BURO HAPPOLD

The London Resort

Contaminated Land Management Strategy

0042936-BHE-XX-XX-RP-YG-0005

0042936

16 July 2021

Revision P03

Revision	Description	Issued by	Date	Checked
P01	Issue	HM	09/11/2020	AC
P02	Final	HM	19/11/2020	AC
P03	Revised Final	HM	16/07/2021	AC

https://burohappold.sharepoint.com/sites/042936/Shared Documents/F9 Ground Eng- Site Inv/03 Reports/BH Reports/CLMS/2021 Up-date/0042936-BHE-XX-XX-RP-YG-0005 P03 tracked.docx

author	**Hugh Mallett**
date	**16/07/2021**
reviewed	**Andrew Comer**
signature	[redacted]
date	**16/07/2021**

Contents

Executive Summary

Approach

This Contaminated Land Management Strategy (CLMS) describes the approach to the management of contaminated land associated with the Proposed Development of the London Resort. The study area covered by this report includes both the Kent Project Site (Swanscombe Peninsula and the Resort Access Road) and the Essex (Tilbury) Project Site.

The CLMS sets out an overarching strategy such that contamination risks for each of the areas of the Project Sites can be identified and managed during the Proposed Development. It provides a summary of best practice and considers options to mitigate contamination risks across the Project Site consistent with the aspirations of the Proposed Development.

The CLMS follows the recommended phased approach (Environment Agency LCRM [1]): Stage 1 – Risk assessment; Stage 2 – Appraisal of remediation options; and Stage 3 – Remediation and verification. In all of these stages, appropriate definition and consideration is given to the conceptual site model or the source-pathway-target approach. If one of these three elements is absent, there is no risk of harm, whereas if there is a linkage between source and receptor then a risk-based approach is used to assess the significance or the risk and the means to mitigate it.

Baseline information

Currently, the Proposed Development is at Stage 1 and the large majority of the information on the ground conditions on the Project Site is based upon the desk based studies of existing and published information and monitoring data. Preliminary Risk Assessments have established the potential for risks to people and the environment associated with the Proposed Development and land affected by contamination.

This existing information is currently being supplemented by a programme of site-wide groundwater monitoring / sampling from existing groundwater wells and a substantial programme of ground investigation is planned for 2021. This programme of ground investigation will have combined geotechnical and geoenvironmental objectives (and archaeological / ecological where appropriate) and will comprise exploratory holes (e.g. trial pits and boreholes) sampling, testing and monitoring to characterise the soils, rocks and groundwater, surface water and ground gas regimes.

Strategy definition

Assessment of all of these data will determine the appropriate options for remedial design or action necessary to mitigate the identified risks. This will be set out in a Remediation Strategy describing; how the remedial objectives and regulatory requirements will be met, how a sustainable approach will be incorporated, and how the remediation will be compatible with other aspects of the Proposed Development (e.g. construction, geotechnics and areas of archaeological or ecological sensitivity).

The appointed contractor(s) will prepare detailed plans of how the remediation will be implemented, defining the works to be carried out, the programme; the health, safety and environmental control regimes; the relevant licences and permits and provisions for unexpected contamination. Monitoring and recording of the works will be carried out in order to provide evidence and confirmation of successful implementation of the works and enable completion of a Verification Report.

Contamination risks

There are potential risks to people (construction workers, neighbours site visitors and staff) and the natural and built environments associated with the potential ground contamination sources from former uses of the Project Sites (Made Ground / Fill from past and recent industrial and commercial activities), landfill and industrial process wastes and hazardous ground gas. There is also a potential for unexploded ordnance (from World War Two).

Outline Remediation Strategy

An outline of the Remediation Strategy is presented. This is based upon consideration of a series of remedial objectives identified to address all of the potential contamination risks for the Project Sites associated with the Proposed Development. These objectives address aspects of contamination, engineering and management / amenity. The selection of the preferred options to be implemented will be based upon consideration of practicality, effectiveness, durability, cost benefit and sustainability.

The Outline Strategy describes the measures that will be implemented to mitigate the potential contamination risks related to the large scale earthworks involved in the Proposed Development, the protection of human health (both during construction and in operation), the prevention of pollution of surface waters and groundwater, the protection and enhancement of flora and fauna and the design of the built environment. The potential for unforeseen contamination (including unexploded ordnance) is also addressed.

Particular local aspects that require specific remediation design or actions to be implemented in addition to the site-wide Remediation Strategy are also described. On the Kent Project Site (Swanscombe Peninsula) these measures are related to; the widespread occurrence of cement kiln dust, the leachate collection and management system and the presence of areas subject to Environmental Permits. On the Kent Project Site (Resort Access Road) the particular issues are again associated with the regulatory / management constraints presented by the presence of licensed (Environmental Permitted) landfills. There are also additional constraints with respect to an archaeologically sensitive site (Bakers Hole) which is a Scheduled Monument and a geologically designated Site of Special Scientific Interest (SSSI).

Monitoring and verification

The necessary monitoring and verification activities will be defined in site specific Verification Plans for the Proposed Development across both the Essex and Kent Project Sites. The monitoring and verification will record all aspects of the works as they are undertaken with respect to; earthworks management, air and water quality, nuisance and unexpected contamination. These activities will obtain the evidence necessary to demonstrate the successful implementation of the Remediation Strategy. All of that evidence will be collated, assessed and presented in the Verification Reports.

Supporting information

Specific more detailed information on particular issues associated with the Proposed development and the presence of land affected by contamination is presented in a series of Appendices at the end of this report. These issues are related to; cement kiln dust (Appendix A), soil treatment (Appendix B), soil suitability criteria (Appendix C), Environmental Permits (Appendix D) and Northfleet Landfill infrastructure (Appendix E).

1 Introduction

1.1 Background, scope and aim

This Contaminated Land Management Strategy (CLMS) sets out the approach to the management of contaminated land associated with the Proposed Development of the London Resort. It has been prepared by Buro Happold on behalf of London Resort Company Holdings Limited (LRCH). This report is the result of one of several studies related to contaminated land and the London Resort (appropriately referenced in the text). This report was originally published in November 2020 but has since been updated to reflect the notification of the Swanscombe Peninsula SSSI, which encompasses much of the study area under consideration.

The study area covered by this report includes both the Kent Project Site (Swanscombe Peninsula and the Resort Access Road) and the Essex (Tilbury) Project Site delineated by the Order Limit in Figure 1-1 below. The Swanscombe Peninsula is located in a meander of the River Thames, centred at National Grid Reference (NGR) TQ 60657 76055, and covers over 300 hectares. The Essex Project Site located on the north bank of the River Thames, occupies land within the Port of Tilbury centred on NGR TQ 66438 75459.

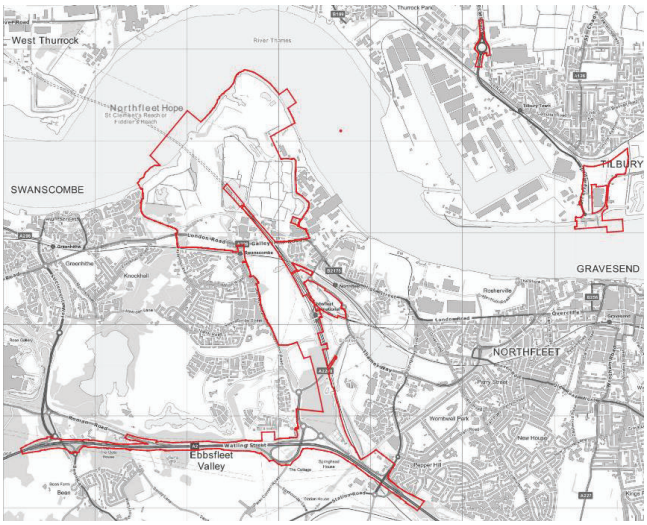


Figure 1-1 - Study area

The aim of this report is to set out an overarching strategy such that contamination risks for each of the areas of the Project Sites can be identified and managed during the Proposed Development. The CLMS aims to:

- Identify appropriate land uses and construction methodologies in relation to potential contamination risks;
- Identify development methodologies which could provide the required remedial measures to minimise specific remediation requirements; and
- Provide an outline material re-use strategy and methodology to minimise offsite disposal of materials.

The strategy provides a summary of best practice and considers options which correspond to the known contamination issues across the various areas of the Project Site. It has been informed by the aspirations of the Proposed Development but also tailors those aspirations to minimise potential impacts to people and / or the environment. It has been prepared in general accordance with the Environment Agency's guidance on Land Contamination Risk Management (LCRM) [1].

1.2 Regulatory regime

This CLMS has been prepared to support an application in accordance with the Planning Act (2008) [2] for a Nationally Significant Infrastructure Project (NSIP) for the London Resort and is also a technical appendix to Chapter 18: *Soils, hydrogeology and ground conditions* of the Environmental Statement.

Land contamination is regulated under several regimes, including environmental protection, pollution prevention and control, waste management, planning and development control, and health and safety legislation. The key legislation under which contaminated land is managed in the UK (all of which are relevant to this current report) are:

- Part 2A of the Environmental Protection Act 1990 [3];
- The Contaminated Land (England) (Amendment) Regulations 2012 [4];
- The Waste (England and Wales) Regulations 2011 [5]; and
- The Environmental Permitting (England and Wales) Regulations 2016 [6].

Part 2A of the Environmental Protection Act 1990 establishes a legal framework for dealing with land contamination in England. It provides a means of dealing with unacceptable risks posed by land contamination to human health and the environment. Government objectives with respect to land contamination policy and the Part 2A regime are set out in the Department for Environment Food and Rural Affairs (Defra) Contaminated Land Statutory Guidance 2012 and may be summarised as:

- to identify and remove unacceptable risks to human health and the environment;
- to seek to ensure that contaminated land is made suitable for its current use; and
- to ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development.

Land affected by contamination is also a material planning consideration. The principles to be applied to land affected by contamination are set out within the National Planning Policy Framework (NPPF) (February 2019) [7]. These principles can also broadly apply to NSIPs, namely that policies and decisions should ensure (and that the developer should demonstrate) that:

- a site is suitable for its proposed use taking account of ground conditions and any risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);
- after remediation, as a minimum, land should not be capable of being determined as Contaminated Land under Part IIA of the Environmental Protection Act 1990; and
- adequate site investigation information, prepared by a competent person, is available to inform these assessments.

1.3 Approach

The approach adopted in developing and implementing the CLMS follows the phased approach set out in much of the good practice guidance over the last 30 years, most recently in the Environment Agency LCRM [1]. This phased approach consists of three main stages:

Stage 1 – Risk assessment [Preliminary, Generic Quantitative, Detailed Quantitative];
Stage 2 – Appraisal of remediation options [Feasibility, Evaluation, Selection]; and
Stage 3 – Remediation and verification [Strategy development, implementation, verification, long term monitoring & maintenance].

In all of these stages, appropriate definition and consideration is given to the conceptual site model or the source-pathway-target approach. If one of these three elements is absent, it is considered that there is no risk of harm. If,

however, there is considered to be a linkage between any given source and any given target /receptor then a risk-based approach is used to assess the significance or impact of the potential linkage. Risks are defined as the probability of an event occurring combined with the severity of the consequence should that event occur. To assess the risk to site end-user(s) posed by a given source, the sensitivity of each receptor is considered. This then identifies the potentially significant risks, requiring remedial design and / or remedial action.

Currently, the Proposed Development is at Stage 1 with respect to the phased process set out above. The risk assessment is at the preliminary stage and the available information on land affected by contamination is largely based upon desk-based studies and existing ground investigation data. Accordingly, there is currently uncertainty with respect to the precise description of the various sources of contamination across the Project Site the receptors that could be affected and the pathways that link them. These uncertainties will be reduced or resolved by a substantial programme of ground investigation planned to commence in 2021. Accordingly, the strategy for the management of the land contamination across the Project Site set out here, reflects those uncertainties and the need for and scope of remedial design and/ or action. It sets out the principles for that management, both site-wide and with respect for some of the areas of the Project Site that will present particular challenges with regard to land affected by contamination. Site specific proposals for remedial design and action will therefore be developed in due course.

1.4 High Speed 1

Although not related to land affected by contamination, there are ground related constraints related to the existing High Speed railway (HS1) that traverses the Swanscombe Peninsula and is adjacent to the eastern boundary of the Resort Access Road corridor, that must also be taken into account. A Preliminary Tunnel Impact Assessment report [8] has been prepared which summarises the potential impacts of the earthworks excavation and filling associated with the London Resort on existing HS1 infrastructure. That report provides a set of ground rules for future development in the vicinity of the existing tunnel infrastructure. The report is intended to support initial discussions with HS1 but recognises that additional analyses will be required for individual construction packages at the appropriate stage of design. Ground rules for development near the HS1 infrastructure are provided in the Network Rail (High Speed) Asset Protection Development Handbook (July 2016). The minimum requirements pertaining to tunnels are summarised below, but appropriate reference should be made to the full report [8] and to other relevant reports and advice that will be developed in the near future.

- The existing HS1 tunnel infrastructure has been designed to accommodate a 50kPa increase of vertical stress at tunnel axis level. Any increase of vertical stress beyond this value will require an assessment of the tunnel lining capacity. Network Rail (responsible for HS1 asset protection) have confirmed that additional tunnel lining assessments will also be required where the tunnels are subject to a reduction of vertical stress at tunnel axis level.
- Where temporary dewatering works are required in connection with the Proposed Development, the impact of these activities on existing tunnel infrastructure will need to be considered.
- As part of the original development, HS1 was granted ownership of all subsoil located within three metres of the existing tunnels. Importantly, this ownership forms a rectangular section and includes the subsoil located between the twin bored tunnels.
- Although pile exclusion zones are not referenced in the guidance, a license is required prior to undertaking any works within the HS1 subsoil ownership boundary. These licenses are unlikely to be granted for any piles located within three metres of existing tunnels.
- All designs which have the potential to affect existing tunnel infrastructure will be subject to independent (Category 3) checking.
- HS1 consultation is required in connection with any development within the HS1 ‘safeguarding’ zone.

2 The management strategy

2.1 Stage 1 – Risk assessment

Currently, the large majority of the information on the ground conditions on the Project Site is based upon the desk based studies of existing and published information [9] [10] [11] [12] [13] [14] [15] [16] which includes limited ground investigation data at particular locations. There are also monitoring data sets on specific parts of the Project Site (Swanscombe Peninsula, Bamber Pit and Northfleet Landfill) [17] [18] [19]. Accordingly, to-date Preliminary Risk Assessments have been carried out [13] [14] [15] which have established the potential for risks to people and the environment associated with the Proposed Development and land affected by contamination. Upon completion of the planned ground investigation (see below) Generic (and where appropriate – Detailed) Quantitative Risk assessments will be undertaken to define the precise need for and scope of remedial design or action, both across the Project Sites and locally.

The exploratory level ground investigations completed to date were undertaken when the details of the Proposed Development were not fully defined. There are areas where no recent investigation has been undertaken, for example within areas of permitted landfills and areas outside of the Resort footprint, but where specific information on the ground conditions is required (e.g. in the areas of the proposed salt marsh enhancement etc.). The existing information is currently being supplemented by a programme of site-wide groundwater monitoring / sampling from existing groundwater wells (being carried out over 2020 / 21) but a substantial programme of ground investigation is planned for 2021.

This programme of ground investigation will be targeted to both the built elements of the Proposed Development and also to other particular areas of the Project Site (e.g. areas of particular constraint or sensitivity – such as landfills and areas of particular ecological or archaeological interest). The investigations will have combined geotechnical and geoenvironmental objectives (and archaeological / ecological where appropriate) and will include a suitable number of exploratory holes to appropriate depths and with adequate sampling / testing and duration / frequency of monitoring to enable the characterisation of soils, rocks and the groundwater, surface water and ground gas regimes. All ground investigations will include measures appropriate to mitigate the potential health, safety and hygiene risks associated with ground contamination, including unexploded ordnance (UXO) – see section 4.6.

Liaison with local authority Contaminated Land and Environmental Health Officers, the Environment Agency and other key stakeholders (e.g. HS1) has commenced and will be carried out over the coming months to agree scope of any such investigation, as well as analytical suites and reporting protocol. The results of the investigations will inform the quantitative risk assessments and identify the site-specific need for and scope of remedial design or action. It is anticipated that these investigation and assessment reports will be prepared under the National Quality Mark Scheme [20] (https://www.claire.co.uk/projects-and-initiatives/nqms).

2.2 Stage 2 - Remediation options

A step-wise approach will be followed to establish the appropriate option for the remedial design or action necessary to mitigate the risks for each of the relevant contaminant linkages identified in Stage 1. Namely: (i) the identification of feasible options, (ii) their evaluation, and (iii) the selection of the preferred option. This process will take into account the specific aspects of the conceptual site models across all the areas of the Project Site, each of which will have their own particular objectives (contamination, engineering and management related) to be achieved. Consideration will also be given to any regulatory controls (both existing regulatory controls on the land and also

relevant to the remediation techniques / methods being assessed). The assessment will also consider the practicality, effectiveness and durability of the remedial action together with an analysis of their costs, benefits and sustainability.

2.3 Stage 3 – Development, implementation and verification of remediation

2.3.1 Development

Following the ground investigation and consideration of options, an overarching Remediation Strategy will be prepared for the whole of the Project Site. Within that overall strategy, particular objectives and elements will be prepared for the various parts of the site, i.e. The Essex Project Site, the Kent Project Site (Swanscombe Peninsula) and the Kent Project Site (Resort Access Road). It is likely that particular Remediation Strategy reports will be prepared for each of these three areas. However, the overall Remedial Strategy will define how the set of remedial designs and / or actions will mitigate all of the risks identified in Stage 1. It will describe how the remedial objectives and regulatory requirements will be met, how a sustainable approach has been incorporated and how the remediation is compatible with other aspects of the Proposed Development (e.g. construction, geotechnics and areas of archaeological or ecological sensitivity). As above, it is anticipated that these Remediation Strategy reports will be prepared under the National Quality Mark Scheme [20]. This current CLMS anticipates the eventual Remediation Strategy. As it is based upon preliminary data and the Preliminary Risk Assessments, the following chapters provide an anticipated outline for that document.

2.3.2 Implementation

Remediation Method Statements will be prepared by the appointed contractor(s) describing how the remediation will be implemented. These plans will provide: the definitions of the works to be carried out; the programme; the health, safety and environmental control regimes that will be implemented; the regulatory regimes / requirements for the various actions; and the provisions necessary to deal with any unexpected contamination. Monitoring of the works as they proceed will be carried out in order to:

- Record the works as they are undertaken, any impact on surface water, groundwater or air quality, any nuisance (noise or dust);
- Record any unexpected contamination (including UXO) encountered during the works, together with any remedial action undertaken;
- Provide confirmation of successful implementation of the works; and
- Enable completion of a Verification Report.

2.3.3 Verification

The Verification activities will be carried out by appropriately competent and qualified organisation(s), independent of the contractor(s). A summary of this phase of activity is presented below with a more detailed account given here in Chapter 6. The anticipated scope of works comprises:

- Collation of all relevant information available from contractors' reports, drawings and records;
- Inspection and recording of works (including observation, inspection and recording of health, safety, hygiene and environmental management);
- Management of the sampling and testing necessary to demonstrate compliance with agreed criteria;
- Management of the environmental monitoring programmes (groundwater, air quality, noise);
- Immediate response to any unexpected contamination;
- Continuing review all of this data and assessment of compliance with the agreed Remediation Strategies,
- Liaison with the local authority and Environment Agency regulators; and
- Preparation of the Verification Report at the conclusion of the works.

2.3.4 Verification Report

The overall objective of verification activity is to demonstrate that the remedial works have been carried out in accordance with the agreed plan and that the works have not given rise to any unacceptable impacts upon people or the environment. The verification activities will also provide evidence that the planning / permit / licence conditions (or, in the case of the DCO, requirements) and the environmental management goals have been met. The verification report(s) will be prepared on completion of the works (or section of the works) and will comply with relevant Environment Agency guidance [21]. The reports will provide authoritative documentary evidence of the remedial works. They will describe the area of the Project Site concerned, the remediation objectives, the techniques or processes employed and the verification / monitoring data in succinct text supported by as built drawings, figures, photographs etc. As above, it is anticipated that these verification reports will be prepared under the National Quality Mark Scheme [20].

2.4 Uncertainty

It is important to recognise that there are inherent uncertainties associated with ground conditions and the data that inform its understanding, both geotechnical and geoenvironmental. For example, geological strata can be very consistent or highly variable, both laterally and vertically. Similarly, contamination can be both widespread and relatively localised, depending upon its source, location, nature and mobility. This variability is compounded on the Kent Project Site, by the very large area of land involved (over 450 hectares) and by the large range and nature of activities that have taken place there over more than 100 years (e.g. quarrying and landfilling, cement and paper manufacturing and many other industrial activities described in detail in the desk study reports [9] and [14]). No investigation, however comprehensive can be expected to determine absolutely the geological conditions, the geotechnical parameters or the nature and extent of contamination which could be present on any site. There will always be an element of uncertainty about the ground conditions, including contamination.

This potential for uncertainty must (and will) therefore be taken into account in any risk assessment, in the assessment of the need for, scope and design of the Remediation Strategy, in geotechnical design, in health and safety planning, in financial risk management and in the implementation of any remediation works.

Accordingly, in preparing this CLMS, consideration has been given to the level of uncertainty associated with each of the identified potential sources of contamination and also with the migration pathways that could link such sources to any of the identified receptors. For example, much of the information is based upon historical records which are partial and not complete. The existing ground investigation reports do not provide current, comprehensive, design level data. Given this uncertainty, the identification of the sources is based upon and reflects a conservative assessment of the potential location, nature and extent of the source(s), including the potential for currently unforeseen contamination). The probability or likelihood of the hazard being realised has been assessed by consideration of the directness / integrity of the potential exposure pathways that could link the receptor to the source and the uncertainties associated with those pathways. The assigned level of risk has been determined by the terms of consequence and probability in accordance with the relevant guidance, but also takes into account the uncertainties associated with all the elements of the various contaminant linkages.

3 Remediation

3.1 Contamination linkages

3.1.1 Approach

As described above the assessment of risk from contamination follows the source-pathway-target approach. If one of these three elements is absent it is considered that there is no risk of harm. If, however, there is considered to be a linkage between any given source and any given target / receptor then a risk-based approach is used to assess the significance of the potential linkage and the consequent need for remedial design / action. The potential contaminant sources relevant to the Project Site are listed below followed by the receptors and the plausible exposure pathways that could link them. The potentially significant risks, requiring remedial design or action are summarised in Section 3.1.1.

Potential contamination sources from former uses of the Project Site and neighbouring area have been identified and described in the Desk Study reports [13] [14] [15]. In summary, across all areas of the Project Site, these sources comprise:

1. Made Ground (from many and various past and recent industrial and commercial activities)
2. Landfill / waste materials (Domestic, commercial, mining and manufacturing wastes, including CKD)
3. Process wastes etc (e.g. from sewage treatment, paper and cement manufacture, tar distillery, whiting & chemical works, light industry, railway sidings, petrol station, electricity grid and sub stations
4. Hazardous ground gas (from both landfill wastes and natural soils).

In addition to this ground contamination profile, there is also a potential for UXO on both Essex and Kent Projects Sites, where risks and mitigation are subject to separate consideration (see section 4.6). Site specific pathway-receptor linkages have been identified with all of these sources in the Desk Study reports. A summary of these linkages is tabulated below with respect to the Proposed Development.

Table 3-1 Receptors and pathways

Receptor		Pathway
Human Health	Construction workers (including investigation)	Direct contact, dermal uptake, soil and dust ingestion, gas and vapour inhalation
	Future site visitors and workers	Direct contact and dermal uptake, soil and dust ingestion. Migration / accumulation of ground gas to hazardous concentrations
	Neighbours	Soil and dust ingestion Migration / accumulation of ground gas to hazardous concentrations
Groundwater	Secondary and Principal Aquifers	Leaching and migration via permeable strata / preferential pathways
Surface waters	Rivers Thames, Ebbsfleet Ponds & channels	Migration of contaminated via run off, drainage, shallow permeable strata
Environment	Flora and fauna	Direct contact, dust, uptake via plant roots
Built environment	Below ground infrastructure	Direct contact

3.1.1 Potentially significant risks

Source-pathway-receptor linkages have been identified, considered and the results of the Preliminary Risk Assessments relevant to the Proposed Development are presented in the Desk Study reports [13] [14] [15]. A summary of the potentially significant risks that require remedial design / action is presented below:

- to construction / investigation workers, from the potential for exposure to contaminants (including UXO) during construction;
- to neighbours, from the potential for migration of contaminants during construction and accumulation of hazardous ground gas after development;
- to site visitors and workers, from the potential for exposure to contaminants and accumulation of hazardous ground gas after development;
- to surface waters, from the migration of contamination during construction and after development;
- to groundwater, from the migration of contamination during construction and after development;
- to flora and fauna, from contamination in soils and groundwater during construction and after development; and
- to the built environment, from aggressive ground conditions and hazardous ground gas after development.

3.2 Remedial objectives

The overall aim of the remediation is to ensure that potential risks from land contamination in all areas of the Project Site to all these receptors are appropriately mitigated. The remedial objectives therefore address all of the significant contaminant linkages set out above. The objectives can be defined in three categories:

i) contamination related;
ii) engineering related; and
iii) management and amenity related.

3.2.1 Contamination related objectives

The contamination related objectives are:

1. To ensure construction / investigation workers are not exposed to concentrations of contamination in the solid, liquid or gaseous/vapour phase at concentrations that could give rise to acute risks (including UXO);
2. To ensure neighbours to the Project Site are not exposed to concentrations of contamination or hazardous ground gas that could give rise to acute or chronic risks;
3. To ensure future site visitors and workers are not exposed to concentrations of contamination or hazardous ground gas that could give rise to acute or chronic risks;
4. To ensure the quality of surface waters or groundwater resources are not significantly impacted by mobile inorganic or organic contaminants in both the short and long term;
5. To ensure soils in areas of soft landscaping meet appropriate physical and chemical criteria to enable health / growth of on-site plants;
6. To ensure the performance of the below ground infrastructure is not impaired over the long term; and
7. To ensure that the redeveloped Project Site cannot be determined as 'Contaminated Land'.

3.2.2 Engineering related objectives

The engineering related objectives are:

1. To ensure integration of the remediation with other elements of the development (e.g. river wall works, flood protection strategy, ecological and archaeological assets etc.);
2. To ensure integration of the remediation with the planned future development (i.e. areas for future buildings / hardstanding and areas of soft landscaping);
3. To ensure that the geotechnical properties of any relevant soils (e.g. fill materials) meet appropriate criteria; and
4. To ensure the durability of any areas of land raise.

3.2.3 Management and Amenity Related Objectives

The management and amenity related objectives are:

1. To deliver the remediation works to time and budget;
2. To enable discharge of the relevant DCO requirements;
3. To minimise environmental impacts and ensure that 'nuisance' effects to neighbours are acceptably low;
4. To ensure mitigation of the potential risks associated with UXO during all below ground works; and
5. To ensure the remedial works undertaken are cost effective and meet sustainability goals.

3.3 Consideration of remedial options

As discussed above (Section 2.2), consideration should be given to the full range of remedial design / measures that are potentially capable of meeting the remedial objectives. Appraisal of these options should then be carried out to determine which particular remediation options are feasible and likely to be effective for the particular site and circumstances under consideration (i.e. the development proposals and relevant pollutant linkages). A systematic review and evaluation of these options would then be carried out. There are three main types of control for achieving the remedial objectives. These comprise:

1. Source control – the removal or treatment of the source(s) of contamination:
2. Pathway control;
    a. The construction of a barrier to prevent contact to contaminated materials by sensitive receptors;
    b. The construction of a barrier to prevent the migration of contamination to sensitive receptors; and
3. Receptor control – restricting the presence/ access of sensitive receptors to the source(s) of contamination.

The criteria by which remedial actions for each of these control systems are assessed can be summarised under three headings:

- Practicality (e.g. technicality, site, time, regulatory constraints);
- Effectiveness (e.g. in achieving the remedial targets); and
- Durability (e.g. remaining effective over the longer term).

However, it is recognised, that because of the proposed nature of the Project Site there are a relatively small range of suitable remedial actions capable of, or suitable for, meeting the remediation objectives identified above it is likely that no formal detailed evaluation of remedial options may appropriate for this element of the Proposed Development / in particular areas. This situation, where effectively there is only one (or a very limited number of) feasible remediation option, is recognised by the guidance which advises that, in such circumstances, consideration should then be given to the broad practicalities of implementing the Remediation Strategy. It is likely that, in due course, on particular areas of the Project Site and with respect to particular contaminant linkages, a more formal appraisal of remedial options will be appropriate and will be carried out.

3.4 Cost benefit and sustainability

Current initial estimates relating to the Proposed Development conservatively envisage the off-site disposal of approximately 60% of spoil arisings by road and river transport (with the aim to increase on-site re-use and reduce off-site disposal). The Proposed Development aims to utilise the remaining 40% plus of the spoil in the creation of development platforms (which will prepare the Project Site for construction, in the creation of enhanced flood protection and other landscape works). The onsite re-use of spoil would deliver environmental and economic benefits, namely:

- allowing for the beneficial re-use of an otherwise waste material in accordance with the waste hierarchy;
- reducing transport and other associated environmental impacts, particularly air quality impacts from barge and lorry movements; in the immediate neighbourhood and beyond;
- reducing disposal to landfill, thus saving void space; and
- reducing any subsequent demand for suitable soil materials / primary aggregates associated with any future redevelopment.

It is envisaged that the physical and chemical treatment of the potentially suitable spoil arisings will take place on an on-site soil treatment centre ("soil hospital") – see Appendix B. This facility would be designed to provide several treatment techniques necessary to cope with the variable physical and chemical properties of the soils excavated from the earthworks. Well defined, operated and recorded Materials Management Plans [soil sources, properties, treatment and destination] will be operated to plan and track the earthworks. The treatment techniques provided are likely to include; screening, sorting, stabilisation, washing, bioremediation and thermal treatments. Topsoil/ subsoil manufacture may also be possible. The efficient use of the facility will balance the throughput of the soil arriving for treatment with the demand for fill, thus minimising the stockpiling of soils at either end of the process.

4 Outline Remediation Strategy

4.1 Earthworks

4.1.1 General

Current preliminary estimates indicate that substantial volumes of earthworks (some 860,000m^3 of cut and 490,000m^3 of fill) will be required for the construction of the London Resort with some 190,000m^3 cut and 120,000m^3 fill for the Resort Access Road works. The spoil arising from the earthworks will be a heterogeneous mix of Made Ground / fill materials and the natural geological strata (Alluvium and peat, Gravels, Thanet Sand and Chalk). A substantial proportion of the earthworks from the Resort Access Road works will be landfilled materials. The overall objective of the earthworks plan is to re-use as much of the spoil arising as possible in the earthworks necessary for the construction of the Resort's development platform and to minimise the volume of spoil consigned for off-site disposal to landfill. A proportion of these spoil arisings will be directly suitable for re-use, a proportion will be suitable following treatment (on-site) and a proportion will not be suitable for re-use and would be disposed off-site to landfill.

The nature of the Made Ground / Fill varies considerably across the Kent Project Site. In some areas it is a mix of man-made and natural materials "typical" of Brownfield sites. Some of this will be amenable to treatment for re-use but some will not (due to particularly poor chemical or physical properties). In some other areas, the fill is much more consistent (the result of disposal from one particular source). This includes cement kiln dust (CKD), which currently occupies significant areas of the Swanscombe Peninsula, and Thanet Sand, former overburden to Chalk pits and now occupying the southern part of Bamber Pit.

4.1.2 Cement kiln dust

The predominant use of the cement kiln dust (CKD) spoil arisings on the Project Site would be as an earthworks fill material and / or as part of a soil stabilisation treatment. The potential for the reuse of CKD material for earthworks purposes is subject to consideration and assessment of particular aspects, summarised below (see also Appendix A):

1. Mixing CKD with other materials / soil which may affect leaching (both CKD and soil / mixing agent);
2. Variance in concentrations of contaminants / chemicals within the individual CKD material;
3. Use of CKD in the stabilisation of soft clayey soil;
4. Treatment of CKD material may be required prior to re-use with other materials for earthworks on site; and
5. Investigation (including sampling and laboratory testing) will be carried out to determine the composition and characteristic properties of the CKD material to facilitate this reuse.

4.1.3 Regulation

The re-use of on-site derived spoil will be managed under a range of regimes dependent upon the particular location and nature of the spoil arising. For example, direct re-use may take place under the Development Industry Waste Code of Practice (DoWCoP) [22], treatment (at the on-site facility) and re-use may refer to Environmental Permits (for the plant) and / or the DoWCoP Cluster Guide [23]. Adherence to these Codes and permits will require the design and implementation of robust Materials Management Plans (signed off by a Qualified Person). There will be areas where any such re-use requires an Environmental Permit, or modification to existing permits (see Appendix D). Investigation and any earthworks (e.g. for remediation of construction) on areas subject to notification as a part of the Swanscombe SSSI will require the approval of English Nature. Off-site disposal will require disposal to an appropriately licensed facility in accordance with Waste Management Licensing Regulations. Any stockpiling may require an Environmental Permit depending upon the volumes / nature of materials and the period of residence.

4.1.4 Site preparation prior to spoil re-use

Prior to the earthworks, any existing hardstanding (and below ground obstructions to a depth of 3m below ground level) will be excavated and crushed for subsequent re-use. The removal of hardstanding (and any areas of open excavation) will take place in phases so as to enable the area of open ground to be kept to a practicable minimum (to minimise rainwater infiltration and to facilitate access and other uses). Any areas of gross / mobile contamination encountered during this work will be excavated and disposed of off-site.

4.1.5 Material placement

In areas where ground levels are to be raised, following site preparation, a composite cap will be constructed. A regulating layer will be placed to bring the ground level up to a "Formation Level". That is a level below the Final Finished Level to a depth appropriate to the capping materials to be placed. All materials of the composite cap will be placed in layers of appropriate thickness and compacted to achieve appropriate geotechnical criteria [in accordance with the Specification for Highway Works – Series 600]. Sampling and testing of Made Ground materials being re-used will be carried out to at an appropriate frequency and spacing to demonstrate geotechnical and chemical suitability. The acceptable criteria for all materials of the capping will be defined by the relevant thresholds current at the time (see Appendix C).

The regulating layer will be overlain by a marker layer. This will typically comprise a coloured plastic mesh sheet or geotextile fabric placed to separate the clean soils forming the engineered cap from the underlying contaminated Made Ground. The purpose of this marker layer is to provide a visual "barrier", warning anyone carrying out excavations on the site that they are moving from clean to potentially contaminated materials. In areas of built development, the underside of the floor slab / road paving would typically form the "marker layer".

The first layer of the engineered cap above the marker layer may be a capillary break layer, if required to prevent the upward migration of contamination due to capillary action. The need for such a layer will depend upon the nature of the contamination, to be determined by site investigation. Typically, such a layer would be 200mm thick and comprise a clean coarse granular aggregate (either crushed concrete or natural gravels). A geotextile layer is usually placed over such a granular break layer, to prevent it becoming silted up from the overlying soils. If natural sands and gravels are used, then no testing is necessary. If crushed materials are used, then testing will be carried out to confirm compliance with relevant thresholds.

In areas planned for soft landscape (except areas of salt marsh or other areas of particular ecological value – see Section 4.4) or for built development (where levels require) clay or other suitable low permeability soils would be placed in layers and compacted to provide a geotechnically suitable material. The objectives of the low permeability soils are to inhibit rainwater infiltration (and also to prevent direct contact by people). The final landforms will be designed and constructed to ensure that incident rainwater does not pond / flood on the surface. This will require the ground surface elevation to be laid to falls at an appropriate gradient and to incorporate a surface water drainage system.

In the areas of soft landscaping the thickness of the soil cover required in landscaped areas will vary to reflect the nature of the subsequent planting but will typically be a minimum of 300mm in grassed areas. Shrubs typically require 500-600mm minimum and trees over 1m of subsoil and topsoil (although trees are usually planted in over-deepened "tree pits" in such landscaped areas). Sketches illustrating these two patterns for the composite cap are set out below.

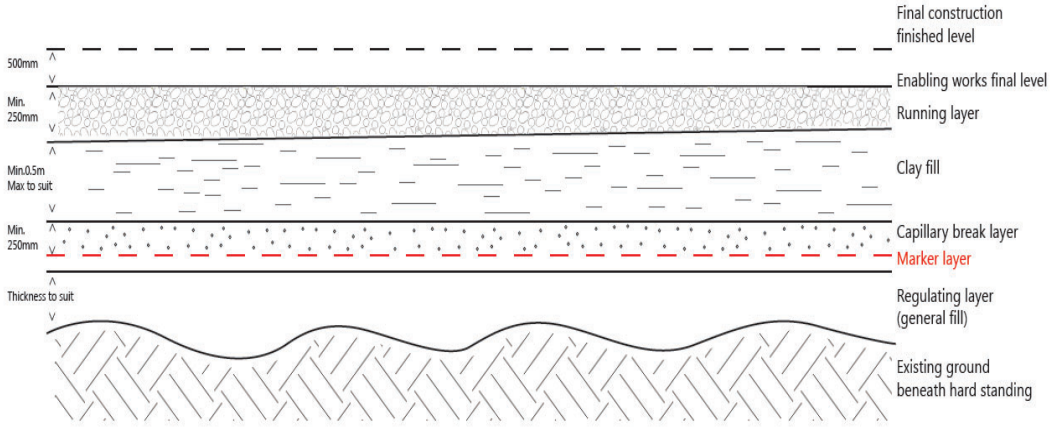


Figure 4-1 - Sketch of composite cap in areas of hardstanding

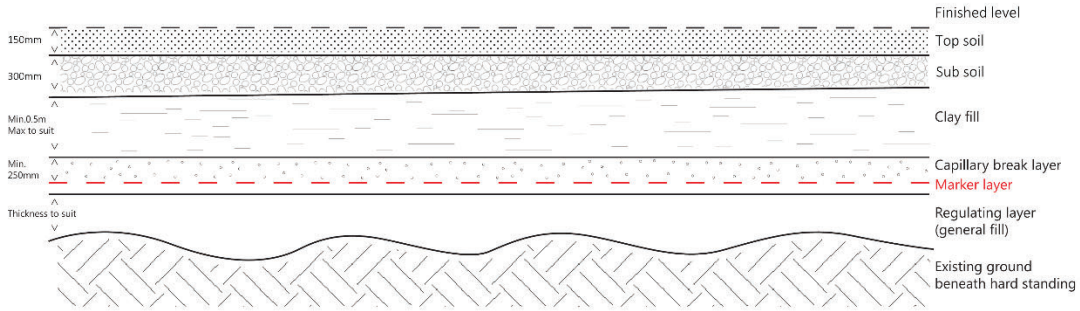


Figure 4-2 - Sketch of composite cap in areas of soft landscaping

4.1.6 Excavation and off-site disposal

Any materials not suitable for re-use (direct or following treatment) will be subject to off-site treatment / disposal at an appropriately licensed facility. The majority of the Made Ground not suitable for re-use on site (directly or following treatment) is likely to be classified as Non-Hazardous Waste, with more impacted material likely to be classified as Hazardous Waste and requiring segregation for separate disposal accordingly. The waste classification of the various Made Ground soils encountered across both Project Sites will be subject to consideration in the planned ground investigations. These waste streams will be separated on excavation and subject to confirmatory testing to ensure correct classification and disposal of any hazardous materials. It will be the earthworks contractor's responsibility, in association with the operator and / or owner of the landfill to classify and record any such materials for appropriate disposal. Waste classification and landfill Waste Acceptance Criteria (WAC) leachate testing will be undertaken prior to disposal to landfill to meet the requirements of the disposal facility's licence.

4.2 Protection of human health

The following paragraphs provide a description of how the remedial objectives for human health will be met, taking into account the Proposed Development. The receptors are addressed in the order of the pollutant linkages summarised above in Table 3-1.

4.2.1 Construction and investigation workers

The potential for direct contact and/ or ingestion of contaminated soils and for dust inhalation by the investigation and construction workforce during works (including; ground investigation, earthworks and landscaping) will be mitigated by a combination of the measures to be set out in the Construction Environmental Management Plan (CEMP) and summarised below:

i. Ensuring awareness of the potential for contamination (including UXO and hazardous ground gas/ vapours) in the workforce engaged in any below ground works by the provision of briefing and site induction including description of the potential for and the nature of potential contaminants and setting out the provisions being implemented on site;
ii. Avoiding / minimising the extent of ground excavations where appropriate;
iii. Controlled excavation and removal of any localised / gross contamination ("hot spots") in sensitive locations prior to any substantial earthworks;
iv. Providing an appropriate level of Personal Protective Equipment (PPE) and ensuring this is worn at all times;
v. Ensuring that supplementary PPE that may be necessary (e.g. vapour masks) are immediately available to be used if required;
vi. Ensuring a good standard of hygiene with the consumption of food and drink permitted only in designated areas. Smoking will not be permitted on site;
vii. Ensuring good construction practice (including appropriate mitigation) is followed during excavation and any below ground works to prevent the generation and migration of dusts created by such construction activities including: damping down dust, avoiding dropping of spoil from height, sheeting lorries and areas of soil stockpile etc.);
viii. Where appropriate, air monitoring shall be carried out to detect presence of any airborne asbestos fibres in the event that significant amounts of suspected asbestos containing material are identified, in accordance with HSE guidance [24]. The specific processes shall be defined in the Contractors Method Statement(s); and
ix. Making plans and provisions for unforeseen contamination (see section 4.6)

4.2.2 Neighbours

The presence, location and type of neighbours to the Project Site, varies considerably reflecting the large area of the Project Site and the variety of land uses nearby. Accordingly, in some parts of the Project Site the neighbours are the owners and occupiers of residential housing, in others the neighbours are the workers and visitors to industrial and commercial businesses. There are also parts of the Project Site where there are few if any human neighbours. The potential for dust inhalation by neighbours (and the nature of those neighbours) during earthworks will therefore vary location by location. This potential will be mitigated by ensuring good construction practice to prevent the generation and the migration of dusts created by below ground works and other construction activities with particular attention and measures provided in the more sensitive locations. These measures shall be set out in the CEMP and include use of dust suppression measures (described above). Air monitoring referred to above, will also apply to include perimeter monitoring as appropriate.

The potential for hazardous ground gas to migrate and accumulate to hazardous concentrations in confined spaces in neighbouring buildings in particular locations of the Project Site will be mitigated by the incorporation of gas

protection systems to prevent off-site migration. Such systems will be commensurate with the site-specific ground gas regime determined by the programme of ground investigations, subsequent earthworks and the potential for off-site migration. Such a system would for example include perimeter vent / cut off trenches together with associated monitoring.

4.2.3 Future site visitors / workers

The potential for Resort visitors to come into contact with the residual contamination is limited to exposure in areas of soft landscaping and over a relatively short period of a few days or so. There is a potential for Resort staff to be on site for a substantially longer period. There is no plausible potential for such contact in the areas of the built development where the roads, paving and building will provide the capping. However, in the soft landscaped areas (not planters etc. at Podium level) residual Made Ground will be present beneath the topsoil and capping layer. These areas will be open to public access and people may have cause (and are likely to be encouraged) to visit / inspect some parts (although others are likely to be restricted to protect the sensitive ecology) when it is no longer subject to the controls of a construction site and prior to the development of the staff accommodation. However, the presence of the composite capping (section 4.1.5) will prevent the accidental exposure of visitors to the underlying residual Made Ground (from which any "hot spots" of contamination will have been excavated and removed (see Section 4.2.1).

Where areas of soft landscaping are present an appropriate thickness of subsoil / topsoil will be provided primarily for horticultural / landscaping reasons, but it will also act as an element of capping to the underlying Made Ground. Due to the nature of materials across the Project Site it is unlikely that site-won materials will be suitable for reuse as topsoil unless treated. Accordingly, clean suitable soils may need to be imported and placed to a minimum thickness of 450mm of sub soil and topsoil (see Section 4.4). However, in some of the landscape areas, it is the nature of the ground conditions that has led to the development of a particular ecology with important flora and fauna. In such areas, it is envisaged that the "capping" material and design will be constructed to protect people from the hazardous ground conditions, whilst minimising infiltration and enable the particular ecosystem (flora and fauna) to thrive.

In these soft landscape areas, the soil cover and subsequent layers of the composite cap will provide a suitable barrier between people on site and the underlying residual Made Ground and mitigate the generation of contaminated dust during the operational phase. The properties of potentially contaminated material being re-used within the capping will be proven chemically and physically to ensure appropriate re-use (Appendix B). Testing will be carried out on representative samples at an approximate spacing and a frequency of one sample per 250m3 or a minimum of five samples per source area.

If in-situ testing shows that some areas of the Made Ground fail the criteria (i.e. average concentrations exceed thresholds) the contractor will be required to either carry out further testing to demonstrate compliance or to excavate and remove the non-compliant soils and replace them with compliant material with further sampling and testing to confirm suitability. Non-compliant material will be determined on the basis of the average values (mean or US95 as appropriate). Exceedance of this average would either result in rejection of that material and its removal and replacement by compliant material or in further testing to confirm non-compliance and / or delineate any particular contaminant 'hotspot'. The further testing will be at a frequency, spacing and depth specific to reflect the location specific circumstances.

There are potential sources of hazardous ground gas potential for hazardous ground gas to migrate and accumulate in confined spaces in buildings to hazardous concentrations will be mitigated by the incorporation of gas protection systems commensurate with the site specific ground gas regime determined by the programme of ground investigations, subsequent earthworks and the nature of the building. Any such gas protection system will be

designed, constructed and verified in accordance with the relevant British Standard [25] and good practice guidance [26] respectively.

4.3 Controlled Waters

4.3.1 Groundwaters

The potential risks to groundwater resources varies across the site, reflecting the particulars of each location. The Chalk Principal Aquifer underlies both the Essex and Kent Project Sites. The Secondary Aquifers (Alluvium, River Terrace Deposits) are important locally (although as a pathway for contaminant migration rather than as a resource).

The potential for contamination of these groundwater resources by the investigation and construction workforce during construction (including; ground investigation, earthworks and landscaping) will be mitigated by a combination of the measures to be set out in the CEMP and summarised below:

i. Groundwater monitoring wells to be retained wherever possible throughout the works and new wells to be installed as required;
ii. Continued monitoring of both the shallow and deep groundwater aquifers to assess any impacts of quality resultant from any earthworks / remediation associated with the development;
iii. Restricting the area / temporary sealing and drainage of open excavation at any one time to reduce the potential for infiltration;
iv. Controlled excavation and removal of any localised / gross contamination ("hot spots") in sensitive locations prior to any substantial earthworks;
v. Control of groundwater (volume, quality and disposal) during excavation; and
vi. Deep earthworks / foundations (especially piled foundations) to be constructed in accordance with a Foundation Works Risk Assessment undertaken in accordance with relevant Environment Agency guidance [27].

The potential for contamination of these groundwater resources in the long-term during operation of the Resort will also be mitigated by particular design / measures implemented during construction (and to be set out in the CEMP) and summarised below. Groundwater monitoring outside of areas subject to Environmental Permits (discussed in Section 5.2.3 and Appendix D) will take place for a minimum period of one year following completion of construction in each particular locality:

i. Infiltration minimised by the built development with associated surface water drainage system;
ii. Soft landscaped areas to include low permeability composite cap and surface water drainage systems to inhibit deeper infiltration. Particular measures in areas of special ecological interest;
iii. Open drainage channels and bodies of standing water to be lined to prevent / minimise infiltration;
iv. Any areas of gross contamination removed during development; and
v. Deep earthworks / foundations (especially piled foundations) constructed in accordance with the Foundation Works Risk Assessment undertaken in accordance with relevant Environment Agency guidance [27].

4.3.2 Surface waters

The potential risks to surface water bodies also varies across the Project Site, reflecting the particulars of each location. The River Thames bounds the Essex Project Site (to the south) and the Kent Project Site (along the northern boundary of the Swanscombe Peninsula). The River Ebbsfleet is close to the eastern boundary of a substantial length of the Resort Access Road works and there are numerous ponds and channels mainly on the Swanscombe Peninsula but also elsewhere, for example the Fishing Lake in Bamber Pit.

The potential for contamination of these surface water bodies by the investigation and construction workforce during construction (including; ground investigation, earthworks and landscaping) will be mitigated by a combination of the measures to be set out in the CEMP and summarised below:

i. Prevention of uncontrolled run off during earthworks particularly in the vicinity of surface water bodies, including the provision of appropriate cut-off, bund or barrier in these areas as necessary;
ii. Continued monitoring of the shallow groundwater aquifer in these sensitive areas to warn of any potential impacts on water quality resultant from earthworks /remediation associated with the development;
iii. Restricting the area / temporary sealing and controlled dewatering / drainage of excavations in these sensitive locations to reduce the potential for infiltration/ run-off; and
iv. Controlled excavation and removal of any localised / gross contamination ("hot spots") in these sensitive locations prior to any substantial earthworks.

The potential for contamination of the surface water bodies in the long-term during operation of the Resort will also be mitigated by particular design / measures implemented during construction (and to be set out in the CEMP) and summarised below. Monitoring of the groundwater in the shallow aquifer outside of areas subject to Environmental Permits (discussed in Section 5.2.3 and Appendix D) will take place for a minimum period of one year following completion of construction in each particular locality:

i. Infiltration minimised by the built development with associated surface water drainage system which will also control run off;
ii. Soft landscaped areas include low permeability composite cap and surface water drainage systems to inhibit deeper infiltration. Particular measures in areas of special ecological interest;
iii. Open drainage channels and bodies of standing water to be lined to prevent contact with residual contamination and to minimise infiltration; and
iv. Any areas of gross contamination removed during development.

4.4 Flora and fauna

The potential risks to the ecology also varies across the Project Site, reflecting the particular nature of each location. The sensitive flora and fauna of the Essex Project Site is mainly located in / at the boundary of the River Thames where limited (if any) earthworks are proposed. There are a number of ecologically sensitive habitats on the Swanscombe Peninsula and much of this area falls within the Swanscombe Peninsula SSSI, which was notified on 11th March 2021. This is an area of open mosaic habitat on previously developed and traditional estuarine habitat. Zone 1 and includes chalk pits, grazing marsh and saltmarsh. It is of special interest for its nationally important assemblages of invertebrates and breeding birds, populations of vascular plants, and its geological features~~, which although not formally designated are locally important and their presence in places reflects its unusual soil chemistry~~. Furthermore, the creation and restoration of a series of habitats are planned (including salt marsh, wetlands, scrub and grasslands on both Black Duck and Broadness Marshes. Along the Resort Access Road works, parts of which also fall within the Swanscombe Peninsula SSSI, a range of animal / invertebrate species and sensitive habitats are present, mainly associated with the River Ebbsfleet.

The potential for contamination to affect these ecological resources by the investigation and construction workforce during construction (including; ground investigation, earthworks and landscaping) will be mitigated by a combination of the measures to be set out in the CEMP (and subject to agreement with Natural England) as summarised below:

i. Avoiding / minimising the extent of ground excavations;

ii. Ensuring awareness of the potential for contamination to affect the ecological resources by the provision of briefing and site induction including description of the potential for and the nature of potential contaminants and setting out the provisions being implemented on site;
iii. Ensuring good construction practice and mitigation is followed during excavation and any below ground works to prevent the generation and migration of dusts created by such construction activities including: damping down dust, avoiding dropping of spoil from height, sheeting lorries and areas of soil stockpile etc.);
iv. Prevention of uncontrolled run off during earthworks particularly in the vicinity of sensitive ecological environments and surface waters, including the provision of appropriate cut-off, bund or barrier in these areas as necessary;
v. Restricting the area / temporary sealing and controlled dewatering / drainage of excavations in these sensitive locations to reduce the potential for infiltration / run-off;
vi. Controlled excavation and removal of any localised / gross contamination ("hot spots") in sensitive locations prior to any substantial earthworks; and
vii. Making plans and provisions for unforeseen contamination (see Section 4.6).

The potential for contamination to affect flora and fauna in the long-term during operation of the Resort will also be mitigated by particular design / measures implemented during construction (and to be set out in the CEMP and agreed with Natural England) and summarised below. In addition to the restored marshes (for which there will be particular provision), there are areas of soft landscaping that will be constructed both at Podium level (where the issue will be restricted to the importing of suitable topsoil) and also on existing site soils / Made Ground. As described above, these areas of soft landscaping will be constructed as an integral element of the composite capping. In these areas an appropriate thickness of subsoil and topsoil will be provided primarily for horticultural / landscaping reasons, but also acting as a cap on the underlying Made Ground and thus ensure the protection of human health. A minimum thickness of 450mm of suitable topsoil and sub soil materials (in addition to any suitability requirements set out by the landscape architect) will be underlain by up to some 750mm of suitable soil materials.

It is likely that a proportion of the site-won soil materials will be suitable for reuse as topsoil / sub soil following treatment at the soil treatment facility. That material will be supplemented by topsoil imported from off-site. All topsoil will comply with British Standard 3882:2015 as a multipurpose soil with a defined granular or blocky structure and be free from non-soil material i.e. brick, other building materials, wastes, hydrocarbons, etc. that would render the topsoil unsuitable for use. All topsoil and sub soil to be used as part of landscaping areas will comply with the physical, biological and chemical parameters set out in Appendix C. Testing for both topsoil and subsoil would be carried out on representative samples at a frequency of one sample per 250m^3 for each material type, or a minimum of five samples per source to demonstrate compliance.

In the areas of ecological sensitivity (e.g. the marshes, grasslands, inter tidal habitats etc.) the design of the works will aim to reduce infiltration in areas underlain by hazardous soils materials (e.g. CKD) whilst also retaining the soils responsible for supporting the sensitive flora and flora. Such measures will include the creation of a topography and surface water drainage system, the incorporation of impermeable linings to standing water bodies (where appropriate), the incorporation of a suitable thickness of sub soil and topsoil particular to the relevant species. Earthworks in the vicinity of the River Thames (e.g. the creation of the extended areas of salt marsh) will be designed and carried out with safeguards to prevent the pollution of the River by silts, where comprised of CKD (e.g. by the provision of temporary coffer dams, by excavations from land rather than River, etc). In the longer term, the new intertidal habitat will have unhindered tidal exchange, require minimal management with capacity to respond to dynamic estuarine change. Similarly, the extended salt marsh level is set to facilitate natural colonisation, with silts washed into the new creeks providing the growing medium.

4.5 Built environment

Across much of the Resort, below ground infrastructure and utilities will be constructed through land affected by contamination (including residual contamination on remediated ground). These potential risks will be mitigated by:

- The construction of below ground "service corridors" – trenches large enough to carry several utilities, separated from the contaminated soils by a permanent barrier (e.g. HDPE membrane) and backfilled with inert fill;
- The design and construction of below ground concrete in accordance with BRE guidance [28] to address aggressive ground conditions;
- The design and construction of water supply pipework [in accordance with UKWIR [29] to mitigate the potential for contaminant permeation and tainting of potable water; and
- The design and construction of gas protection measures into building foundations and service corridors (in accordance with the relevant British Standard [30]) to mitigate the potential risks associated with hazardous ground gas.

4.6 Unforeseen contamination and UXO

Consideration of the Project Site's history together with the results of the various Desk Study reports indicate that notwithstanding the planned programme of ground investigation, there will remain a significant potential for unforeseen, more grossly contaminated materials (including landfill wastes) across much of the Kent Project Site. Such a potential also applies to the Essex Project Site, although given the nature of the Proposed Development here, that potential is substantially lower. The potential risks related to any such localised / gross or otherwise unforeseen contamination will be mitigated by the following management regime:

i. During earthworks, a 'watching brief' will be held by the responsible environmental engineer involving periodic inspection, appropriately recorded in a site diary. This will supplement daily records maintained by the Contractor;
ii. The Contractor's toolbox talk will alert the construction workforce to the potential for such unforeseen contamination. Encountering any such unforeseen contamination will require immediate cessation of excavation and notification of the Contractor's Site Manager and the Engineer;
iii. In the event of any such unforeseen contamination being encountered an appropriately qualified environmental specialist will visit the site/ area of excavation as soon as practicable (but within a maximum of 24 hours) to determine the need for and scope of any remedial action. Proposals for any such action (investigation, analysis, modelling, monitoring and remedial action if appropriate) will be discussed and agreed with the relevant Local Authority (and Environment Agency as appropriate) prior to implementation; and
iv. Any such action will be appropriately recorded and included in the relevant Verification Report.

The results of the current UXO risk assessments have indicated that there are potential risks related to UXO on both the Essex and Kent Project Sites. These risks can be mitigated by one or a number from a range of measures as appropriate, that will reflect both the location and the nature and extent of the below ground works. This range of measures includes:

- The preparation of operational UXO risk management plans (three such plans envisaged; the Essex Project Site, the Kent Project Site (Swanscombe Peninsula) and the Kent Project Site (Resort Access Road);
- UXO safety and awareness briefing for all personnel involved in below ground works;
- The availability of an "on call" explosive ordnance disposal (EOD) engineer and EOD banksman support; and
- Magnetometer survey ahead of piling and intrusive boreholes.

5 Additional local remediation

5.1 Essex Project Site

The nature of the ground conditions and of the nature of the Proposed Development on the Essex Project Site is such that no site-specific remediation / mitigation measures additional to the measures set out above will be required.

5.2 Kent Project Site (Swanscombe Peninsula)

On the Swanscombe Peninsula part of the Kent Project Site there are three elements that require particular measures to be implemented in addition to the site-wide Remediation Strategy, namely:

- The widespread occurrence of CKD;
- The presence of a leachate collection and management system over particular areas of the Kent Project Site; and
- The presence of areas subject to Environmental Permits.

5.2.1 CKD

The extent and properties (both physical and chemical) of the CKD in the several areas on the Swanscombe Peninsula (including the Swanscombe Peninsula SSSI) is currently not well defined. Some initial desk-based research has been carried out (Appendix A). The programme of ground investigation outlined above will address this data gap and will inform both the potential for treatment / beneficial re-use of CKD spoil arising from the earthworks. It is also likely that trials into treatment and re-use by specialist remediation contractors will be carried out which will include further investigation, testing and assessment. Assessment will also be carried out into the need for and scope of any particular remedial measures necessary to prevent contamination of the natural environment from the CKD (whilst also recognising that in the restored salt marsh area, these ground conditions have contributed to the particular ecological value of that part of the peninsula).

5.2.2 Leachate collection and management

The existing leachate collection and management system on the Swanscombe Peninsula is complex but relatively well understood. This current understanding is illustrated in the Surface Water Drainage Strategy ~~(Ref XXXXX~~. This existing system is not functioning as well as it could do and furthermore substantial elements of it will be disrupted / removed by the Proposed Development. The leachate management and treatment system will therefore require re-instatement and reconstruction as well as the creation of enhanced capacity.

Further investigations of the existing system are planned and these (together with consideration of the planned development) will inform the detailed design of the new and improved leachate collection, management and treatment system. Currently it is anticipated that the leachate treatment plant that serves the Broadness Marsh area will be adapted and upgraded to increase its treatment capacity. The conveyance channels around the Broadness Marsh area will be formalised and enlarged to capture the leachate and surface water runoff. The flows will be conveyed to open lined detention ponds and pumped to the upgraded plant.

The leachate treatment plant currently located within the South Pit area will be relocated to enable the Proposed Development. The most appropriate location for the plant and the required treatment levels will be considered during design development, including the option of pumping the leachate from the South Pit area to the upgraded Broadness Marsh leachate treatment plant.

5.2.3 Environmental Permits

There are several areas of this part of the Kent Project Site that are subject to Environmental Permits (former Waste Management Licences). Most of these have been subject to landfilling, but there are also permitted areas where no disposal has taken place. The existence of these Permits has particular implications that will be taken into account (assuming that the permits are likely to remain in force and will not be surrendered prior to construction), namely:

- The development must not compromise the permit holder's ability to manage and monitor the site in accordance with the permit and to continue to comply with the permit conditions;
- The Environment Agency must be notified (and approve) any proposals for ground investigation on these landfills; and
- The Environment Agency must be notified (and approve) the construction of any infrastructure on the permitted landfill which could affect the landfill cap, its profile and its management and monitoring regime.

5.3 Kent Project Site (Resort Access Road)

On the Resort Access Road works part of the Kent Project Site the presence of licensed landfills again presents elements that require particular measures to be implemented in addition to the site-wide Remediation Strategy. The regulatory / management constraints presented by the presence of licensed landfills and the particular mitigation measures needed to address them described above with respect to the Swanscombe Peninsula are equally applicable to the landfills on this part of the Kent Project Site (Bamber Pit, Northfleet Landfill and Southfleet Landfill) and also to those parts of this area that fall withing the Swanscombe Peninsula SSSI.

Particular mitigation will be applicable to all three affected landfills and to the areas within the designated SSSI (that will require the approval of Natural England. The construction of the Resort Access Road and the people mover route across Bamber Pit will involve the construction of a substantial cutting through the inert wastes of the southern flank of the pit and through the commercial / industrial wastes of the northern flank. This excavation will generate substantial volumes of spoil (much likely to be Hazardous Waste) but will also affect the existing leachate regime (there is no current collection / treatment system) and the landfill gas management system. The programme of ground investigation (seereferred to above) will address the need to provide site specific data (on the nature of the waste and the leachate and gas regimes) and will inform the need for and scope of any particular remedial design / construction measures necessary to prevent contamination of the natural environment and enable safe design and construction.

The construction of the Resort Access Road and the people mover route across Northfleet Landfill will involve some earthworks, although the design has aimed to minimise excavation and also to avoid as far as possible interference with the existing landfill cap and the leachate and gas management and monitoring regimes on the site (but with some managed impact upon the archaeology. The location of the existing landfill infrastructure is well defined (Appendix E) but will be supplemented by the programme of ground investigation referred to above and will address the need to provide supplementary data and will inform the need for and scope of any particular remedial design / construction measures necessary to prevent contamination of the natural environment, reinstate any existing control systems and enable safe design and construction.

There are also additional constraints with respect to an archaeologically sensitive site at Bakers Hole, a Scheduled Monument and a geologically designated Site of Special Scientific Interest (SSSI). The planning of the Resort Access Road and people mover routes have been promoted so as to minimise the impact upon these resources (whilst also reflecting the engineering constraints and those associated with the landfills and their environmental management).

The detail of the planned mitigation with respect to Bakers Hole is presented in Chapter 14: *Cultural heritage and archaeology* of the Environmental Statement ~~(document reference XXX)~~.

6 Monitoring and verification

6.1 Monitoring objective

Monitoring of the Proposed Development as it proceeds across the various areas of the Essex and Kent Project Sites will be carried out in order to:

- Record the works (earthworks, remediation and construction) as they are undertaken;
- Record any impact on surface water, groundwater or air quality;
- Record any nuisance (noise or dust);
- Record any unexpected contamination (including UXO) encountered during the works, together with any remedial action undertaken;
- Provide confirmation of successful implementation of the Remediation Strategy(ies); and
- Enable completion of Verification Reports.

6.2 Verification plan

The Verification activities undertaken for both the Essex and Kent Project Sites will be carried out by an appropriately competent and qualified organisations, independent of the contractors. The scope of works for the verification programmes will include:

- Collation of all relevant information available from contractors' reports, drawings and records. This will include data on the treatment / re-use of suitable soil materials, on source removal, on the waste management of spoil (contaminated and uncontaminated natural soils), management of groundwater etc;
- Inspection and recording of remediation and earthworks undertaken at site will be carried out by an appropriately competent and qualified persons independent of the contractors. This activity will span the whole period of the development with the period and frequency of inspection varying to suit the complexity and type of activity underway;
- Observation, inspection and recording of health, safety, hygiene and environmental management;
- Management of the soil sampling and testing necessary to demonstrate compliance with the agreed Criteria. Testing would be carried out on representative samples at the agreed spacing and frequency;
- Chemical analysis of soils and groundwater will be carried out by an appropriate specialist laboratory (with MCERTS / UKAS accreditation for relevant determinands). The chemical analytical suite will reflect the contaminants of concern relevant to each location on the Kent Project Site or Essex Project Site agreed with the relevant local authority and the Environment Agency;
- Management of the environmental monitoring programmes (groundwater, air quality, noise);
- Immediate response to any unexpected contamination (including UXO) being encountered;
- Continuing review of data and assessment of compliance with the agreed Remediation Strategy,
- Liaison with the local authority and Environment Agency; and
- Preparation of Verification Reports. A number of such reports is anticipated (for the various phases / areas) demonstrating how the work has been carried out in accordance with the approved strategy.

Once the contractor's Remediation Method Statements, and Construction Environmental Management Plans (CEMPs) are available, a detailed plan of the verification activities for each phase / area of the Proposed Development will be set out. This will identify the names and contact details of the relevant partied involved and define their roles and responsibilities. It will define the period and frequency of site inspections, the period and frequency of monitoring (air, dust and groundwater). It will identify the laboratories undertaking the chemical and geotechnical testing, and

the specialists carrying out monitoring. The detailed plans will identify all of the activities that will be necessary to demonstrate achievement of the remedial objectives of the works.

6.3 Recording

The verification data will be obtained, managed and stored by the contractor with copies also retained by the organisations responsible for the management of the activities and the preparation of the report. All chemical and geotechnical data will be obtained, retained and made available in AGS format.

6.4 Verification Reports

The overall objective of verification activity is to demonstrate that the remedial works have been carried out in accordance with the agreed Remediation Strategy and that the works have not given rise to any unacceptable impacts upon people or the environment. The verification activities will also provide evidence that:

- Planning / permit/ licence conditions have been met, and
- Environmental management goals have been met.

The verification reports will be prepared on completion of the works and will comply with relevant Environment Agency guidance [31]. The object of the reports is to provide authoritative documentary evidence of the remedial works. The reports will describe the area of the Project Site concerned, the remediation objectives, the techniques or processes employed and the verification / monitoring data in succinct text supported by as built drawings, figures and photographs etc.

References

[1] Environment Agency, Land Contamination Risk Management, 2020.

[2] HM Government, "Planning Act," 2008.

[3] HM Government, "Part 2A Environmental Protection Act," 1990.

[4] HM Government, "Contaminated Land (England) (Amendment) Regulations," 2012.

[5] HM Government, "The Waste (England and Wales) Regulations," 2011.

[6] HM Government, "The Environmental Permitting (England and Wales) Regulations," 2010.

[7] UK Government, National Planning Policy Framework, 2019.

[8] Buro Happold, London Resort. Preliminary Tunnel Impact Assessment., September 2020.

[9] Atkins, Paramount Park Entertainment Resort. Phase 1 Geo-environmental and Geotechnical Risk Assessment. Ref: 5134008/Phase I/FinalRev3.0., 2014.

[10] Atkins, Paramount Park Entertainment Resort. Phase 1 Geo-environmental and Geotechnical Risk Assessment (A2(T) Corridor and Access Roadway). Ref: 5139214/AdditionalPhase1/Rev1.0, 2015.

[11] Atkins, Paramount Park Entertainment Resort. Geotechnical and Geo-environmental Interpretive Report. Ref. 5139214/GIR/Draft/Rev1.0., 2015.

[12] Geotechnical Engineering Limited, London Paramount Entertainment Resort. Factual Report on ground investigation. Ref 30766., 2016.

[13] Buro Happold, The London Resort. Phase 1 Geo-environmental Assessment – Essex Project Site., 2020.

[14] Buro Happold, The London Resort. Phase 1 Geo-environmental Assessment Update – Kent Project Site (Swanscombe Peninsula)., 2020.

[15] Buro Happold (2020), The London Resort. Phase 1 Geoenvironmental Assessment Update – Kent Project Site (A2 Access Corridor)., 2020.

[16] Groundsure, Groundsure Insight Report for London Resort., 2020.

[17] WSP, Bamber Quarry Landfill Annual Report 2019., 2020.

[18] CMS Enviro (2, Peninsula Annual Report 2019., 2020.

[19] CMS Enviro, Northfleet Landfill Annual Monitoring Report, 2020.

[20] CL:AIRE, "NQMS for Land Contamination Management," [Online]. Available: https://www.claire.co.uk/projects-and-initiatives/nqms. [Accessed 03 November 2020].

[21] Environment Agency, Verification of remediation of land contamination. SC 030114/R1., 2010.

[22] CL:aire, The definition of waste: Development Industry Code of Practice. Version 2., 2011.

[23] CL:aire, The Definition of Waste; Development Industry Code of Practice. Cluster Guide, 2012.

[24] Health & Safety Executive, "Managing and working with asbestos L143," 2013.

[25] BSI, BS 8485:2015+A1:2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, 2019.

[26] CIRIA, C735. Good pracice on the testing and verification of protection systems for buildings against hazardous ground gases, 2014.

[27] Environment Agency, Piling and penetrative ground improvements methods on land affected by contamination: Guidance on pollution prevention. NC/99/73, 2001.

[28] Building Research Establishment, Concrete in aggressive ground. Special Digest 1, 2005.

[29] UK Water Industry Research, Guidance for the selection of water supply pipes to be used in Brownfield sites, 2010.

[30] British Standards Institute, Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. BS8485:2015+A1:2019, 2019.

[31] Environment Agency, Verification of remediation of land contamination. SC 030114/R1, 2010.

Appendix A – Use of cement kiln dust (CKD)

A.1 Introduction

Buro Happold carried out an initial review of the use of cement kiln dust (CKD) associated with the Proposed Development of the London Resort. The Project Site contains areas where CKD landfill is present as well as areas where CKD material has been placed across the Project Site including upon the Swanscombe Peninsula SSSI. The Proposed Development will involve substantial earthworks, including the excavation of CKD. One of the objectives of the Remediation Strategy is to maximise the beneficial re-use of spoil and to minimise disposal off-site. Any investigations and / or earthworks on these materials will required the approval of both the Environment Agency and Natural England. Accordingly, this Note presents the results of a desk-based review of available publications [see Reference List] on the potential for the use of CKD material in construction with a particular focus on the reuse of CKD material for earthworks (fill material).

The information reviewed suggests that in addition to its use in cement manufacture, there are three main uses of CKD material namely:

- Use within the agricultural industry (as a soil improver).
- Use as a fill material in earthworks.
- Reuse as a cement or supplementary product within construction material (e.g. block) manufacture.

A.2 Discussion

The predominant use of the CKD material on the Project Site would be for the use as an earthworks fill material. There are also potential benefits in using any CKD spoil arisings as part of a soil stabilisation treatment. Re-use of CKD will also reduce the financial costs and environmental impacts of importing soil materials from off-site. This potential for the reuse of CKD material for earthworks purposes, is subject to consideration and assessment of particular aspects, namely:

1. Consideration of mixing CKD with other materials / soil which may affect the leaching process based on the chemical properties of the materials (both CKD and soil / mixing agent).
2. Variance in concentrations of contaminants / chemicals within the individual CKD material and consideration should be made to include a large suite of testing criteria when testing the samples obtain from the Project Site.
3. CKD can be used in the stabilisation of soft clayey soil which typically reduces its plasticity and increases the optimum moisture content (OMC) and maximum dry density (MDD).
4. Treatment of the CKD material may be required prior to being used with other materials for earthworks on the Project Site. As such, testing of the CKD material on site is required to determine its properties and the need for and scope of any such re-use.

A.3 Conclusion and recommendation

The available information provides empirical based data for the use / reuse of CKD material and provides general characteristics of CKD which demonstrate potential benefits (technical, economic and environmental) of its use however, this material varies in composition from site to site.

Therefore, it is recommended that a site-specific investigation and assessment (including laboratory testing) is carried out to determine the composition and characteristic properties of the CKD material which are present at the Project Site for potential re-use.

A.4 References

Abo-Hashema, M. A. A. E.-A. a. M. A., Volume:19, Issue:2, December 2018. ENHANCING STABILITY OF CLAYEY SUBGRADE MATERIALS WITH CEMENT KILN DUST STABILIZATION. The International Journal of Pavement Engineering and Asphalt Technology (PEAT) ISSN 1464-8164., p. 19.

Ahmed Mancy Mosaa, A. H. T. L. A. A.-J., 2017. Improvement of poor subgrade soils using cement kiln dust. Case Studies in Construction Materials, p. 6.

Anil kumar, A. S., 2017. Stabilization of Soil using Cement Kiln Dust. International Journal of Innovative Research in Science, Engineering and Technology, p. 7.

Anon., 2004. The Essential Guide to Stabilisation/Solidification for the Remediation of Brownfield Land using Cement and Lime. Camberley: A Cement and lime industry publication.

Anon., n.d. User Guidelines for Wase and Byproduct Materials in Pavement Construction. [Online]

Available at: http://www.fhwa.dot.gov/publications/research/infrastructure/pavements/97148/032.cfm

[Accessed 14 August 2020].

Gerald A. Miller, M. M. Z. J. R. N. K. T., 1999. LABORATORY AND FIELD EVALUATION OF SOIL STABILIZATION USING CEMENT KILN DUST, Oklahoma: Oklahoma Department of Transportation.

Okeke, E. A. A. a. C. A., 2019. Clay soil stabilization using cement kiln dust. 1st International Conference on Sustainable Infrastructural Development, p. 11.

Robert L. Parsons, E. K. J. P. M., 2004. USE OF CEMENT KILN DUST FOR SUBGRADE STABILIZATION, TOPEKA, KANSAS: KANSAS DEPARTMENT OF TRANSPORTATION.

Santagata, A. S. a. M. C., 2006. DEVELOPMENT OF CRITERIA FOR THE UTILIZATION OF CEMENT KILN DUST (CKD) IN HIGHWAY INFRASTRUCTURES, Indiana : School of Civil Engineering, Purdue University.

Wayne S. Adaska, P. D. P. W. P. C. A. D. H. T. D. P. &. T. S. C. C., 2008. BENEFICIAL USES OF CEMENT KILN DUST. p. 19.

Appendix B – Soil Treatment

General

Current preliminary estimates suggest that for the Resort (including both Gates but excluding the Resort Access Road and any "marsh restoration" works) the total cut (volume of spoil arising from excavations) is approximately 860,000m^3 and the total requirement for fill is 490,000m^3. These initial and approximate volumes, although substantial, have been derived from modelling of the existing and planned topographies of the Swanscombe site, with the overall aim of minimising the volumes of excavation (particularly relating to contaminated and licenced land) whilst also being consistent with various other aspects (such as flood risk, accessibility, landscape aesthetics etc). The volumes are not "absolute", must be treated with caution and will change but, nonetheless, they are useful in assessing the scale of the work to be undertaken (including time and costs etc).

In an absolute worst case scenario, none of spoil from site will be suitable for use (chemically or geotechnically), requiring transport and disposal to an off-site landfill (classified as a mixture of Hazardous, Non Hazardous and Inert wastes) with a consequent requirement for the import of 725,000m^3 of primary and / or secondary aggregates. This would carry with it significant financial costs and environmental impacts (mainly associated with transport). Equally, an absolute best case would be that all spoil arisings could be re-used as fill on site and effectively avoiding most off-site environmental impacts.

A more realistic scenario is that a proportion of the spoil arisings will be directly suitable for re-use, a proportion will be suitable following treatment (on-site) and a proportion will not be suitable for re-use and would be disposed off-site to landfill. Currently a cautious approach is to assume that 40% of the spoil arisings is able to be re-used on site (either directly or following treatment). The treatment costs would be less than disposal but would still need to be factored in.

There are some particular issues associated with the potential beneficial re-use of any excavated cement kiln dust (CKD) which currently occupies large areas of the Peninsula (including the SSSI). These issues involve its physical and chemical properties and its potential as a fill material, and as an additive to treat / improve other soil arisings. Much of the published research on CKD is related to its potential for re-use in cement manufacture (see Appendix A). Any investigation and or earthworks involving CKD on the Peninsula will be subject to approval by the Environment Agency and Natural England.

Requirements

The main requirements to enable the most efficient re-use of spoil and minimising off-site disposal are:

1. Space, time and ambition to maximise beneficial re-use, minimise off-site disposal and minimise demand for primary aggregates;
2. Good definition of the existing ground conditions (location, type / nature, physical & chemical properties of the various soil types) from an appropriately designed and implemented ground investigation. [Note: 3,500 exploratory holes defined the earthworks on the Olympic Park];
3. Plan and track earthworks - Well defined, operated and recorded Materials Management Plans [soil sources, properties, treatments and destinations];
4. Rapid test techniques [field kit and on-site laboratory] and pragmatic on-site assessment to determine the fate of spoil arising: i) direct re-use, ii) treatment for re-use or iii) off-site disposal; and
5. Effective treatment (on-site) of unsuitable (physical & chemical) soils to render them suitable.

Soil Hospital

A soil treatment centre ("soil hospital") will be an on-site facility designed to provide several treatments techniques necessary to cope with the variable physical and chemical properties of the soils excavated from the earthworks. Such a facility will typically occupy some 2.5ha and likely to be in operation for a minimum of 1 year. The treatment techniques provided are likely to include; screening, sorting, stabilisation, washing, bioremediation and thermal treatments. Topsoil manufacture may also be possible.

The efficient use of the facility will balance the throughput of the soil arriving for treatment with the demand for fill, thus minimising the stockpiling of soils at either end of the process. Relevant data from the approach adopted for the London 2012 Olympic Park is summarised below as an example of volumes, rates and programme implications.

Initial discussions with specialist remediation contractors have confirmed interest and the potential for such a facility on the Kent Project Site.

Queen Elisabeth Olympic Park development 2007 – 2010.

By way of example, the following data is summarised from an account on the operation of a soil treatment facility that operated at the site of the London 2012 London Olympic Park.

Earthworks	2.2m m3 of cut and 2.2m m3 of fill in 3 years. Typically, 10,000m3 / week cut and 9,000m3 / week fill.
Soil washing	5No plants washing 12,000m3 / week [max]. Total 690,000m3 washed over 3 years
Stabilisation	30,000m3 treated in 13 weeks (>2000m3 / week)
Bioremediation	32,000m3 treated (biopiles and windrows) in 6-8 weeks
Sorting / screening	82,000m3 treated.

Reference: Mead I, Apted J, Sharif S. Delivering London 2012. Contaminated soil treatment at the Olympic Park. Proceedings of the Institute of Civil Engineers. Geotechnical Engineering Vol 166. 2012.

Appendix C - Soil Material Suitability Criteria.

General

All material that is re-used or that is imported into site, including geotechnical fill, topsoil and subsoil for landscaping, will be required to meet the parameters set out below. If any material is to be retained and reused, it should be stripped and stored in stockpiles which are separate from other stockpiled soils. Topsoil must not be stockpiled for longer than two years, after two years the stockpile is to be excavated, reconditioned and formed into a new stockpile. The following sets out an initial set of suitability criteria which will be subject to further review and confirmed in the final Remediation Strategy report(s).

Topsoil and Subsoil Specification

All topsoil and subsoil to be used as part of the landscaping areas (imported or site derived) must comply with the physical, biological and chemical parameters set out in the following sections. All topsoil must comply with British Standard 3882:2015 as a multipurpose soil (as set out in Table 1 of that Standard). The soil should be a clay loam as defined in BS3882:2015. The soil is to have a defined granular or blocky structure and be free from non-soil material i.e. brick, other building materials, wastes, hydrocarbons, plant matter, roots and rhizomes of perennial weeds and any other foreign matter or material or substance that would render the topsoil unsuitable for use. Topsoil must also contain sufficient nutrients that it allows plant growth as detailed in Table 2.

Table 1 Physical Parameters

Determinand	Unit	Sub soil	Topsoil
Clay (less than 0.002mm)	%	5 - 40	5 – 27
Silt (0.002 - 0.06mm)	%	5 - 60	5 -45
Sand (0.06 - 2.00mm)	%	20 – 65	50 - 90
Max. Stone Content (2 - 50mm)	% by weight	<50	<35
Max. Stone Size in any dimension	mm	75	30

Table 2 Soil Quality Parameters (suitability as a growing medium related)

Determinand	Unit	Concentration
pH value	pH units	5.0 - 8.0
Electrical Conductivity (1:2.5 extract)	µS/cm	100 to 1500
Organic Matter	%	4.0 – 15.0
Total Nitrogen	%	>0.2
Extractable Phosphorus	mg/l	>26
Extractable Potassium	mg/l	>240
Extractable Magnesium	mg/l	>50

Chemical (contamination related) Parameters

Table 3 below details the chemical compounds that require testing for each sample and also details the maximum permissible average concentration of those compounds (i.e. the US^{95} average value). In the first instance the values have been derived from the LQM Suitable for Use Levels (S4UL) or the phytotoxic values and with lead C4SL values have been used. Topsoils and near surface soils to be re-used must comply with residential thresholds. Materials below the marker layer must comply with the thresholds shown in square brackets (e.g. Arsenic [640]). In addition to complying with these individual parameters, any soils to be re-used or used as fill on the Project Sites must not be capable of being classed as Hazardous Waste or exceed the leachate criteria set out in Table 4.

Table 3 - Chemical (contamination related) Parameters

Determinand	Concentration (mg/kg)	Determinand	Concentration (mg/kg)
Arsenic	40[2] [640]	Cadmium	85[1] [410]
Chromium (total)	910[1] [8600]	Lead	310[2] [2330]
Mercury	56[1] [58]	Selenium	430[1] [12,000]
Boron	11000[1] [240,000]	Copper	200[3] [68,000]
Nickel	40[1] [980]	Zinc	300[3] [730,000]
Naphthalene	2.3[1] [190]	Benzo[a]anthracene	11[1] [170]
Acenaphthylene	2900[1] [83,000]	Chrysene	30[1] [350]
Acenaphthene	3000[1] [84,000]	Benzo[b]fluoranthene	3.9[1] [44]
Fluorene	2800[1] [63,000]	Benzo[k]fluoranthene	110[1] [1,200]
Phenanthrene	1300[1] [22,000]	Benzo[a]pyrene	3.2[1] [35]
Anthracene	31000[1] [520,000]	Indeno[123-cd]pyrene	45[1] [500]
Fluoranthene	1500[1] [23,000]	Dibenzo[ah]anthracene	0.31[1] [3.5]
Pyrene	3700[1] [54,000]	Benzo[ghi]perylene	360[1] [3,900]
TPH aliphatic >C5-C6	42[1] [3,200]	TPH aromatic >C5-C7	370[1] [26,000]
TPH aliphatic >C6-C8	100[1] [7,800]	TPH aromatic >C7-C8	860[1] [56,000]
TPH aliphatic >C8-C10	27[1] [2,000]	TPH aromatic >C8-C10	47[1] [3,500]
TPH aliphatic >C10-C12	130[1] [9,700]	TPH aromatic >C10-C12	250[1] [16,000]
TPH aliphatic >C12-C16	1100[1] [59,000]	TPH aromatic >C12-C16	1800[1] [36,000]
TPH aliphatic >C16-C35	65000[1] [1,600,000]	TPH aromatic >C16-C21	1900[1] [28,000]
Free cyanide	760[1] [16,000]	TPH aromatic >C21-C35	1900[1] [28,000]
Benzene	0.38[1] [27]	Toluene	880[1] [869]
Ethylbenzene	83[1] [518]	Xylene	79[1] [576]
		Asbestos	No detectable fibres above trace levels*

[1] Value derived from LQM Suitable for Use Levels
[2] Value derived from Category 4 Screening Levels
[3] Value derived from British Standard BS3882:2007
* Trace levels defined as occasional sporadic occurrence typically at concentrations less than the limit of quantification (<0.001%).

Table 4 - Threshold concentrations for leachable material

Determinand	Concentration	Determinand	Concentration (mg/kg)
Arsenic	50(µg/l) [1] or 0.5mg/kg [3]	Cadmium	5(µg/l) [1] or 0.04mg/kg [3]
Chromium (total)	50(µg/l) [1] or 0.5mg/kg [3]	Lead	20(µg/l) 1 or 0.5mg/kg [3]
Mercury	1(µg/l) 2 or 0.01mg/kg [3]	Selenium	10(µg/l) 2 or 0.1mg/kg [3]
Lead*	20(µg/l) 1 or 0.5mg/kg [3]	Copper*	28(µg/l) 1 or 2mg/kg [3]
Nickel*	200(µg/l) 1 or 0.4mg/kg [3]	Zinc	125(µg/l) 1 or 4mg/kg [3]
Antimony	5(µg/l)2 or 0.06mg/kg [3]	Cyanide	50(µg/l) [2]
PAHs Sum UK Four	0.1(µg/l) [2]	Benzo(a)pyrene	0.7ug/l 4
Naphthalene	10ug/l [1]	EPH	10(µg/l) [2] or 500mg/kg [3]
Chloride	250 (mg/l) [2] or 800mg/kg [3]	Sulphate	250 (mg/l) [2] or 1000mg/kg [3]
Ammonia	500(µg/l) [2]	Nitrate	50 (mg/l) [2]
Phenol Index	1mg/kg [3]		

* Hardness dependant [Based on hardness >250mg/l]

1 Environmental Quality Standard

2 UK Drinking Water Standard

3 Landfill waste acceptance criteria - inert waste

4 WHO Drinking water standard

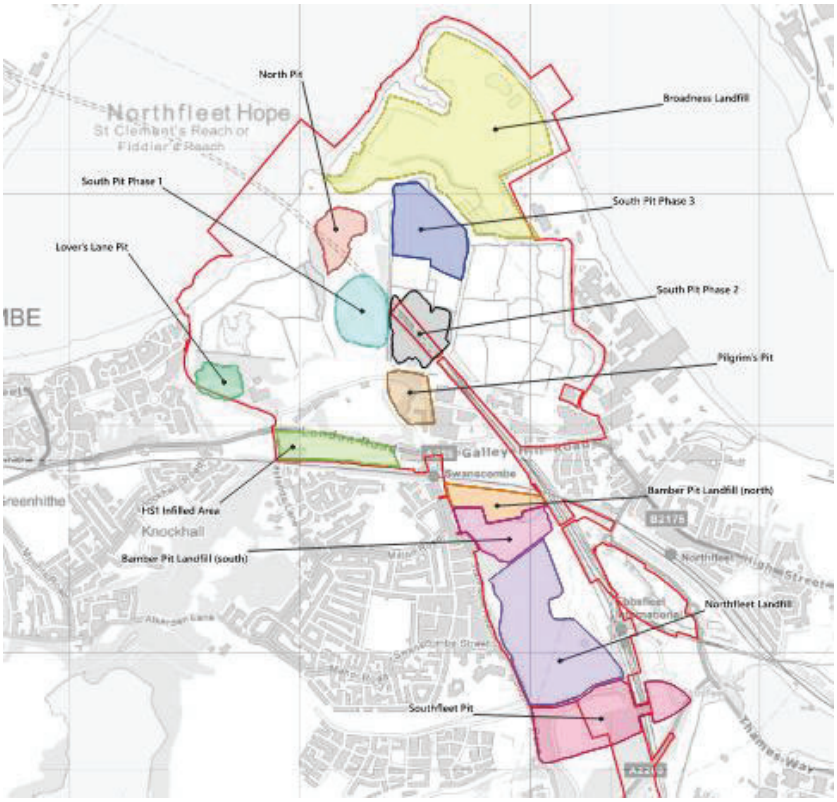
Appendix D Environment Agency comments on permitted landfills

The following text is derived from discussions and information provided by the Environment Agency in 2017 (and conformed still to be relevant following discussions held in 2020. The following permitted landfills are located within the Kent Project Site (as shown in the figure below – taken from the Environmental Statement [Figure 18.3].

1. South Pit and surge pile and south pit phase III (located in the area that will be developed into the Leisure Core). These two landfills mainly accepted cement kiln dust. Both of the landfills have no basal engineering. There is no gas management system at either of the two sites. There is ongoing leachate management;
2. Bamber Pit (located in the area that will be developed as parklands). Bamber Pit is a non-engineered landfill that mainly accepted paper waste. There is no leachate management system at the site. The site has a gas management system;
3. Northfleet (located within the area that will be developed as parklands, future development by others and replacement parking facilities). Northfleet landfill has no basal engineering. The site mainly accepted household waste. The site has a gas management system but no leachate management system.
4. Southfleet landfill (located south of Northfleet landfill and relevant to the Resort Access Road works.

All sites have a network of in-waste and perimeter monitoring boreholes.

A recovery permit is also located within the Project Site at Northfleet lake (located within the DCO Order Limits that is not identified for development).



Permit Surrender

It is unlikely the permits for the sites listed above can be surrendered immediately or in the near future. In order to surrender a landfill permit the landfill operator is required to satisfy the Environment Agency that:

- The site has ceased accepting waste;
- Relevant closure procedures have been complied with;
- An appropriate period of aftercare has passed to allow the waste to stabilise and to gather evidence to demonstrate that the pollution control measures are no longer necessary; and
- The deposits of waste are in a satisfactory state that, if left undisturbed, will not cause pollution to the environment.

The Environment Agency advise that the following document should be referred to for further information: "Landfill (EPR 5.02) and other permanent deposits of waste: how to surrender your environmental permit". As the permits are likely remain in force, the landfill operator will need to ensure they remain compliant with all permit conditions if the site is developed.

Site Development

Developments proposed on top of permitted landfills must not compromise the operator's ability to manage and monitor their site in accordance with their permit. The Environment Agency must be notified by the landfill operator before any infrastructure is installed, if the development is likely to have an impact on:

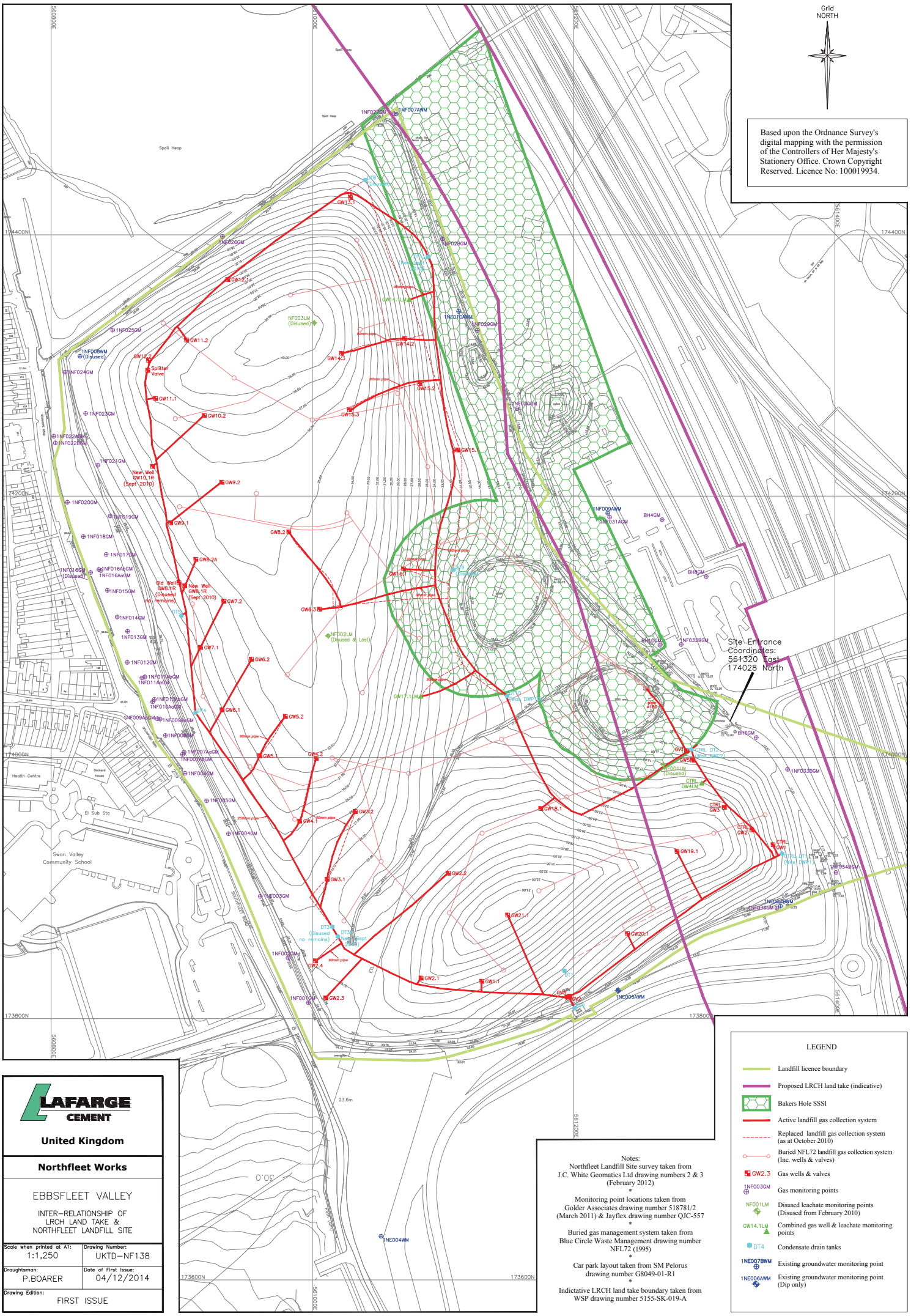
- The inspection, maintenance and / or integrity of the landfill cap;
- The restoration profile;
- Landfill gas management, including;
  - Monitoring fugitive emissions;
  - Gas abstraction infrastructure, including replacement; and
  - In-waste gas monitoring;
- Maintenance and monitoring of leachate infrastructure;
- Maintenance and monitoring of groundwater infrastructure;
- Surface water management and / or the quality of run off,
- Obtaining topographic surveys;
- Any monitoring to provide evidence that the waste is 'stable' for a surrender application;
- Access by appropriate vehicles for any of the above (for example drilling rigs); and
- Site security.

Landfill operators must put procedures in place to ensure they continue to comply with their permit conditions (and Landfill Directive, article 13(c) requirements, where applicable). The Environment Agency will require a construction quality assurance (CQA) plan where an engineered cap is present.

At design stage, if boreholes are required to be drilled through landfills, proposals for these works must to be submitted by the landfill operator to the Environment Agency. These proposals should include how the works will be undertaken to ensure impacts on the environment are minimised (e.g. no drilling through the base of landfill).

The Environment Agency strongly recommend that liaison and discussions are held with the operators of these landfills to confirm the existing infrastructure to help inform the design options.

Appendix E Northfleet Landfill Infrastructure



LAFARGE CEMENT

United Kingdom

Northfleet Works

EBBSFLEET VALLEY

INTER-RELATIONSHIP OF LRCH LAND TAKE & NORTHFLEET LANDFILL SITE

Scale when printed at A1:	Drawing Number:
1:1,250	UKTD-NF138
Draughtsman: P.BOARER	Date of First Issue: 04/12/2014
Drawing Edition: FIRST ISSUE	

Hugh Mallett
Buro Happold Limited
17 Newman Street
London
W1T 1PD
UK

T: +44 (0)207 927 9700
F: +44 (0)870 787 4145