15. Ground Conditions, Soil and Contamination

15.1 Introduction

15.1.1 This chapter details the potential receptors and likely significant environmental effects of the Proposed Development in terms of ground conditions and land contamination.

15.1.2 It describes the baseline conditions at the Application Site and its surrounding area and examines the likely significant environmental effects and mitigation measures required to offset any significant adverse effects. It also considers the likely residual significant environmental effects after these measures have been implemented.

15.1.3 The likely significant effects relate to two key areas, physical aspects relating to: topography, geological conditions and geomorphological features; and soil contamination aspects relating to the likely significant effects of pollution on human health, controlled waters, ecology and other receptors.

15.2 Policy Context

National Policy
Planning Policy Statement 23: Planning and Pollution Control,
Annex 2: Development on Land Affected by Contamination, (2004) [1]

15.2.1 The Government policy on development on land affected by contamination is set out in Planning Policy Statement 23 (PPS23). PPS23 states that the developer should demonstrate that the Site can be developed to a minimum standard whereby the Site could not be designated as contaminated land under Part IIA of the Environment Act 1990.

15.2.2 A potential developer will need to satisfy the local authority that unacceptable risk from contamination will be successfully addressed through remediation without undue environmental impact during and following the development.

15.2.3 Environmental Protection Act (1990) [2]
The main legislation with regards to the clean up of historic contamination is contained within Part IIA of the Environmental Protection Act (EPA) 1990 (HMSO, 1990). Section 78A(2), EPA 1990 provides the definition of contaminated land for the purposes of Part IIA which is 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused; or pollution of controlled water is being, or likely to be caused'. Harm is defined as meaning

'harm to health of living organisms or other interference with the ecological systems of which they form part and in the case of man includes harm to his property'.

15.2.4 The potential for harm is based on the presence of three factors:

- Source: Substances that are potential contaminants or pollutants that may cause harm;
- Pathway: A potential route by which contaminants can move from the source to the receptor; and
- Receptor or target: A receptor that may be harmed, for example the water environment, humans, flora and fauna.

15.2.5 Where a source, pathway and target are all present a pollutant linkage exists and there is potential for harm to be caused. However, the presence of measurable concentrations of contaminants within the ground and subsurface environment does not automatically imply that a contamination problem exists, since contamination must be defined in terms of pollutant linkages and unacceptable risk of harm.

15.2.6 The nature and importance of both pathways and receptors, which are relevant to a particular Site, will vary according to the intended use of the Site, its characteristics and its surroundings.

15.2.7 The key principle which underpins this approach is the 'suitable for use' criterion. This requires remedial action only where contamination is considered to pose unacceptable actual or potential risks to health or the environment and appropriate and cost effective remediation techniques exist, taking into account the actual or intended use of the Site.

15.2.8 Planning Policy Guidance 14 – Development on Unstable Ground (1990)
PPG14 states that the developer should make a thorough investigation and assessment of the ground to ensure that it is stable or that any actual or potential instability can be overcome by appropriate remedial, preventive or precautionary measures. Where there are reasons for suspecting instability, the developer should determine by appropriate site investigations and geotechnical appraisal whether:-

- the land is capable of supporting the loads to be imposed;
- the proposed development will be threatened by unstable slopes on or adjacent to the site;
- the proposed development will initiate slope instability which may threaten its neighbours;
- the site could be affected by ground movements due to natural cavities; and

- the site could be affected by ground movements due to past, present or foreseeable future mining activities.

Regional Policy

The London Plan, Consolidated with Alterations since 2004, (February 2008)

15.2.9 Policy 4A.33 Bringing contaminated land into beneficial use states that:

"The Mayor will work with strategic partners to enhance remediation of contaminated sites and bring the land into beneficial use."

"4.94 The principle of sustainable development means that where practicable, brownfield sites including those affected by contamination should be recycled into new uses. Such recycling also provides an opportunity to deal with the threats posed by contamination to health and the environment. The re-use of brownfield sites is a key objective running throughout this plan. Any land which is affected by contamination, whether or not identified under the regulations, may require measures to prevent contamination being activated or spread when building takes place."

15.2.10 The London Plan, Consultation Draft Replacement Plan (October 2009)
Policy 5.18 Construction, excavation and demolition waste states that:

Planning decisions
A. New construction, excavation and demolition (CE&D) waste management facilities should be encouraged at existing waste sites, including safeguarded wharves, and supported by:
a using mineral extraction sites for CE&D recycling
b ensuring that major development sites are required to recycle CE&D waste on-site, wherever practicable, supported through planning conditions.
B Waste should be removed from construction sites, and materials brought to the site, by water or rail transport wherever that is practicable.

Local Development Framework preparation
C Local Development Frameworks should require developers to produce site waste management plans to arrange for the efficient handling of CE&D waste and materials.

15.2.11 Policy 5.21 | Contaminated land states that

Strategic
A The Mayor supports the remediation of contaminated sites and will work with strategic partners to bring contaminated land to beneficial use.

Planning decisions
B Appropriate measures should be taken to ensure that development on previously contaminated land does not activate or spread contamination.

LDF preparation
C LDFs should encourage the remediation of contaminated sites and set out policy to deal with contamination.

Local Policy

London Borough of Lewisham Unitary Development Plan (2004)

15.2.12 ENV.PRO 10 Contaminated Land states that:

"Where development is proposed on contaminated land, or land suspected of being contaminated, the Council will require developers to investigate and identify any remedial measures that may be required to deal with the hazards."
"Full details of proposals for remedial treatment will be required before a planning application is considered. Where necessary, the Council may appoint independent consultants to assess such proposals."

15.2.13 The Lewisham Local Development Framework Core Strategy Submission Version (October 2010) SE9 Development on Contaminated Land states that:

"Where development is proposed on contaminated land, or land suspected of being contaminated, the Council requires the developers to:

(a) submit a contaminated land survey

(b) identify any contamination of land and provide details of proposed remedial treatment which can be required as a condition on a planning application or through a planning obligation."

15.2.14 The key message from national, regional and local policies is that redevelopment of brownfield and contaminated land for beneficial use should be supported through the planning system.

15.2.15 Local Authorities will use the planning system through the use of conditions to ensure that brownfield sites are redeveloped safely and can no longer be classified as Contaminated Land. It is the developer's responsibility to identify and manage the risks arising from contaminated land and to demonstrate to the Local Authority that they can be mitigated.

15.3 Methodology and Assessment Criteria

15.3.1 The assessment is based on a review of Phase I desk based studies completed by BWB for the Site and reported in the BWB Phase 1 Geo-environmental Assessment Report reference NTW321SE/01/V1, dated September 2010, which is reproduced as Technical Appendix 15.1.

15.3.2 The desk study report includes a review of historical ordnance survey plans, published geological mapping, borehole logs provided by the British Geological Survey for the Site and published regulatory information presented in a Groundsure Report reference HMD-214-945273, 945274 and 945275.

15.3.3 The interpretation of data in the context of ground conditions and contamination will comprise the following:

- Assessment of the data in the form of baseline survey i.e. reported and historically proven ground conditions and likely contaminants identified from the conceptual Site model;
- Identification and evaluation of likely significant effects with respect to anticipated ground conditions and likely contamination on the Proposed Development;
- Assessment of the construction process in terms of effects on land contamination and the effects of land contamination on the construction process;
- Discussion of likely mitigation measures including any remedial activities that would reduce significant environmental effects arising from the Proposed Development to acceptable levels; and
- Statement on any residual significant environmental effects both positive and negative from the proposals following implementation of likely mitigation measures.

15.3.4 This assessment follows the process set out in Environment Agency report CLR11 "Model Procedures for the Management of Land Contamination"[3]. CLR11 sets out the key requirements for each step in the assessment and subsequent remediation of land contamination.

15.3.5 Land contamination has been assessed using a risk assessment approach. A significant risk only exists where a 'source – pathway – receptor' pollutant linkage is present. The significance of the risk depends on the severity of the harm caused and the likelihood of the harm occurring.

15.3.6 A pathway is defined as a mechanism or route by which a contaminant comes into contact with, or otherwise affects a receptor. Pathways by which the identified receptors may be impacted upon in the context of the Proposed Development are identified as follows:

- Ingestion;
- Skin contact;
- Inhalation;
- Inhalation of vapour indoors and outdoors;
- Direct contact by buried structures;
- Limited leaching of soluble contamination into groundwater;
- Saturated zone flow through Principal and Secondary A Aquifer; and
- Accumulation of potentially explosive/lethal gas within confined spaces.

15.3.7 Definition of Significance

Receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely or positively impacted by the geology and ground conditions. The sensitivity of the receptor is proportional to the relative importance or resource value of the receptor and the geographical location of the receptor in relation to the Site. The importance of the receptor is expressed using the terms in Table 15.1.

15.3.8 When considering Geology and Ground Conditions, receptors will generally/predominantly fall within the local/immediate importance. In the context of the assessment of significant Environmental Effects receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by contaminant(s) or through physical interaction with ground conditions.

Human Health

- End users of the Site –residential, commercial and community;
- Construction workers, maintenance and ground staff;
- Off site residential users in housing developments adjacent to the Site, and
- Football fans using the Site.

Controlled Waters

- Principal, Secondary A and undifferentiated Aquifers beneath the Site
- Non-potable abstraction point 340m to the south.

Construction Materials

- Buried foundations and services.
- South Bermondsey Railway Station
- Railway line embankments forming the southwestern and northern Site boundaries.
- Millwall FC Stadium.

Table 15.1 Methodology for Determining Importance of Receptors

Importance	**Area**
International	Not Applicable
Regional	Underlying Principal Aquifer, River Thames catchment
Local / Immediate	Site Drainage system, utilities, substructures, Site users including future residents, workers and construction workers. Underlying Secondary A Aquifer and Principal.

15.3.9 The scale of the effects is defined under the terms given in Table 15.2 below:

Table 15.2: General Methodology for Scale (Magnitude) of Effects

Scale of Impact	**Description**	**Topic Description**
High	Effects resulting in a considerable change in baseline environmental conditions	A significant change in environmental or physical risk to human health and controlled waters due to the change in use of the Site leading to contamination of the soil and groundwater environment. Generation of large volume of hazardous and non-hazardous waste materials for disposal off-site.
Medium	Effects resulting in a discernable change in baseline environmental conditions	A noticeable change in environmental or physical risk to human health and controlled waters due to the change in use of the Site leading to contamination of the soil and groundwater environment. Generation of hazardous and non-hazardous waste materials for disposal off site.
Low	Effects resulting in a discernable change in baseline environmental conditions which can be tolerated	A barely perceptible change in environmental or physical risk to human health and controlled waters due to the change in use of the Site. Generation of non-hazardous waste materials for disposal off site.
Negligible	No discernable change	An imperceptible change in environmental or physical risk to human health and controlled waters due to the change in use of the Site. No disposal of waste materials off site.

15.3.10 By considering the importance of the receptor with the scale of the effects the 'significance' of the effects can be assessed by using the matrix in Table 15.3:

Table 15.3 – Dependence of Significance on Magnitude and Sensitivity

MAGNITUDE	**High**	Moderate	Moderate/major	Major
	Medium	Minor/moderate	Moderate	Moderate/major
	Low	Minor	Moderate	Moderate
	Negligible	Minor/no effect	Minor/moderate	Minor/moderate

	Low	Medium	High
	VALUE AND SENSITIVITY		

15.3.11 The significance of the impact is further defined by considering the nature of the effects, as shown in Table 15.4:

Table 15.4 – Definition of Significance

Significance	**Definition**
Major adverse	The effect is large scale, giving rise to great concern. It may be considered unacceptable. E.g. long term pollution of the Principal Chalk aquifer
Moderate adverse	The effect gives rise to some concern but it is likely to be tolerable in the short term. E.g. long term pollution of the Secondary A aquifer.
Minor adverse	The effect is small scale and of little concern, being undesirable but acceptable. E.g. Short term pollution of controlled waters
Minor beneficial	The effect is small scale and of slight significance, providing some benefit to the environment.
Moderate beneficial	The effect provides positive gain to the environment.
Major beneficial	The benefit is large scale, providing a significant positive gain to the environment.

Study Area

15.3.12 Data from Historical Ordnance Survey Maps and regulatory information contained in the Groundsure, Enviroinsight and Geoinsight Report has been used in the assessment of ground conditions and land contamination. The use of the Environment Agency's maps has assisted in identifying the Aquifer designations in which the Application Site lies. The assessment of water quality and the risk to any groundwater or aquifers in the area has also been examined on the Environment Agency's maps.

Consultations

15.3.13 An ES Scoping Report was submitted to the Local Authority. A response was received from the LB Lewisham (LBL) dated 14 July 2010 reference 10/74106 (Technical Appendix 1.2). The LBL response also took into account consultation with the Environment Agency.

15.3.14 LBL were keen to ensure that the EIA was not just a risk assessment and assessed all environmental effects, including for example physical effects of railway embankments surrounding the Site. The assessment should include both incorporated mitigation and additional mitigation measures.

15.3.15 LBL Requested that environmental effects for an interim construction scenario taken as a snapshot after completion of Phase 1a and 1b of the development should be assessed.

15.3.16 In addition, as part of the desk study, the Environment Agency was contacted in order to obtain information regarding the Site, which is presented as Appendix 6 of the Phase 1 report (Technical Appendix 15.1) and summarised below:

- No site specific information for the Site was available however numerous site investigations have been completed for surrounding sites.
- A former railway line that ran across the Site, has been investigated to the south and was found to be impacted by low levels of heavy metals and hydrocarbons in the soil and low levels of the hydrocarbons within the groundwater. The Environment Agency did not require any remedial works.
- Several sites to the north east were known to have heavy metal and hydrocarbon ground contamination issues however no remedial works have been conducted.
- A gas works 500m west of the Site is known to have hydrocarbon contamination issues within the soil and groundwater. The Environment Agency are currently undertaking remedial works at the site. A site to the north of the gas works is known to have been remediated.

Uncertainty/ Assumptions

15.3.17 The assessment is based on desk based information on the history of the Site and ground conditions and observations made during a site walkover. BGS Borehole logs from recent investigations in the vicinity of the Site have been obtained to provide more detailed ground conditions information. At this time no intrusive investigation has been undertaken to confirm the ground conditions or presence of potential contamination sources. In order to provide a robust assessment of likely significant environmental effects the assessment therefore errs on the side of caution.

15.3.18 A Phase 2 report/s, detailed quantitative risk assessment and remediation strategy will be provided prior to construction, and is expected to be the subject of an appropriate planning condition.

15.4 Aspects of the Proposed Development of Relevance to the Assessment

15.4.1 Worse Case Scenario

The worst case scenario is assumed to comprise areas of permeable soft landscaping and extensive basement car parking. In the absence of quantitative ground investigation data we have assumed that mobile persistent contaminants are present in the shallow made ground which are migrating into the Secondary A aquifer and subsequently down into the Chalk Principal Aquifer. Volatile contaminants and ground gases are present at levels that may be toxic or explosive. All soils that are excavated for basement construction are either hazardous or non-hazardous.

15.4.2 This would present the highest potential for groundwater to be contaminated by infiltrating rainfall leaching contaminants into the aquifer. Mitigating against effects to groundwater once realised may take many months and may in some cases be technically unfeasible.

15.4.3 The Proposed Development will require a significant earthworks programme to create development platforms and basements, which could mobilise contamination to the wider site area and underlying aquifer. The construction of extensive basement car parks, which will generate a significant volume of soil and will require disposal off site either as hazardous or non-hazardous waste.

15.4.4 Construction of multi-storey developments will require foundations to be taken to deeper strata potentially creating pathways by which contamination may impact upon the underlying aquifer. Areas of permeable soft landscaping will create pathways between soil contaminants and humans and increase infiltration of rainfall into the ground.

15.5 Baseline Situation

15.5.1 Site Description

The Site is occupied by the Millwall FC Stadium, several small commercial estates located to the north west, south and south east, which are predominantly utilised for Class B uses, the Lions Centre and some live/work and residential uses to the south. The Site is bounded by raised railway lines to the west and north east with several waste transfer stations located to the north and east of the Site with the remainder of the surrounding area occupied by houses.

15.5.2 Site History

The Site has historically been occupied by a mixture of residential housing and heavy industry. The Grand Surrey Canal previously passed through the centre of the Site along what is now Surrey Canal Road. The Site was subsequently developed between the 1970s and 1990s with the construction of the Millwall FC Stadium, starter commercial units in the north west and the infilling of the Surrey Canal. The surrounding area has seen a range of land uses typical of a city centre location, including a gas works to the west present until the 1960s and a glass works to the south present until the early 1980s.

15.5.3 Regulatory Review

A review of regulatory information has indicated a legacy of current and historical industrial uses on and off the Site including multiple waste transfer stations, scrapyard and the backfilling of the former canal with a mixture of waste materials. Depending on the operational practices of these facilities and the direction of the groundwater flow, the identified activities may potentially have a detrimental impact upon the Site environment.

15.5.4 Geology, Hydrogeology and Hydrology

Based on borehole logs provided by the British Geological Survey the Site is anticipated to be underlain by a significant thickness of made ground (recorded on BGS logs at between 1.8m and 3.3m deep) overlying drift deposits of alluvium and Kempton Park Gravel to depths between 6m and 8m bgl. The underlying bedrock is anticipated to consist of chalk with bands of flint of the Upper Chalk Formation.

15.5.5 The nearest surface water feature is Southwark Pond, located approximately 600m to the north. The River Thames is located approximately 750m to the north east.

15.5.6 The Kempton Park Gravel and alluvium have been classified by the Environment Agency as Secondary A and undifferentiated Aquifers, whilst the Upper Chalk is classified as a Principal Aquifer. The Site is however not located within a Source Protection Zone (SPZ). Groundwater flow is anticipated to be towards the River Thames to the north.

15.5.7 Information contained within an Environment Agency Environmental information request has indicated the following:

- Groundwater within the Kempton Park Gravel is expected at depths between 4-5m below ground level (bgl), flow direction unknown
- Groundwater within the chalk aquifer is expected at 10-12m bgl flowing to the north.
- There is no impermeable layer between the two groundwater bodies and perched groundwater would be able to leak into the Chalk Aquifer.

Potential Contamination Sources

On Site:

- Made ground from residential and industrial/commercial uses – predominantly petroleum / polyaromatic hydrocarbons, some heavy metals and asbestos.
- Backfilled Canal – heavy metals, petroleum / polyaromatic hydrocarbons, carbon dioxide and methane.
- Japanese Knotweed – located on and off Site (also referred to in Chapter 17 of this ES).
- Railway Lines – limited petroleum / polyaromatic hydrocarbons.
- Timber yard, tar paving and leather cleaning works including ancillary tanks – heavy metals, long chain hydrocarbon fractions, Semi Volatile Organic Compounds (SVOCs, creosote), VOCs, plasticisers and asbestos.
- Tank associated with large warehouse – petroleum / polyaromatic hydrocarbons.
- Electrical substations – polychlorinated biphenyls (PCBs).
- Alluvial Deposits – methane and/or carbon dioxide.

Off Site:

- Gas Works to the west and Glass Works to the south east high pH, ammonia, petroleum / polyaromatic hydrocarbons and heavy metal contaminants.
- Surrounding industrial uses – heavy metals, petroleum / polyaromatic hydrocarbons.
- Railway sidings – petroleum / polyaromatic hydrocarbons and herbicides.
- Electrical substations – PCBs.
- Waste Transfer/ incinerator – dioxins, heavy metals and PAHs.

15.6 Identification and Assessment of Effects

15.6.1 Construction Effects

The potential significant environmental effects associated with the construction phase relate to exposure of the soil due to site preparation, earthworks and foundation construction.

15.6.2 Following demolition of existing units and stripping of hardstanding, the ground surface will become exposed and shallow contamination may be mobilised by the action of wind, rainfall and trafficking of the Site by construction vehicles. Excavation of basements may expose underground structures including former drainage, disused underground storage tanks (USTs)

and asbestos. This may lead to migration of soluble contaminants into the underlying Secondary A and Principal Aquifers and increased exposure to humans including construction workers, visitors including users of Millwall FC stadium and nearby residents. Breaking out of slabs, footing and roadways will be sequenced to limit the potential for mobilisation of contaminants. The effect on humans will be short term and on a local level and may range from nuisance effects such as odours to health effects on sensitive members of the population. The effect on groundwater may be short term to long term, as different contaminants will be attenuated at different rates. The effect is likely to be local and could range from an imperceptible change in water quality to gross contamination by free product.

15.6.3 Local short term minor adverse effects may arise from dewatering of basements. Depending on the permeability and groundwater flows in the gravels this may require well points and or sheet piling to restrict ingress into excavations. Over pumping may cause removal of the fine silt and sand fraction from gravels which could cause settlement on neighbouring plots.

15.6.4 Medium term local to regional minor to moderate adverse effects arise from the construction of basements that will require offsite disposal of excess soils. The excavated soils are expected to comprise non-hazardous and hazardous waste. Pre treatment of wastes may be required to reduce contaminant concentration or stabilise excavated soils. There are significant permanent and temporary adverse environmental effects from using landfill space and from extensive road haulage to landfill.

15.6.5 Short to medium term minor adverse local effects arise from the weathering of stockpiled soils particularly during the winter months increasing mobilisation of particulates into the drainage system and underlying aquifers. The effect from particulates entering controlled waters may be aesthetic only to causing chemical pollution where the sediments are contaminated. Soil structure will be damaged and may lead to materials becoming geotechnically unsuitable and requiring stabilisation to render them useable or as a worst case requiring off site disposal.

15.6.6 Short to medium term minor to moderate adverse local effects arise from construction of piled foundations, which may create pathways through which contamination may migrate into the Secondary A and Principal Aquifers. Driven piles may also drag contamination down into the aquifer.

15.6.7 Short term local minor adverse effects may arise from earthworks near to the railway embankments may create slope instability through increased saturation of soils and where the sides of the excavation are unsupported or inappropriately benched.

15.6.8 Short to medium term local minor adverse effects may arise from poorly controlled bulk earthworks leading to spreading of Japanese Knotweed Rhizomes across the Site.

15.6.9 Interim Construction Scenario

Following completion of Phase 1a and 1b, the bulk of the remediation of soil and groundwater is expected to have been completed at this stage. The environmental effects identified in the construction phase as described in Sections 15.6.1 to 15.6.9 will be applicable at this stage and are expected to due to the continuation of earthworks and construction of basements in future phases across the Site.

Operational Effects

15.6.10 Medium term local minor to moderate adverse significant environmental effects associated with the operational phase relate to pollutant linkages between site users and soil and groundwater contamination and soil and groundwater contamination impacting upon the underlying Secondary A and Principal Aquifers. The underlying aquifers may be impacted through the continued leaching of contamination through the unsaturated zone and through continued migration of contamination within the aquifers. This will be further assessed through the Phase 2 investigation and detailed quantitative risk assessment of any identified pollutant linkages. A remediation strategy will be developed to mitigate against the risks to controlled waters and human health.

15.6.11 Short term local minor adverse effects will arise from elevated ground gases which may impact upon site users and buildings through accumulation into confined spaces. Buildings with basement car parks will require forced ventilation to the basement which will provide mitigation from gas and vapour ingress.

15.6.12 Soil contaminants are unlikely to impact upon site users in areas of hard cover as this will provide a barrier between soil contamination and humans using the Site. Local short term minor adverse effects may arise in areas of soft landscaping on contaminated ground. Where volatile contaminants are present site users may be affected where vapours can penetrate into buildings and accumulate into confined spaces.

15.7 Opportunities for Further Mitigation Measures

15.7.1 Based on the identified likely significant environmental effects being present the mitigation measures outlined below should be undertaken.

15.7.2 Detailed intrusive investigation is required to confirm the ground conditions and conceptual site model for the Site and to determine parameters for foundation design and classification of soils for offsite disposal. A detailed remediation strategy/strategies will be prepared and

presented to the Local Planning Authority prior to construction of each part or phase of the Proposed Development, setting out in detail the mitigation measures outlined below.

15.7.3 Construction Effects

Soil Contamination – Construction Workers

Construction workers could become exposed to contaminated soils including asbestos during groundworks, and may be exposed to contamination through accidental ingestion, inhalation and dermal contact with soils and dust. Use of appropriate Personal Protective Equipment (PPE) and appropriate hygiene and health and safety measures to minimise exposure should be adopted during any groundworks at the Site. Reference should be made to guidance presented in document HSG 66 "Protection of Workers and the General Public during Redevelopment of Contaminated Land' during development works"

15.7.4 Japanese Knotweed

Japanese Knotweed will be dealt with prior to construction. Methods to eradicate Japanese Knotweed from the Site will be set out in a formal Japanese Knotweed Management Plan and submitted to the Local Planning Authority as part of the remediation strategy for the Site. Spraying of knotweed will generally be preferred to avoid offsite disposal of large volumes of soils.

15.7.5 Generation of large volume of non hazardous and hazardous waste

There may be opportunities to recover natural soils excavated from basement excavations to enable re-use as aggregates or fill on other sites. Careful management and control of excavations and stockpiles is essential to reduce the volume of soil destined for landfill and maximise recovery. Management of excavated soils will be covered under the Code of Construction Practice (COCP).

15.7.6 Physical likely significant effects to soil structure and drainage

General site good practice measures implemented under the COCP will be adopted to mitigate against adverse effects these may include:

- Damping down of earthworks to reduce dust generation;
- Use of settling tanks to remove particulates from water generated from excavations prior to discharge to the drainage system;
- Benching of excavations to reduce erosion of soils;
- A Site Waste Management Plan will be adopted to minimise the generation of wastes during the construction works; and

- Surface drainage system to incorporate petrol interceptors to reduce the potential for spillages of fuels and lubricants from vehicles using the Site to migrate into the subsurface and impact soil and groundwater.

15.7.7 The stability of slopes associated with the railway lines will be assessed as part of the Phase 2 investigations of the Site. The sides of excavations will be left at a safe angle of repose, in order to prevent sidewall collapse. Where it is not possible to provide a batter, a sheet piled solution will be required.

15.7.8 Contamination effects from piled foundations

A piling foundation risk assessment will be completed to assess the most suitable foundation solution for the Site. Continuous Flight Auger cast in situ piles are likely to be the most suitable option from a contamination perspective although they may generate excess soils that require off site disposal. The volume of soil is likely to be small in comparison to the soil generated from basement excavation.

Operational Effects

Site Contamination – Site Users

15.7.9 Within buildings or hard landscaping areas direct exposure to contaminated soils through ingestion, inhalation or dermal contact with soils or dusts is not considered to be a plausible pollutant linkage. Soft landscaped publicly accessible open space areas will require capping by topsoil growing medium including if necessary a geotextile and / or capillary break / hard to dig layer which will provide a barrier between soils and site users.

15.7.10 Volatile organic compounds which may be recorded in soils could generate significant vapours which could migrate into buildings. Suitable protection measures will be installed in buildings to be designed following an appropriate period of gas monitoring. Where basement car parking is provided positive ventilation will be required which will provide sufficient mitigation

15.7.11 Remediation of volatile compounds may be required to reduce or remove the contaminant source, suitable methods will be proposed following a remediation options appraisal. Remediation methods may include soil vapour extraction, bioremediation, in-situ chemical oxidation. Remediation methods which avoid or reduce off site disposal and landfilling will generally be adopted where possible.

Ground Gas and Buildings/ Site users

15.7.12 A suitable period of gas monitoring will be completed to enable design of gas protection measures for buildings at the Site. The methodology set out in CIRIA Report C665 and BS 8485 will be followed to design suitable measures. Measures may include source removal or

remediation, gas impermeable membranes within the slab, passive venting or positive pressurisation of the underslab void and construction of venting wells or trenches.

15.7.13 Soil Contamination – Secondary A Aquifer

Soluble contamination including hydrocarbon, volatile organic compounds and PAH contamination may be present in the made ground soils which have the potential to leach into the Secondary A Aquifer through the action of percolating rainfall. The potential effect will depend on the nature of the hydrocarbons present. In general terms hydrocarbon fractions in the longer mineral oil range will have a lower effect than shorter chain petrol or diesel type fuels or VOCs such as degreasing solvents and dry cleaning fluid.

15.7.14 The potential effects will be assessed following detailed investigation and remediation levels set by a detailed quantitative risk assessment. Remediation, if required, will be designed in order to retain as much soil as possible on Site. Onsite and in situ techniques will be used where feasible these may include soil vapour or dual phase extraction, chemical oxidation, bioremediation.

15.7.15 Long term monitoring of groundwater before, during and after construction will ensure that any deterioration in water quality is detected and mitigated. The remediation strategy will detail contingency measures which could be employed should impact to offsite receptors be detected.

Groundwater – Secondary A and Principle Aquifers on and offsite

15.7.16 Intrusive investigation will be completed to confirm the presence of significant contamination in the Secondary A Gravel aquifer and Principal Chalk aquifer.

15.7.17 Remediation of groundwater if required may range from very intensive enhanced pump and treat systems, dual phase vacuum extraction, air sparging, in situ bioremediation to monitored natural attenuation. Remediation of groundwater may be integrated with soil remediation if practical.

15.7.18 Under a worst case where the Principal Chalk Aquifer is heavily impacted by organic contamination, in particular light and dense non-aqueous phase liquids (Typically petroleum hydrocarbons, tars and chlorinated solvents), it is unlikely that technology would be available to remediate the aquifer to risk based target levels. Remediation would need to be based on a cost-benefit approach. Remediation standards for groundwater pollution are less dependent on land use than human health led remediation.

15.7.19 Monitoring of groundwater during construction will ensure that any deterioration in water quality is detected and mitigated. Details of monitoring will be set out in a remediation

strategy which will also detail contingency measures which could be employed should impact to offsite receptors be detected. The remediation strategy/strategies will be submitted to the Local Planning Authority prior to construction.

15.7.20 Perched Groundwater – Waste Supply Pipes

Organic contaminants may penetrate plastic water supply pipes tainting water supplies. This linkage may be mitigated by lining trenches for water pipes with sufficient granular packing and a low permeability membrane reducing contact with contaminated perched waters, alternatively supply pipes may be constructed of a more resistant material such as ductile iron.

15.7.21 Hydrocarbon Impacted Run off from roads and car parks to Groundwater

Sustainable Drainage Systems (SuDS) as described in Section 16 will be incorporated into the drainage design to remove any pollutants and maintain water quality on Site, reducing any potential effects to receiving waters.

15.8 Summary of Residual Effects

15.8.1 Following implementation of the mitigation measures discussed above, the adverse residual risks to ground and ground water would be negligible.

15.8.2 Should significant groundwater contamination be present in the Principal Chalk Aquifer then remediation technology may not be available to clean up the groundwater to background or risk based target levels. Remediation would need to seek betterment and adopt a cost benefit approach.

15.8.3 There would be a minor to moderate beneficial effect through the removal or remediation of contamination sources and subsequent improvement in groundwater quality.

15.9 Assessment of Cumulative Effects

15.9.1 The cumulative effects associated with Geology, Ground Conditions and Contamination are not considered significant because the likely significant effects identified are all considered to be highly localised to the Site and the potential effects on receptors offsite is considered negligible.

15.10 References

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