using the above categories. In many cases it is appropriate to combine several treatment technologies at a given site to form a 'treatment train'.

A Immobilization technologies for contaminants in soil

These technologies involve isolating the contamination (which remains untreated), thereby breaking the pathway to identified receptors. These work by reducing the physical accessibility or chemical availability of contaminants. Examples include:

- Stabilization - addition of chemicals to immobilise contaminants e.g. by neutralisation, adsorption, conversion to insoluble species
- Solidification - addition of cements or thermoplastics to form a solid which may also have improved structural properties
- Containment - vertical barrier to control fluid lateral migration (eg slurry walls, permeable reactive barriers); horizontal barrier (cover system) to limit access to inorganic contamination
- Encapsulation
- Excavation and removal of soils to secure landfill site - not environmentally sustainable; however often used on smaller sites where insufficient space exists for other treatments

Many of the treatment methods in categories B and C below can be applied either in-situ or ex-situ to contaminated materials. The advantages of ex-situ techniques are that contaminants can be more easily assessed and the process more easily controlled. In-situ methods have advantages on operational sites or where live services are to remain since less ground disturbance is caused and large stockpiles are not required.

B Destruction or alteration of contaminants in soil

These technologies involve the alteration of the chemical structure of the contaminants using some or all of the following treatment methods:

- Biological - using bacterial populations to biodegrade a compound into smaller, less harmful or less mobile chemical sub units (includes bioremediation and monitored natural attenuation)
- Thermal desorption - removes volatile contaminants by evaporation from soil matrix after excavation and crushing
- Incineration - destroys contaminants and soil matrix after excavation and crushing
- Chemical - rely on chemical reactions (e.g. oxidation, reduction, hydrolysis, precipitation, ozonation, polymerisation, dechlorination) to destroy or neutralise contaminants
- Vitrification - melts contaminated soils at high temperatures forming an inert glassy-like mass

C Extraction / separation of contaminants from soil

Soil treatments in this category (often used in combination) aim to separate contaminants from the soil matrix by exploiting differences between the soil and contaminant, thus reducing the volume of contaminant. In some cases the extracted contaminant would need to be treated by one of the methods in category B. Methods include:

- Soil washing - excavation and water washing to extract contamination in fines
- Particle size separation
- Solvent extraction - excavation and removal of contamination using solvents
- Soil vapour extraction (SVE) - in situ treatment for volatile contamination in soils above the water table
- Thermal desorption (hot air/steam stripping) - as SVE but using hot air or steam

5 OPTIONS APPRAISAL

The table below sets out relevant pollutant linkages together with the remediation options considered as potentially suitable to deal with the pollutant linkages.

- Encapsulation
- Excavation and removal of soils to secure landfill site - not environmentally sustainable; however often used on smaller sites where insufficient space exists for other treatments

Pollutant Linkage		Remediation Option	Method	Suitability
Source	**Receptor & pathway**			
Organic contamination in made ground (PAH)	Future site users via ingestion / skin contact	Encapsulation: Provision of hard cover to external areas	Removal of pathway	Y
Organic contamination in made ground (PAH)	Future site users via ingestion / skin contact	Encapsulation: Provision of clean cover materials to landscaped areas	Removal of pathway	Y
Contamination in topsoil	Plant growth via root uptake	Excavation and removal of soils to secure landfill site	Removal of source	Y
Contamination in topsoil	Plant growth via root uptake	Screening of debris and re-testing of topsoil once stockpiled	Potential Removal of source	Y subject to enough space on site
PAH contamination in near- surface soils	Future site users via ingestion / inhalation / skin contact	Excavation of PAH contaminated soils and treatment to reduce concentration	Reduction in source concentration	N as too costly for the concentrations of contaminants recorded

Based on the above appraisal, appropriate remediation options have been selected and these are outlined in the following section.

The final Conceptual Site Model showing how each of the pollution linkages is to be addressed is shown graphically in Drawing D6135RS/01 in Appendix A.

6 OVERVIEW OF PROPOSED REMEDIATION WORKS

Based on the results of the Options Appraisal process described in Section 5, it is considered that the objectives outlined in Section 3 would best be achieved by undertaking the remediation works below.

Design phase

- Design site layout so as to minimise areas of soft landscaping & maximise hard cover to external areas
- Design suitable gas protection measures for new structure

Preliminary works

- General site clearance and preparation
- Breaking up and excavation of surface hardstand and slabs

Excavation and associated works

- Stockpiling of topsoil, separating and screening and re-testing to further confirm suitability
- If topsoil remains unsuitable then topsoil to be removed from site

Construction phase

- Excavation of foundation trenches, stockpiling of clean soils and clay for re-use in clean cover in proposed garden and landscaped areas
- Provision of hard surfacing to car parking and other external areas
- Any landscaped areas to be provided with clean cover 600mm thick including 150mm topsoil
- Placement of excess made ground materials beneath areas of hardstand
- Provision of appropriate service pipes

Verification works

Verification is required that the remediation works have been undertaken satisfactorily. In particular verification is required to demonstrate that:

- Thickness and suitability of cover material to landscaped areas

7 REMEDIATION WORKS

The following sections describe elements of the remediation works in more detail.

Management of Remediation Works

The Contractor appointed to undertake the remediation works shall provide a detailed Method Statement describing how the objectives set out in this Strategy are to be achieved. Prior to remediation works commencing on site this Remediation Strategy and the Contractor's Method Statement shall be approved in writing by the Local Planning Authority.

The Client and Contractor shall liaise directly with regard to all contractual matters relating to the remediation works so as to ensure that responsibility is clearly allocated to one or other of the parties. The Contractor shall maintain records of the works undertaken. These records will need to be submitted to Dunelm to form the basis of a Validation Report to be provided to the Client on completion of the works.

Excavation and subsequent remedial works should be supervised on a part-time basis by a Dunelm engineer. Where any non-compliance from this Remediation Strategy or the Contractor's Method Statement occurs, the Dunelm engineer shall inform the Contractor and the Client immediately. The Contractor and Client shall then agree how the non-compliance is to be resolved with advice from Dunelm where necessary. Any significant non-compliance may result in Dunelm being unable to provide a Verification Report on completion of the works.

Preliminary Arrangements

Prior to the commencement of the remediation works it is recommended that the Client should appoint the Contractor to undertake the items below, together with any other matters required to ensure the proper organisation of the contract. Dunelm will not comment on these matters except where there is a need for site-specific technical advice, for example concerning contamination.

- Prepare the necessary documentation required by CDM regulations
- Provide a Health & Safety plan and ensure that it is complied with.
- Determine the locations of all overhead and underground utility apparatus and make arrangements with utility companies to safeguard services in close proximity to their apparatus
- Arrange for any live services within the site boundary to be marked and protected, or verify that these have been disconnected
- Agree any necessary matters with the Local Authority (eg working hours, noise, dust control)
- Agree any proposed discharge to sewer with the Water Company
- Undertake a survey utilising dated photographs or video footage to record the condition of the site boundaries and any adjacent properties and highways.

Site Clearance & Demolition

Prior to the excavation of hardstand, the existing borehole installations shall be treated in accordance with the Environment Agency document "*Decommissioning of Redundant Boreholes & Wells*".

Excavation of Hydrocarbon Contaminated Material

Should hydrocarbon or fibrous materials be encountered during redevelopment then Dunelm should be contacted for further information. Materials should be stockpiled for chemical testing.

Waste Materials

The contractor should ensure that all waste materials are removed from site to landfill in accordance with the current regulations. Materials to be removed from site shall be tested to determine the appropriate type of landfill facility and the results of these tests shall be supplied to the landfill facility. Dunelm should be contacted for further assistance in relation to this. Further details of the required testing can be found in the following document:

Guidance On Sampling And Testing Of Wastes To Meet Landfill Waste Acceptance Procedures, Environment Agency 2005.

Overview of subsequent works

Suitable gas protection measures should be provided in new structures.

Following the completion of the remediation and construction works, it will be necessary for the developer to place clean cover materials to landscape areas. This cover layer is to comprise 450mm of clean subsoil plus 150mm of topsoil.

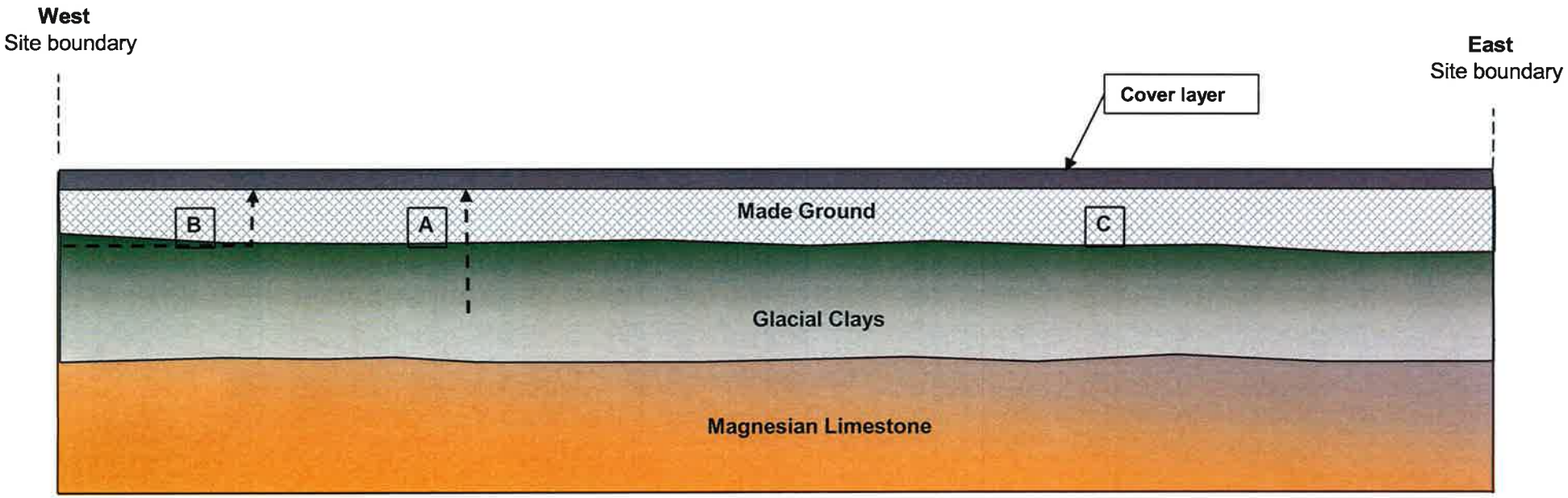
Imported material for use as clean cover should be validated in accordance with Dunelm's Procedure for the Assessment of Imported Soils for use in Cover Systems (included as Appendix B). Soils should be imported once the remediation works in respect of contamination at the site have been completed. Imported materials should be stockpiled in a location to be agreed with the Client.

Following placement, the clean cover layer should be verified by Dunelm to ensure that the cover layer is formed from appropriate materials and is of sufficient thickness.

Verification

On satisfactory completion of the works Dunelm will provide a Verification Report to the Client. The Verification Report will provide certification that the remediation works have been carried out in accordance with this Remediation Strategy. The Verification Report will include a summary of the remediation works undertaken, laboratory test results, drawings supplied by the Contractor's surveyor, and details of any other relevant matters.

APPENDIX A
Drawings



Potential Contamination linkages identified in Geoenvironmental Appraisal:
A – Ingestion / Inhalation / Dermal contact of determinants within topsoil & Made Ground
B – Gas emissions migrating from off site. Eg: surrounding landfills and made ground.
C – Aggressive ground conditions for building materials (concrete and underground services) and plants.

Remedial Measures
A – Contaminated materials removed or encapsulated.
B – Amber 1 gas protection measures installed
C – Suitable concrete classification used in construction

DUNELM GEOTECHNICAL & ENVIRONMENTAL	**Contract:** Park Avenue, Cleadon, Sunderland			
	Client: Bellway Homes NE			
TEL: 0191 3783151 FAX: 0191 3783157	**Drawing Title:** Conceptual Site Model			
Drawing No: D6135RS/01	**Date:** May 2015	**Scale:** NTS	**Status:** Final	**Drawn by:** KD

APPENDIX B
Procedure for the Assessment of Imported Soils

Procedure for Assessment of Soils at Source

The assessment of soils involves a visit to the site where the soils are to be sourced. The work should be carried out by an experienced Geoenvironmental Engineer and should comprise two elements:

- Visual inspection of the soils
- Sampling and chemical testing

During the visual inspection the Engineer should verify that the soils do not contain a significant proportion of cobbles and boulders. The soils should be generally free from materials unsuitable for use in garden areas (such as timber, plastic, metal, wire and glass).

The Engineer should take a minimum of 5 representative soil samples for chemical testing. Where the volume of soil to be imported exceeds 1800m^3, an additional sample should normally be taken for each 300m^3 of soil.

Procedure for Assessment of Soils after Placement

Where materials have been imported and placed without an assessment of suitability at the source site, trial pits or similar should be excavated through the full thickness of placed material. The number of inspection pits should be sufficient to properly evaluate the nature of the placed material and representative samples should be taken of the soils for testing as described above. The excavated soils should be logged by an Engineer and assessed visually to ensure compliance with the specification above.

Chemical Suitability

Once results have been received from the chemical laboratory, the Engineer should check that the test results do not exceed the assessment criteria shown in the tables below, and then notify the client whether the soil is suitable for use.

Chemical assessment criteria

All values in mg/kg	**Residential (based on 1% SOM)**	**Residential (based on 6% SOM)**
Arsenic (inorganic)	32	*32*
Cadmium	10	*10*
Chromium VI	*14.2*	*14.5*
Copper	*3970*	*4020*
Lead	*276*	*342*
Mercury	170	170
Nickel	130	130
Selenium	350	350
Zinc	*16900*	*17200*
	Assessment Criteria mg/kg (MAFF *The Soil Code* (1998) (mg/kg))	
Copper	135	
Zinc	200	

Soil Screening Values in *italic* are from Atkins ATRISK*SOIL* database, all other figures are Environment Agency Soil Guideline Values

Contaminant	**Generic Assessment Criteria** (mg/kg)		
	Resi with plant uptake	**Allot ments**	**Comm / industrial**
Acenaphthene	210	34	85000
Anthracene	2300	380	530000
Benz(a)anthracene	3.1	2.5	90
Benzo(a)pyrene	0.83	0.6	14
Benzo(b)fluoranthene	5.6	3.5	100
Benzo(g,h,i)perylene	44	70	650
Benzo(k)fluoranthene	8.5	6.8	140

Chrysene	6.0	2.6	140
Dibenz(a,h)anthracene	0.76	0.76	13
Fluoranthene	260	52	23000
Fluorene	160	27	64000
Indeno(1,2,3,-cd)pyrene	3.2	1.8	60
Napthalene	1.5	4.1	200
Pyrene	560	110	5400

All values from LQM/CIEH Generic Assessment Criteria 2nd Edition. Threshold based on 1% SOM