APPENDIX 2.5: 2016 ES TECHNICAL CHAPTERS AND ASSESSMENTS:

- CHAPTER 11: WATER RECOURSES AND FLOOD RISK;
- CHAPTER 12: GROUND CONDITIONS AND CONTAMINATION; AND,
- CHAPTER 14: DAYLIGHT, SUNLIGHT AND OVERSHADOWING AND SOLAR GLARE.

11 WATER RESOURCES AND FLOOD RISK

11.1 Introduction

11.1.1 This chapter has been prepared by Mayer Brown and assesses the potential effects of Development on water resources, flood risk and drainage. The chapter identifies environmental receptors and potential significant effects associated with demolition and construction activities and the completed Development are identified as appropriate and, where necessary, mitigation measures outlined. The potential for flood risk is also examined in accordance with national guidance and the requirements of the Environment Agency.

11.1.2 The chapter is supported by a detailed Flood Risk Assessment (FRA), which has been produced by Hyne Tillett Steel (HTS), consulting engineers, and is included as Appendix 11.1. The FRA includes a surface water drainage strategy.

11.2 Legislation, Planning Policy and Guidance

Legislation

11.2.1 This section provides an overview of the key legislation which underpins the assessment of hydrology, flood risk and foul drainage in the UK and are applicable to this assessment. The applicable principal pieces of legislation are as follows:

- The Flood and Water Management Act 2010[1];
- Water Resources Act 1991[2];
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003[3];
- The Water Act 2003[4] and 2014[5;]
- The Environmental Protection Act 1990[6;]
- The Land Drainage Act 1991 (as amended 1994)[7;]

- The Environmental Damage (Prevention and Remediation) Regulations 2009[8];
- The Environmental Permitting (England and Wales) Regulations 2010[9];
- The Control of Pollution (Oil Storage) (England) Regulations 2001[10]; and
- Water Supply (Water Quality) Regulations 2010[11].

National Planning Policy

National Planning Policy Framework, 2012

11.2.2 The National Planning Policy Framework[12] (NPPF) sets out the Government's reform of the planning system. The NPPF sets out requirements for management of flood risk within new developments including the application of the Sequential and Exception Tests and completion of site specific Flood Risk Assessment (FRA). The NPPF is supported by web-based Planning Practice Guidance (PPG)[13] with specific mention to flood risk. This supersedes all the Planning Policy Statements (PPS) including PPS25-Development and Flood Risk.

11.2.3 The PPG to the NPPF provides guidance to local planning authorities to ensure the effective implementation of the planning policy set out in the NPPF on development in areas at risk of flooding and in relation to mineral extraction. This guidance retains key elements of PPS25 which are considered necessary and helpful in relation to these policy areas.

11.2.4 The guidance explains how flood risk should be considered at all stages of the planning and development process, such that:

- Inappropriate development is avoided in areas at risk of flooding by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere; and
- New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change and consideration should be given to the control of the additional volume of water generated by the climate change.

Regional Planning Policy

The London Plan, 2016

11.2.5 The London Plan[14] is the overall strategic plan for Greater London. The key policies within the London Plan relating to water resources and flood risk include;

- Policy 5.3 which requires new developments to meet the highest standards of sustainable design and construction under and include measures to conserve water and reduce the effects of flooding;
- Policy 5.12 requires developments to comply with the flood risk assessment and management requirements set out in the NPPF and associated technical guidance. Developments are also required to have regard to measures proposed in Thames Estuary 2100 and the Thames Catchment Flood Management Plan.
- Policies 2.18 and 5.13 promote the use of Sustainable Drainage Systems (SuDS) and states that new developments should aim to achieve greenfield runoff rates and ensure that surface water runoff is managed as close as possible to its source.
- Policy 5.15 promotes the conservation and minimisation of mains water use.
- Policy 5.14 aims to ensure that London has adequate and appropriate wastewater infrastructure to meet the requirements placed upon it by population growth and climate change, and prevent adverse environmental effects.

Securing London's Future - The Mayor's Water Strategy, 2011

11.2.6 The Mayor's Water Strategy[15] details ways in which present water resources could be used more effectively, in order to tackle problems such as water supply, wastewater generation and flood risk across London.

The Sustainable Design and Construction Supplementary Planning Guidance, 2014

11.2.7 The Sustainable Design and Construction Supplementary Planning Guidance (SPG)[16] sets out supplementary guidance to London Plan policies and forms part of the Implementation Framework. The SPG sets out the Mayor's priorities and best practice ambitions. The SPG provides guidance on water minimisation, flood mitigation and water pollution.

Local Planning Policy

LBB Local Plan Core Strategy, Development Plan Document, 2012

11.2.8 Core Strategy Policy CS13: Ensuring The Efficient Use of Natural Resources details that noise impact assessments are required for developments in-line with Barnet's Supplementary Planning Document (SPD) on Sustainable Design and Construction.

11.2.9 London Borough of Barnet's (LBB) Core Strategy[17] sets out the spatial vision and plan for the future of the borough and how it will be delivered. The principal policy within the Core Strategy that addresses flood risk and drainage is contained in Policy CS13, titled "Ensuring the efficient use of natural resources".

11.2.10 Within this Core Strategy Policy CS13, flooding and water management is addressed in section 18.12, the flood risk element addressed as follows:

> *"18.12.1 One of the major impacts of climate change will be to increase risk of flooding from watercourses (known as fluvial flooding) and sewers (known as surface water flooding). The risk based Sequential Test as set out in the NPPF (paras 100 to 104) should be applied at all stages of planning. Its aim is to steer new development to areas with the lowest probability of flooding. Barnet has 14kms of streams and brooks and the North London Strategic Flood Risk Assessment identified fluvial flooding from Dollis Brook, Silk Stream, Pymmes Brook and their associated tributaries as the primary source of flood risk in the borough. Surface water flooding in Barnet presents a low to moderate risk to the borough while sewer flooding is also noted for being low risk. Groundwater flooding was found to be a relatively low risk due to the impermeable geology (primarily London Clay) and depth of the groundwater table."*

11.2.11 Within this Core Strategy Policy CS13, water quality and supply is addressed in section 18.13, and is as follows:

> *"18.13.1 Barnet's main water courses are of fair to poor chemical quality according to assessments carried out by the Environment Agency. Maintaining the quality of water, especially groundwater, is important in ensuring the borough's population has a good quality domestic water supply. Water pollution can also affect the supply of water for leisure, industrial and agricultural uses and have a harmful impact upon riverside habitats. We will work with the Environment Agency to restrict development which may threaten the quality of either ground or surface water."*
>
> 18.13.2 Water is a precious resource and it is essential that new development

seeks to be efficient in using water, seeking wherever possible to reduce consumption. This can be achieved through grey water systems and rainwater harvesting. Further details on recommended techno***logies are set out in the SPD on Sustainable Design and Construction.***

11.2.12 The supporting evidence for the implementation flood risk and drainage of Policy CS13 is as follows:

- Surface Water Management Plan, Volume 1 (Version 02), Hyder Consulting, 2011[18]; and
- North London Strategic Flood Risk Assessment, Mouchel, August 2008[19].

11.2.13 A Strategic Flood Risk Assessment (SFRA) looks at flood risk at a strategic level on a Local Planning Authority (LPA) scale. It is the responsibility of those allocating land for development to demonstrate that the flood risk to and from development will be acceptably safe throughout the lifetime of the proposed development, taking account of climate change. A SFRA essentially maps out the flood plain into flood zones so that development can be steered to areas with a low risk of flooding

11.2.14 The Surface Water Management Plan is a framework through which key local partners with responsibility for surface water and drainage in their area work together to understand the causes of surface water flooding and agree the most cost effective way of managing surface water flood risk.

LBB Local Plan Development Management Policies Documents, 2012

11.2.15 The Local Plan Development Management Policies (DMP) DPD sets out the borough wide planning policies that implement the Core Strategy, and will be used for day to day decision making by the Planning Service and for planning committee determinations. The DMP DPD sets out the policy basis for delivering the long-term spatial vision and strategic place-shaping objectives in Barnet which are set out in the Core Strategy.

11.2.16 Water Resources and Flood Risk are addressed in development management policy DM04, titled *Environmental Considerations for Development.* Section 5.9 of the document covers *Surface water Run-off and Drainage.*

11.2.17 The specific wording within policy DM04 that relates to Flood risk and Drainage is as follows:

> ***"g. Development should demonstrate compliance with the London Plan water hierarchy for run off especially in areas identified as prone to flooding from surface water run-off. All new development in areas at risk from fluvial flooding must demonstrate application of the sequential approach set out in the NPPF (paras 100 to 104) and provide information on the known flood risk potential of the application site"***

LBB Supplementary Planning Document Sustainable Design and Construction, 2013

11.2.18 The SPD states that "*It is essential that new development uses water efficiently, seeking wherever possible to reduce consumption"* and provides water efficiency standards for developments to be met. The SPD also provides design standards in relation to Flood Risk, Sustainable Urban Drainage Systems and Water Quality.

Pentavia Draft Planning Brief, September 2016

11.2.19 The site specific Pentavia Draft Planning brief was generated by London Borough of Barnet in September 2016 and one of the objectives, relating to water resources and flood risk, is to achieve:

> *"exemplary standards of sustainable design and environmental quality in order to mitigate and adapt to the effects of a changing climate as well as respond to the challenging environmental context of the location"*

11.2.20 The more specific requirements are contained in the Surface Water Management section of the Planning Brief and are as follows:

> *"8.10 The development should not have a harmful impact on the water environment, water quality and drainage systems. There are no water features on site and the site does not fall within a flood zone. However, the site is expected to provide suitable mechanisms for managing surface water flows and runoff within the site to avoid and redirect run-off from the mains drainage system."*
>
> *"8.11 A site wide Surface Water Drainage Strategy is required and this would need approval from the Council in its capacity as Lead Local Flood Authority. New water features should be natural to improve biodiversity. Dependant on the findings of the Surface Water Management Report, the uses of Sustainable Urban Drainage Systems (SUDS) may be appropriate."*

11.3 Assessment Methodology

Consultation

11.3.1 The EIA Scoping Report was submitted to the London Borough of Barnet (LBB) on 8th April 2016 (Appendix 2.1), and a formal Scoping Opinion was issued by LBB on 28th July 2016 (Appendix 2.2). The Scoping Opinion included relevant comments from the Environment Agency and Thames Water and a summary of the consultation responses and how they have been responded to is provided in Table 11.1.

Table 11.1 Consultation Responses

Consultee	Comment	Response
Environment Agency	The Environment Agency identified that there are no environmental constraints on Site within their remit so have not reviewed a large number of scoped topics, including Hydrology and Flood Risk. The EA did identify that the Site is located on a historic landfill site which appears to have been subject to a past activity that poses a high risk of pollution to controlled water.	N/A
Thames Water	Supporting documents to the planning application should include all of the following:	
	The developments demand for water supply and network infrastructure both on and off site and can it be met	Thames Water have been consulted by Chapman BDSP (Building Services and Environmental Consultancy) to carry out an impact assessment on their potable water supply network. The impact assessment will determine if the increased demand for the Development will require on-site or off-site upgrades to their existing network. Liaison with Thames Water is ongoing so the outcome of the assessment is currently unknown.
	The developments demand for Sewage Treatment and network infrastructure both on and off site and can it be met	Thames Water have been consulted by HTS Consulting Engineers to carry out an impact assessment on their foul sewer network and treatment works. The impact assessment will determine if the increased rate and volume of foul effluent from the proposed Development will require on-site or off-site upgrades to their existing network. Liaison with Thames Water is ongoing so the outcome of the assessment is currently unknown.
	The surface water drainage requirements and flood risk of the development both on and off site and can it be met	A surface water drainage strategy, designed by HTS Consulting Engineers, conforms to the requirements of the London Plan and will restrict surface water run-off to a greenfield rate, which will continue to discharge into the Thames Water surface water network at the same location as the existing connection point. The proposed surface water drainage strategy is contained in the FRA. The greenfield run-off rate represents a significant reduction / improvement when compared to the existing situation. The excess surface water generated by the Development will be contained safely on Site in an attenuation pond and below ground attenuation tank that will ensure there will be

Consultee	Comment	Response
		no risk of flooding to properties on site and a reduced risk of flooding to properties off Site.
	Build – out/ phasing details to ensure infrastructure can be delivered ahead of occupation	Three phases of construction are scheduled, and it is proposed that these phases will become occupied once complete and as the next stages come forward. Thames Water have been provided this phasing information and anticipated build-out rate. It is anticipated their impact assessments and potential upgrades for potable water and off site foul sewerage infrastructure will take this into consideration.

Scope of Assessment

Construction

11.3.2 Construction effects of the Development have been considered taking into account the mitigation measures under 'Design and Management' that would be implemented as standard practice as part of a CEMP.

Completed Development

11.3.3 The effects of the completed Development have been considered taking into account the proposed surface water drainage strategy which includes SuDS and forms part of the FRA.

Flood Risk

11.3.4 The FRA for the Development covers the more detailed technical aspects relating to hydrology, flood risk, and drainage. The FRA considers whether the Development is appropriate in planning terms, and assesses the effect of the Development on the local hydraulic regime and risk of flooding.

11.3.5 The key baseline data that informed the FRA is listed in in Table 11.2 below:

Table 11.2 Baseline Data that informed the FRA

Baseline Data	Source
Fluvial / Tidal Flooding	Environment Agency Website (August 2016)
Surface Water / Pluvial Flooding	Environment Agency Website (August 2016)
Groundwater Flooding	Environment Agency Website (August 2016)

Baseline Data	Source
Existing Site and Private Sewers within Site Boundary	Laser Surveys Topographic Survey, April 2009, REF No. C6235
Public Sewer within Site Boundary	Thames Water Asset Plans (TW Ref: ALS/ALS Standard/2016-3268630)
Potable water mains within Site Boundary	Thames Water Asset Plans (TW Ref: ALS/ALS Standard/2016-3268630)

11.3.6 The following sources of flooding have been assessed in the FRA:

- Fluvial flooding;
- Tidal flooding;
- Groundwater flooding;
- Surface water flooding / overland flow; and
- Sewer flooding / infrastructure failure.

Surface Water Drainage

11.3.7 A review of the topographic survey, Thames Water Sewer Asset Plans has been undertaken as part of the FRA to assess the existing drainage system serving the Site. This review of the existing Site drainage has enabled the incorporation of SuDS into the surface water drainage designs for the Development. The proposed SuDS strategy is set out in the FRA.

Foul and Potable Water

11.3.8 There are no standard assessment criteria or methodology relating to the assessment of clean water supply and foul water available to development of a site. For the purposes of this assessment, the proposed foul water strategy has been assessed by:

- Obtaining existing foul water loading details;
- Determining the likely requirements of the Development and establishing the ability of the existing network to meet these requirements; and,
- Establishing if the location of the existing foul water network will be affected by the proposals.

Identification of Effects

11.3.9 The assessment of the potential effects of the Development on the water resources and flood risk to the Site, surrounding areas and relevant receptors has been undertaken. There is potential for changes

to the surface water runoff caused by the Development that can affect the hydraulic regime of the Site.

11.3.10 In general, new development effects water resources by increasing foul discharges into the local sewer network and increasing the demand for clean water supply, which places additional pressure on the local network.

11.3.11 The receptors used are classified as follows:

- On-site – Premises within the Site boundary;
- Site-adjacent – premises, watercourses, sewers and water supply adjacent to the Site boundary;
- Site-distant – Premises, watercourse, sewer and water supply away from the local area at or on route to the water processing / disposal point.

Significance Criteria

11.3.12 The assessment of likely significant effects has taken into account both the demolition and construction phase and once the Development is completed and occupied. The significance level attributed to each effect has been assessed based on the magnitude of change due to the Development and the sensitivity of the affected receptor / resource to change, as well as a number of other factors that are outlined in more detail in Chapter 2: EIA Methodology. Magnitude of change is assessed on a scale of high, medium, low and negligible whilst the sensitivity of the affected receptor / resource is assessed on a scale of high, medium, and low (as shown in Chapter 2: EIA Methodology).

Sensitivity of Receptor

11.3.13 The sensitivity of the baseline conditions is assessed according to the relative importance of existing environmental features on or near the Site, or by the sensitivity of receptors that would potentially be affected by the Development. Criteria for the determination of sensitivity or of importance or value of receptors are established based on approved guidance, legislation, statutory designation and/or professional judgment.

11.3.14 Guidance on the categories and definitions of value and/or sensitivity used in the assessment are given in Table 11.3. Where a receptor could reasonably be placed within more than one value and sensitivity rating, conservative professional judgment has been used to determine which rating would be applicable.

Table 11.3 Definitions of Receptor Sensitivity

Sensitivity / Value	Definition
High	The receptor has low ability to absorb change without fundamentally altering its present character, is of high environmental value, or of national importance. ▪ Receptors including human health and water resources which are of ecological importance. ▪ Sensitive water receptors such as Principal Aquifers, Aquifers within groundwater source protection zones (GSPZs) and surface water features adjacent the Site or with significant hydraulic continuity to the Site. ▪ Water bodies of very good and good status as defined by the Water Framework Directive. ▪ Sites of Special Scientific Interest with geological features.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some environmental value, or is of regional importance. ▪ Secondary Aquifers not within groundwater source protection zones. ▪ Other water features or water resources at or within 250 metre (m) of the Site which are not classed as 'High' value.
Low	The receptor is tolerant of change without detriment to its character, is low environmental value, or local importance. ▪ Receptors with a moderate sensitivity to changes in land quality/contamination levels.

Magnitude of Effect

11.3.15 The magnitude of potential effects on baseline conditions is based on an assessment of the scale or degree of change from the baseline condition as a result of the effect, the duration and reversibility of the effect. The scale of change that the proposed Development would have upon sensitive or valued receptor/ resource is also considered taking into account relevant legislation and/or policy standards and guidance. Table 11.4 provides general definitions of effect magnitude criteria.

Table 11.4 Definitions of Magnitude of Effect

Sensitivity / Value	Definition
Major	Total loss or major alteration to key elements/features of the baseline conditions such that post development character/composition of baseline condition will be fundamentally changed, such as: • Surface Water: Risk of risk of pollution from a spillage during the construction phase. Eventually ends up in the receiving watercourse. Loss or extensive change to fishery. Loss or extensive change to a designated Nature Conservation Site. • Groundwater: Risk of risk of pollution during the construction phase. Loss or, or extensive change to, an aquifer. Loss of, or extensive change to, groundwater supported wetlands

	• Flood Risk: New development could increase the rate and volume of surface water run-off entering the sewer. Increase in peak flood level in receiving sewer will eventually discharge to into the receiving watercourse. Increase peak flood level of >100mm
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition of the baseline condition will be materially changed. • Surface Water: Risk of risk of pollution from a spillage during the construction phase, which eventually end up in the receiving watercourse. Partial loss in productively of a fishery. • Groundwater: Risk of risk of pollution during the construction phase. Partial loss or change to an aquifer. Partial loss of the integrity of groundwater supported wetlands. • Flood Risk: New development could increase the rate and volume of surface water run-off entering the sewer. Increase in peak flood level in receiving sewer will eventually discharge to into the receiving watercourse. Increased peak flood level of >50mm
Minor	Minor shift away from baseline conditions. Changes arising from the alteration will be detectable but not material; the underlying character/composition of the baseline condition will be similar to the pre-development situation. • Surface Water: Risk of risk of pollution from a spillage during the construction phase, which eventually end up in the receiving watercourse. • Groundwater: Risk of risk of pollution during the construction phase Potential low risk of pollution to groundwater from routine surface water run-off. Minor effects on groundwater supported wetlands • Flood Risk: New development could increase the rate and volume of surface water run-off entering the sewer. Increase in peak flood level in receiving sewer could lead to overloading of the sewer and cause flooding locally. The increased run-off will eventually discharge to into the receiving watercourse. Increased peak flood level of >10mm.
Negligible	Very little change from baseline conditions. Change is barely distinguishable, approximating to a “no change” situation. • Surface Water: Risk of risk of pollution from a spillage during the construction phase. Very low risk of pollution that eventually ends up in the receiving watercourse. • Groundwater: Risk of risk of pollution during the construction phase. No measurable impact upon an aquifer or risk of pollution from spillages • Flood Risk: New development could increase the rate and volume of surface water run-off entering the sewer. Increase in peak flood level in receiving sewer could lead to overloading of the sewer and cause flooding locally. The increased run-off will eventually discharge to into the receiving watercourse. Increased peak flood level of >10mm.

Assumptions and Limitations

11.3.16 This assessment has been based on readily-accessible data in the public domain supplemented by information provided in response to data requests to the relevant authorities and agencies.

11.3.17 At the time of writing only outline construction activities and methodologies were available, i.e. no detailed construction methodologies were available. It is assumed that construction activities will follow relevant best practice guidelines and that the appropriate mitigation would be applied.

11.4 Baseline Conditions

11.4.1 The 3.86 hectare Site comprises a retail park, predominantly hardstanding, with an operational restaurant located on the southern boundary. Several larger commercial warehouses occupy the northern section of the Site with adjoining car parking to the south. To the north of the warehouses a service yard is present whilst a triangular soft landscaped area occupies the northern extent of the Site.

Geology & Hydrogeology

11.4.2 Refer to Chapter 12: Ground Conditions for details on the geology of the Site. The salient points, in relations to flood risk and drainage, are that intrusive site investigation at the Site identified ground conditions that comprise 8.5 metres to 11.0 metres of made Ground overlying London Clay, which was proven to a depths of 20 meters below ground level (bgl). With reference to British Geological Society (BGS) records, underlying the London Clay is a Lambeth Group that overlies the Thanet Sands (locally present) and White Chalk Subgroup.

11.4.3 According to the Environment Agency, the Made Ground is unclassified and the London Clay is classified as Unproductive Strata. At depth, the Lambeth Group is classified as a Secondary A Aquifer, whilst the Thanet Sands (where present) and White Chalk Subgroup form the Principal Aquifer.

11.4.4 There are no groundwater abstraction licences within 1,000m of the Site and the Site is not located within a Source Protection Zone (SPZ).

11.4.5 Perched water strikes were encountered during the LGC 2015 ground investigation at depths of between 0.5m to 9.0m. During the monitoring period, standing water levels were recorded at depths of between 2.1m to 6.2m. It is unknown whether perched water exists as part of a larger body or remains in isolated pockets.

Drainage & Potable Water

Surface Water Drainage

11.4.6 The Thames Water Asset Plan (TWAP) contained in Appendix C of the FRA identifies a number of large surface water pipes (750 diameter and 900mm diameter) running between the adjacent M1 motorway and the existing main warehouse building. The topographic survey contained in Appendix A of the FRA recorded the existing surface water drainage serving the retail park discharging via a single outfall location into the 900mm surface sewer within the Development boundary (Thames Water manhole reference 8101) at a restricted rate of discharge.

11.4.7 It is not clear what the existing restricted rate of discharge is but the topographic survey recorded two oversized pipes (1.8 metre diameter and 1.5 metre diameter with combined volume of 140 cubic metres) just upstream of a 225mm diameter outfall pipe into the public sewer.

11.4.8 The topographic survey did not record any petrol separators or specific treatment to the surface water prior to entering the public sewer.

Foul Water Drainage

11.4.9 The TWAP identifies a large and very deep public foul sewer (525mm diameter circa 9.5 metres deep) that follows a similar same route as the surface water sewer between the adjacent motorway and the existing main warehouse building. The topographic survey contained in Appendix A of the FRA recorded the foul water drainage serving the retail park discharging into this public foul sewer.

11.4.10 There are two existing foul water connections to the public sewer, which are the TGI Friday restaurant and the retail warehouse. The rate and volume of foul effluent from these types of premises is generally low. Based upon Sewers for Adoption 7th Edition[20] (Section B5.1 Hydraulic Design, Foul Sewers) the domestic peak foul effluent from commercial / industrial development is 0.6 litres / per second per hectare of developable land. Based upon a site area of 3.86 hectares the peak foul effluent would be approximately 2.31 litres / second. This is a peak design flow rate not a daily average water usage, and represents the peak flow from a number of appliances. The peak flow is usually calculated as 6 x dry weather flow (6DWF), where dry weather flow is representative of the actual flat rate of foul effluent generated by the development.

11.4.11 The foul water effluent from the existing Site eventually discharges to the local Deepham Sewerage Treatment Works (STW), which serves approximately 891,000 people in the London Boroughs of Barnet, Enfield, Haringey and Tottenham.

Potable Water Supply

11.4.12 The TWAP identifies a 100mm distribution main entering the Site at the south east adjacent the roundabout, running through the existing car park parallel to the M1 and underneath the length of the main building on-site. The same 100mm diameter water main runs along Watford Way before entering the Site boundary. There are no clean water trunk mains identified in the immediate vicinity. Based up the figures in paragraph 11.4.10 the clean water demand should be dry weather flow, which equates to approximately 0.38 litres / second.

11.4.13 There are three customer connections identified within the Site boundary. One connection is for the TGI Friday restaurant and the other two are to the retail warehouse. Similar to the foul sewers, the clean water demand from these types of development is generally low.

Flood Data

Fluvial / Tidal Flooding

11.4.14 There are no watercourses on or adjacent the Site, with the nearest located approximately 2 kilometres to the north west.

11.4.15 The Environment Agency flood map indicates the Site is located within a low risk Flood Zone 1, which classifies it as comprising of land assessed as having a less than 1-in-1000 annual probability of river or sea flooding in any year. Therefore, fluvial or tidal flooding is not considered to be a risk to the existing buildings on the Site or the proposed Development.

Surface Water Flooding / Overland Flow

11.4.16 Overland flow and surface water flooding results from rainfall that fails to infiltrate the surface and travels over the ground surface. This is exacerbated by low urban permeable development or low permeability soils and geology (such as clayey soils). Overland flow is likely to occur at the base of an escarpment and low points in terrain.

11.4.17 Figure 11.1, shows the Site is located within a very low risk of surface water flooding, with a less than 1-in-1000 annual probability of sewer or overland flooding in any year. Therefore, flooding from overland flow is not considered to be a significant risk for the Site or the Development.

Figure 11.1 Pluvial Flood Map Figure from FRA

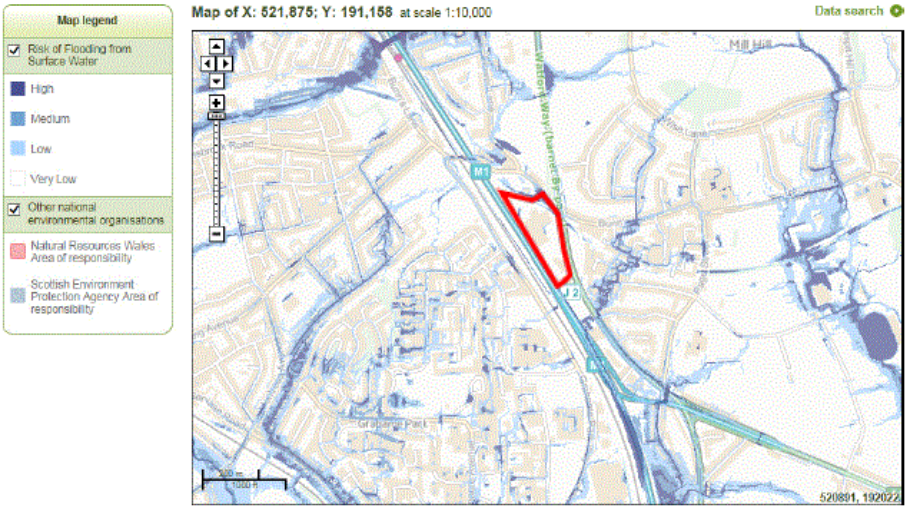

Figure 3.2 Risk of Flooding from Surface Water, Environment Agency website – 9th August 2016

Sewer Flooding / Infrastructure Failure

11.4.18 During extremely wet weather the capacity of the proposed surface water system may be inadequate. Under such conditions sewers may surcharge and surface water may escape from those manhole covers positioned below the hydraulic gradient.

11.4.19 As outlined within paragraph 3.4 of the FRA, there are no recorded historic incidents of surface water flooding relating to the Site. Therefore, surface water flooding from sewers is therefore not considered to be a significant risk for the Site of the proposed Development.

Groundwater Flood Risk

11.4.20 Groundwater flooding occurs when water levels in the ground rise above the surface elevations. Paragraph 3.3 of the FRA states that the Site does not appear to be underlain by an aquifer in the superficial deposits in the bedrock layer and it is considered that the probability of flooding on Site from groundwater is low. The Site Investigation recorded a number of perched water strikes and standing water levels were recorded at depth of between 2.1m and 6.2m below the ground level, neither of which would pose a flood risk to the Site. Groundwater flooding is therefore not considered to be a significant risk for the Site.

Summary of Sensitive Receptors

11.4.21 The relevant receptors which have been identified for the assessment of water resources and flood risk have been selected based upon those which may be sensitive to flooding from overloaded surface and foul water sewers. The key potential receptors and their sensitivity have been identified in Table 11.5

Table 11.5 Identified Sensitive Receptors

Receptor Group	Receptor	Description	Sensitivity
On – Site	Future Site Users	The residential and retail end users of the completed and occupied Development could be effected by the lack of capacity in the existing Thames water sewers passing through the Site, which could lead to flooding of premises within the site boundary.	Low Sensitivity: All new dwellings are located on the upper ground floor, with the lower ground floor containing car parking. In the unlikely event the Site floods from surface water run-off (sewer blockage or failure) the dwellings and residents would remain relatively unaffected. The car park and external areas would flood but would recover with limited and temporary disruption.
Site – Adjacent	Overland surface water flooding	Existing residential properties, commercial properties, retail properties and infrastructure immediately surrounding the Development could be effected by overland flooding from the Development.	Low Sensitivity: In the event neighbouring sites experience flooding it is possible for them to recover to their original condition when the flood waters recede.
	Overloaded Sewers	An increased rate of surface and foul water discharge could also overload the local sewer network and lead to flooding.	
Site – Distant	Receiving Watercourse	The surface water run-off leaving the Site during the construction phase could become polluted, discharge to the surface water sewer eventually discharge into the local watercourse.	There is the potential that pollution from construction activities could discharge into the receiving watercourse via the surface water sewers, which could temporarily effect its water quality.
	Controlled Waters	Secondary A Aquifer of the Lambeth Group, Principal Aquifer of the Thanet Sands and White Chalk Subgroup.	The Secondary A Aquifer of the Lambeth Group and Principal Aquifer of the Thanet Sands and White Chalk Subgroup are considered to be of medium and high receptor sensitivity respectively which could be impacted on a district scale by the Site. Whilst the receptor sensitivity differs for the

			separate aquifers, the Secondary A Aquifer and Principal Aquifer are likely to be in hydraulic connectivity. Therefore, the risk is assessed for the Controlled Waters encompassing each aquifer with a collective high receptor sensitivity.
	Sewerage Treatment Works (STW)	An increased rate of foul effluent from the completed Development will place additional loading on the local STW.	The STW would have the ability to accept the foul effluent from the Development without any material change to its character.

11.5 Environmental Design and Management

Construction

11.5.1 A range of environmental mitigation measures would be employed as standard to minimise effects during the demolition and construction phase of the Development, as part of a site-specific Construction Environmental Management Plan (CEMP).

11.5.2 The following measures to be implemented to control ground and water pollution impacts from construction have been collated from the CIRIA publications 'Control of Water Pollution from Construction Sites' [21] and will form part of the CEMP:

- Management of construction works so as to comply with the necessary standards and consent conditions to be identified by the Environment Agency and LBB;
- Consideration will be given to the appropriate storage of materials in wet weather and certain Site activities may be postponed during heavy rainfall to prevent pollution entering the sewer surface water sewer system and eventual discharge to the aquifer through infiltration;
- The environmental regulator will be consulted before any mains or tankered water, even if not contaminated, is discharged to the local sewer system;
- Any oil, fuel lubrication and other potential pollutants shall be handled on the Site in such a manner as to prevent pollution of any watercourse. For any liquid other than uncontaminated water, this shall include storage in suitable, bunded tanks;

- No extraction, tipping or temporary storage of materials shall take place within an agreed distance of any watercourse unless part of the approved works. Under no circumstances shall tipped material enter any watercourse or culvert without prior consent;
- Effective wheel/body washing facilities to be provided and used as necessary;
- A road sweeper to be available whenever the need for road cleaning arises; and,
- Vehicles carrying waste material off-site to be sheeted.

11.5.3 All contractors and subcontractors will also be required to go beyond best practice site management principles, as defined by the Considerate Constructors scheme.

11.5.4 Measures to protect receptors from ground contamination are discussed in Chapter 12: Ground Conditions.

Completed Development

11.5.5 The use of SuDS is promoted within the national/local guidance to manage surface water on new development. SuDS are an alternative approach to managing surface water runoff, which strike a balance between the management of surface water and the need to conserve natural resources. The three main principles are:

- reduction of quantity, in particular the large peak runoffs during a storm event which cause flooding of the receiving waters;
- improvement of quality, by reducing the level of pollution entering sewers, watercourses or groundwater; and
- enhanced amenity, such as community facilities, landscaping potential.

11.5.6 The design process has involved a technical assessment of the forms of SuDS which are most appropriate to the Site. The proposed drainage strategy will comprise a piped network. Runoff from the northern part of the Site will be attenuated within a pond. Runoff from the southern part of the Site and from the service road around the perimeter of the Development will be attenuated within buried attenuation.

11.5.7 Surface water will discharge to the existing Thames Water sewer to the west of the Site and will be attenuated to greenfield equivalent rate of 13.8 litres per second. The on-site attenuation has been designed to accommodate a 1 in 100 year event plus an allowance of 40% for climate change. The FRA

(page 5) identifies that the northern and southern areas of the Site would provide 1,213m^3 and 1,746m^3 volume of attenuation storage respectively. A drained areas plan, drawing reference 1458/DR006/P5 is contained in Appendix F of the FRA and shows the areas draining to the pond (1.505 hectares) and the attenuation tank (1.653 hectares).

11.5.8 The proposed surface water drainage strategy for the Development is contained in the FRA, Appendix 11.1. A plan showing the proposed drainage strategy is presented in Appendix E of the FRA.

11.5.9 The average water consumption in the Thames Water area per head is 150 litres per person per day. In respect of potable and foul water, the current Building Regulations Part G[22] state that the potential water consumption by occupants of a new dwelling must not exceed 125 litres per person per day. There is now also an optional higher standard which states the potential water consumption by occupants of a new dwelling must not exceed 110 litres per person per day. The Applicant will aim to achieve the optional higher standard of 110 litres per person per day.

11.6 Demolition and Construction

Assessment of Effects

11.6.1 The construction process is outlined within Chapter 5: Demolition and Construction for the enabling, demolition and construction works and the key activities for the Development. The construction programme and activities involved is necessarily broad at this stage and will be subject to modification during any future detailed construction planning with the appointed Principal Contractor. However, this section provides a description of the likely significant effects of demolition and construction activities for the Development on the environment based on the projected construction programme and activities involved. The assessment assumes that the standard mitigation measures as part of the CEMP would be implemented.

Foul and Surface Water Sewers, Potable Water Supply – On Site and Site Adjacent

11.6.2 Lengths of the existing Thames Water surface and foul water sewers and clean water mains within the boundary will need to be diverted to ensure they are not located underneath the building footprint. New surface and foul water sewers and water mains to serve the Development will also need to be constructed. The location of the sewers to be diverted and proposed drainage strategy is contained in Appendix E of the FRA.

11.6.3 Construction activities will require water supply and foul drainage. The volumes of water required and foul sewage generated are likely to be small and to be over a short period when compared to the final development and consequently to not be significant, i.e. negligible.

11.6.4 It is assumed that concrete batching will be done off-site due to the limited size of the Site.

11.6.5 The effects associated with these construction works to the sewer receptors of Low sensitivity, are likely to be temporary, of minor magnitude, which would result in an effect of negligible significance.

Potable Water Supply – Site Adjacent and Site Distant

11.6.6 It is anticipated the existing 100mm diameter clean water distribution main will not be large enough to serve the Development, and construction works adjacent the Site will be required to install a larger water main up to the Site boundary.

11.6.7 The effects associated with these construction works to this receptor of Low sensitivity, are likely to be temporary, of minor magnitude, which would result in an effect of negligible significance.

Water Quality – Site Adjacent and Site Distant

11.6.8 Run-off from construction activities could potentially impact the water quality in the receiving surface water sewer and watercourse through a potential increase in fine sediments, hydrocarbons and other chemical loads, the introduction of cement, accidental spills and/or other wastes discharged from the Site.

11.6.9 The effects associated with the construction activities to this receptor of medium sensitivity, are likely to be temporary, of minor magnitude which would result in an adverse effect of minor significance.

11.6.10 The Development will require the use of foundation piles. Contamination is present in near surface soils. Deep foundation piles are therefore likely since deep Made Ground is considered unsuitable. New foundations would be supported on piles founded well down into the London Clay Formation.

11.6.11 Piling offers a potential pathway for contaminant migration to depth from the near surface to sensitive aquifers. However, the Site is underlain London Clay, proven up to a depth of 25 metres, and piles are not anticipated to penetrate the full thickness of clay. The London Clay provides a barrier to the downward migration of contamination and because the piles will not penetrate the London Clay, the protection provided will remain intact. The likelihood of an effect is low and therefore the significance is negligible. A Piling Risk Assessment will be provided in advance of the commencement of works on-site.

11.6.12 Mitigation measures related to ground conditions and contamination are discussed further in Chapter 12: Ground Conditions.

Mitigation Measures and Residual Effects

11.6.13 Appropriate site management and mitigation practices, would be implemented as set out under 'Design and Management'.

Foul and Surface Water Sewers & Potable Water Supply – On Site, Site adjacent and Site Distant

11.6.14 With the implementation of the CEMP, the potential significance effects of construction activities on and off Site would remain as negligible.

Water Quality – Site Adjacent and Site Distant

11.6.15 With the implementation of the CEMP, the potential significance effects of construction on water quality off-site would remain as minor adverse in the worst case, albeit unlikely, event of an incident.

11.7 Completed Development

Assessment of Effects

Surface Water Runoff – On-Site

11.7.1 The technical aspects of the on-site surface water drainage design have been considered within section 4 of the FRA, paragraph 4.4 details the design of the surface water drainage system to accommodate storms up to the 1-in-100 year return period event, plus an allowance for climate change.

11.7.2 The proposed drainage strategy therefore would ensure the Development manages the rate at which water can leave the Site via the use of SuDS to hold back and attenuate flows as set out under 'Design and Management'. These SuDS would ensure that flow rates are limited, more closely mimicking natural processes (thereby preventing high runoff rates during and immediately after a storm). This would result in runoff enters the receiving sewer more slowly. The SuDs scheme includes the provision of below ground attenuation storage and a pond, which will help to attenuate and reduce the surface water discharge rate from the Site to the calculated greenfield runoff rate. These measures to reduce the rate of surface water runoff represent a significant enhancement over the existing baseline condition and would contribute to a reduction in loading to the public surface water sewer catchment.

11.7.3 With the designed SuDS measures in place, the on-site effect of surface water run-off would be negligible.

11.7.4 As standard, a surface drainage maintenance regime would be in place between the freeholder, adoption authority and Thames Water, such that the likelihood of overloading sewers/drainage system is low. The effects on receptors within the Development would therefore be negligible.

Surface Water Runoff – Site Adjacent and Site Distant

11.7.5 The potential source is increasing the rate of surface water discharge into the receiving Thames Water public sewers that could overload the downstream sewer network and increase the volume of water discharging to the receiving watercourse. The effect is that it could increase the risk of flooding to surrounding or downstream properties. As set out above the discharge rate from the Site would reduce significantly with the Development in place. Assuming the effective implementation of the drainage strategy and maintenance the effects would be negligible.

Potable Water Supply – Site Distant

11.7.6 The existing potable water demand from the completed Development will increase when compared to the existing situation.

11.7.7 The average water consumption in the Thames Water area per head is 150 litres / head / day. Therefore, Thames Water are likely to determine the water demand from the completed Development as 150 litres / head / day from the 694 proposed residential units. Based on Chapter 6: Socio-economics, it is anticipated that the Development would support 1,120 people. Based on a worst case assumption of two people per residential unit the total demand would be approximately 208.2 cubic metres over a 24 hour period, equivalent to 2.41 litres / second.

11.7.8 Thames Water have been commissioned to undertake an impact assessment on their potable water supply infrastructure. The impact assessment is currently being undertaken and will determine if reinforcements of their network will be required. Thames Water will undertake the impact assessment with the goal of achieving a “nil detriment” to the levels of service they provide to existing customers.

11.7.9 The impact associated to this receptor of low sensitivity, will be permanent, of minor magnitude, which would result in an effect of negligible significance. It is anticipated to be negligible because Thames Water’s impact assessment will identify potential reinforcement works that ensure the Development will have a nil detriment to their existing levels of service.

Foul Water – Site Distant

11.7.10 An increase in potable water demand will, by default, result in an increase in foul effluent that will enter the public sewer network and require treatment at the local Deepham Sewerage Treatment Works (STW), which serves approximately 891,000 people in the London Boroughs of Barnet, Enfield, Haringey and Tottenham.

11.7.11 Deepham STW is currently undergoing major upgrade works that commenced in 2015 and will span over seven years. This upgrade project will enable the STW to meet the new Environment Agency sewage treatment standards that will come into force from March 2017, meet the needs of approximately one million people in the near future, reduce odour and improve the quality of discharge into the River Lea.

11.7.12 Based upon sewers for adoption 7th Edition (Section B5.1 Hydraulic Design, Foul Sewers) the peak foul effluent from residential development is 4,000 litres / dwelling / day. This peak flow represent 6 times dry weather flow (6DWF), where DWF is equal to 200 litres per person x 3 people per dwelling. An additional 10% is then added to allow for potential infiltration. Based upon this approach the completed Development of 694 residential units would generate a DWF of 4.82 litres / second, and a peak 6DWF (+10% infiltration) of 31.8 litres / second.

11.7.13 Thames Water have been commissioned to undertake an impact assessment to determine the effect the increased rate of foul effluent will have on their sewers network's ability to convey the additional waste and the ability to treat the waste at the STW. The impact assessment is currently being undertaken and will determine if reinforcements of their network will be required. Thames Water will undertake the impact assessment with the goal of achieving a "nil detriment" to the levels of service they provide to existing customers and, as such, may identify potential upgrades to their sewer network either on Site or downstream of the Site.

11.7.14 From experience on similar sized residential projects it is anticipated Thames water will carry out the impact assessment using diversified flows to determine the peak flow rate from the Mill Hill development. Diversified flows use a flat rate of 3,600 l/s from the first 50 properties and all subsequent properties discharge a flat rate of 600 l/s per dwelling. All flows are then subject to a 10% increase to allow for infiltration. Therefore, the diversified peak flow from the Development, which will inform the impact assessment, is anticipated to be 5.15 litres / second. This peak flow of 5.15 litres / second will discharge into the existing 525mm (10 metres deep) diameter foul sewer traversing the site with a full bore carrying of approximately 300 litres / second.

11.7.15 The effect associated to this receptor of Low sensitivity, will be permanent, of minor magnitude, which would result in an effect of negligible significance. It is anticipated to be negligible because Thames Water's impact assessment will identify potential reinforcement works that ensure the Development will have a nil detriment to their existing levels of service.

Mitigation Measures & Residual Effects

Surface Water Runoff – On-Site, Site Adjacent and Site Distant

11.7.16 The proposed drainage strategy incorporates SuDS in which will ensure that surface water run-off from the completed Development will achieve greenfield runoff rates, which represents a significant improvement when compared to the existing situation. This will be achieved by incorporating SUDS into the completed Development in the form of an attenuation pond and below ground attenuation tank. The peak discharge that will leave the 3.86 hectare Site will be 13.8 litres / second, which will require a total storage volume of 2,959 cubic metres.

11.7.17 A full maintenance scheme would also be implemented.

11.7.18 No further mitigation measures are considered necessary. As such, the residual effects would be as stated under 'Assessment of Effects'.

Potable Water Supply and Foul Water Demand – Site Distant

11.7.1 The effect on water use will be mitigated through the specification of water efficient fittings and equipment in each dwelling, such as low flow taps and showers, as well as through an intelligent control system which will include a smart water meter and display in each home. Rainwater harvesting will be used to minimise water use on landscaped areas. It is anticipated that water efficiency measures will achieve the Building Regulations optional higher standard of 110 litres per person per day reduce, which by default will also result in lower foul sewage flows.

11.7.2 Thames Water have been commissioned to undertake an impact assessment on their potable water and sewer network to determine if it has capacity to convey the effluent from the completed Development, and to treat the effluent at the local sewage treatment works. The outcome of the impact assessment, currently being undertaken, will determine if reinforcements of their network will be required.

11.7.3 The residual effect, both potable supply and foul drainage would remain as stated under Assessment of Effects since Thames Water's impact assessments will ensure the completed Development will have a nil detriment to the existing levels of service they provide to their existing customers.

11.8 Cumulative Effects

Demolition and Construction

11.8.1 Effects relating to water resources and flood risk are typically site specific. Therefore, it is considered highly unlikely that there will be any cumulative residual effects resulting from the Development and the cumulative schemes. The potential for contamination from surface water run-off into the local sewer network and underlying aquifer should be identified by the individual applications of the cumulative schemes. It is anticipated that a range of environmental mitigation measures will be employed as standard to minimise effects during the demolition and construction phase of the Development, as part of site-specific CEMP.

11.8.2 The likely demolition and construction effects from water resources and flood risk effects on cumulative schemes would therefore be negligible.

Completed Development

11.8.3 The proposed Development and all surrounding cumulative schemes will have to adhere to the requirements in the London Plan to ensure that the proposed Developments end use and the cumulative schemes:

- Will not increase the risk of flooding to itself, surrounding or downstream properties
- The potable water supply and receiving foul water infrastructure will have sufficient capacity to serve the respective developments. This will be achieved by instructing Thames Water to carry out impact assessments on the individual sites, which will potentially identify upgrade works to ensure they result in a nil detriment to the existing level of service they provide their customers.

11.8.4 The likely effects of the completed Development on water resources and flood risk on the cumulative schemes would therefore be negligible.

11.9 Summary

Table 11.1 Summary of Effects of the Development

Potential Effect	Geographical Level of Importance[1]					Significance of Effect	Mitigation Measures	Residual Effect
	I	N	R	D	L			
Construction								
Foul and Surface Water Sewers, Potable Water Supply – On-site & Site Adjacent					X	Negligible	Implementation of a CEMP. No additional measures.	Negligible
Potable Water Supply – Site Adjacent & Site Distant					X	Negligible	Implementation of a CEMP. No additional measures.	Negligible
Water Quality – Site Adjacent & Site Distant					X	Minor adverse	Implementation of a CEMP. No additional measures.	Minor adverse (albeit unlikely event of incident)
Completed Development								
Surface Water Runoff – On-site					X	Negligible	None required (SuDS strategy and maintenance would be implemented)	Negligible

[1] Key: I – International; N – National; R – Regional; D – District; L – Local

Potential Effect	Geographical Level of Importance[1]					Significance of Effect	Mitigation Measures	Residual Effect
	I	N	R	D	L			
Surface Water Runoff – Site Adjacent and Site Distant					X	Negligible	SuDS strategy and maintenance would be implemented. No further mitigation required.	Negligible
Potable Water Supply – Site Distant					X	Negligible	Thames Water have been commissioned to undertake an impact assessment on their water supply network that may potentially identify upgrades to ensure the development will have a nil detriment to the level of service they currently provide to their existing customers.	Negligible
Foul Water Sewers – Site Adjacent and Site Distant					X	Negligible	Thames Water have been commissioned to undertake an impact assessment on their water supply network that may potentially identify upgrades to ensure the development will have a nil detriment to the level of service they currently provide to their existing customers.	Negligible
Cumulative Effects								
Surface Water Runoff					X	Negligible	The Development and the cumulative schemes are will need to conform to the requirements London Plan and restrict surface water to greenfield rate of run-off. This will provide betterment when compared to the existing situation.	Negligible
Potable Water Supply and Foul Water Effluent					X	Negligible	The potable water supply and receiving foul water infrastructure will have	Negligible

Potential Effect	Geographical Level of Importance[1]					Significance of Effect	Mitigation Measures	Residual Effect
	I	N	R	D	L			
							sufficient capacity to serve the respective developments. This will be achieved by instructing Thames Water to carry out impact assessments on the individual sites, which will potentially identify upgrade works to ensure they result in a nil detriment to the existing level of service they provide their customers.	

REFERENCES

[1] Department for Environment, Food and Rural Affairs, TSO, London, 2010. *Flood and Water Management Act* 2010.

[2] Her Majesty's Stationary Office (HMSO), 1991. *Water Resources Act 1991*.

[3] HMSO, 2003. The Water Environment *(Water Framework Directive) (England and Wales) Regulations 2003*.

[4] HMSO, 2003. *The Water Act 2003*.

[5] HMSO, 2014. *The Water Act 2014*.

[6] HMSO, 1990. *The Environmental Protection Act 1990.*

[7] HMSO, 1994. *The Land Drainage Act 1991 (as amended 1994)*.

[8] HMSO, 2009. *The Environmental Damage (Prevention and Remediation) Regulations 2009*.

[9] HMSO, 2010. *The Environmental Permitting (England and Wales) Regulations 2010*.

[10] HMSO, 2001. *The Control of Pollution (Oil Storage) (England) Regulations 2001*.

[11] HMSO, 2010. *Water Supply (Water Quality) Regulations 2010*.

[12] Department for Communities and Local Government (DCLG), 2012. *National Planning Policy Framework*.

[13] DCLG, Planning Policy Guidance, available at http://planningguidance.communities.gov.uk/blog/guidance/

[14] Greater London Authority (GLA), 2016. *The London Plan - Spatial Development Strategy for London Consolidated with Alternations since 2011,* March 2016.

[15] GLA, 2011. *Securing London's Water: The Mayor's* Water Strategy, October 2011.

[16] GLA, 2014. *The London Plan, Supplementary Planning Guidance (SPG): Sustainable Design and Construction, Consolidated with Alternations since 2011*, April 2014.

[17] London Borough of Barnet, 2012. *Barnet's Local Plan (Core Strategy), Development Plan Document*, September 2012.

[18] *Surface Water Management Plan, Volume 1 (Version 02)*, Hyder Consulting, 2011

[19] *North London Strategic Flood Risk Assessment*, Mouchel, August 2008

[20] *Sewers for Adoption 7th Edition*

[21] CIRIA, 2001. *Control of Water Pollution from Construction Sites. Guidance for Consultants and Contractors* (C532).

[22] *Building Regulations 2010 Part G, Sanitations, hot water safety and water efficiency. 2015 edition with 2016 amendments*.

12 GROUND CONDITIONS AND CONTAMINATION

12.1 Introduction

12.1.1 This chapter of the Environmental Statement (ES) has been prepared by Ramboll Environ and assesses the potential effect of the Pentavia Retail Park (the 'Development') on Ground Conditions and Contamination. Potential significant effects associated with demolition and construction activities and the completed Development are identified as appropriate and, where necessary, mitigation measures are outlined.

12.1.2 The chapter is supported by the following technical appendices:

- Appendix 12.1: Listers Geotechnical Consultants – Ground Investigation Report (April, 2016);
- Appendix 12.2: Listers Geotechnical Consultants – Ground Investigation Report (May, 2015); and
- Appendix 12.3: Zetica Regional Unexploded Bomb Risk – London, North.

12.1.3 This chapter should be read in conjunction with the Ground Investigation Reports (GIRs) undertaken by Listers Geotechnical Consultants (LGC) at the Site in May 2015 and April 2016.

12.2 Legislation, Planning Policy and Guidance

Legislation Context

12.2.1 This section provides an overview of the key legislation which underpins the assessment of contaminated land in the UK and are applicable to this assessment. The applicable principal pieces of legalisation are as follows:

- Town and Country Planning Act 1990[1];
- Environmental Protection Act 1990[2];
- The Contaminated Land (England) (Amendment) Regulations 2012[3];
- The Environmental Permitting (England and Wales) Regulation 2010[4];
- Water Resources Act 1991[5];
- Building Act 1984[6] and supporting Building Regulations[7] and their Approved Documents (particularly Approved Document C1) [8];
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003[9]; and
- The Environmental Damage (Pollution and Remediation) Regulations 2009[10].

National Planning Policy

National Planning Policy Framework, 2012

12.2.2 The National Planning Policy Framework[11] (NPPF) sets out the Government's reform of the planning system. For sites under redevelopment through the planning system, developers are required to ensure that developed land is suitable for its intended use. The framework states that:

> *"The planning system should contribute to and enhance the natural and local environment by protecting and enhancing geological conservation interests and soils, [and] preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution."*

12.2.3 In accordance with sustainability principles and in line with the principles set out in Part IIA of the Environmental Protection Act 1990, this is undertaken on a risk-basis and remediation measures are limited to those necessary to prevent unacceptable risk.

12.2.4 Paragraphs 109, 110, 120, 121 and 122 of the NPPF provide information relevant to land affected by contamination, land stability, protection of the natural environment and water supply, wastewater, and, water quality.

12.2.5 The NPPF stipulates that land contamination is a material consideration for planning consent and that permitted developments should ensure that:

- *"The site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*
- *The land would not be capable as 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 presented."*

Regional Planning Policy

The London Plan, Spatial Development Strategy for Greater London

12.2.6 The London Plan[12] sets out the overall strategic plan for Greater London, of particular reference to ground conditions is Policy 5.21 - Contaminated Land. The Policy states that the development of

brownfield land should not result in significant harm to human health or the environment. It also states that appropriate measures should be taken to ensure that development on previously contaminated land does not activate or spread contamination and that remediation of contaminated land should be encouraged.

12.2.7 There are also a number of policies relating to contaminated land including Policy 5.14 - Water Quality and Wastewater Infrastructure, which states that the Boroughs, appropriate agencies and planning authorities should work in partnership to protect and improve water quality with regard to the Thames River Basin Management Plan.

The Sustainable Design and Construction Supplementary Guidance (2014)

12.2.8 The Sustainable Design and Construction Supplementary Planning Guidance[13] (SPG) for Greater London provides some key guidance on land contamination. In particularly, where a site is affected by contamination it is the developer's or landowner's responsibility that the site is developed safely. As a minimum, the works should result in the site no longer being classed as contaminated under Part 2A of the Environmental Protection Act 1990. Where an activity has the potential to result in land contamination, appropriate mitigation measures should be identified at planning application stage. The implementation and maintenance of these mitigation measures should be secured by the local authority through a condition or an s106 agreement.

Local Planning Policy

London Borough of Barnet Contaminated Land Strategy

12.2.9 The London Borough of Barnet (LBB) Contaminated Land Strategy[14] outlines how the Borough would inspect, identify and manage contaminated land. Section 1.1.1 Environmental Issues states that:

> "*The Council will have regard to the Planning Guidance which states that contamination is a material planning consideration and that the responsibility for the safe development and secure occupancy of a site lies with the developer".*

London Borough of Barnet's Local Plan Core Strategy, Development Plan Document

12.2.10 The LBB Core Strategy[15] outlines the 'vision' for the Local Plan and includes the most fundamental objectives and policies that the local authority will deliver. The LBB Core Strategy defines contaminated land as:

"Land which contains potentially harmful substances as a result of human activity or from natural causes may be regarded as contaminated land".

London Borough of Barnet's Local Plan, Development Management Policies, Development Plan Document

12.2.11 The LBB Local Plan Development Management (DM) Policies[16] sets out the borough wide planning policies that implement the Core Strategy and is used for day to day decision making by the Planning Service and for planning committee determinations. Section 5.7.1 states that:

"for potentially contaminated land, the developer will be required to carry out a Preliminary Risk Assessment...Where necessary a full site investigation considering both the possible future users of the site and hazards to ground and surface water quality. Before a development can start, planning conditions may require that appropriate remedial measures are agreed with the planning authority and carried out in line with current UK Guidelines..."

Guidance

12.2.12 In addition to the above legislation and policies, there is a large amount of UK best practice guidance documentation which is relevant to land contamination and prevention of pollution and good environmental management during construction. Some of the key pieces of guidance are listed below:

- Environment Agency Report: Model Procedures for the Management of Land Contamination: Contaminated Land Report 11 (2004)[17];
- Environment Agency/DEFRA Report: Human Health Toxicological Assessment of Contaminants in Soil Science Report SC050021/SR2. (2002) [18];
- Environment Agency Report: Groundwater Protection: Principles and Practice (GP3). (2013) [19];
- Environment Agency Report: Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination (2006)[20];
- Environment Agency Report: Guidance on the Assessment and Monitoring of Natural Attenuation of Contaminants in Groundwater (2000)[21];
- Environment Agency Report: Pollution Prevention Guidance (2007)[22];
- Environment Agency Report: Pollution Prevention Guidelines, Incident Response Planning: PPG21 (2009)[23];
- Environment Agency Report: Pollution Prevention Guidelines, Dealing with Spills: PPG22 (2011)[24];

- Environment Agency Report: National Groundwater and Contaminated Land Centre, Piling into Contaminated Sites (2002)[25];
- Environment Agency Report: National Groundwater and Contaminated Land Centre, Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination (2001)[26];
- BS10175:2011 Investigation of Potentially Contaminated Sites - Code of Practice[27];
- BS8485:2015 Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings[28];
- BS8576:2013 Guidance on Investigations for Ground Gases. Permanent Gases and Volatile Organic Compounds (VOCs)[29];
- BS3882 Specification for topsoil and requirements for use[30].
- CIRIA Report C665: Assessing Risks Posed by Hazardous Ground Gases to Buildings (2007)[31];
- CL:AIRE (2011): The Definition of Waste: Development of Industry Code of Practice[32];
- CIRIA Report 132: A guide for safe working practices on contaminated Sites (1996)[33];
- CIRIA Report C532: Control of Water Pollution from Construction Sites (2001) [34];
- CIRIA Report C692: Environmental Good Practice on Site (3rd Edition) (2010)[35]; and
- BS6031: Code of Practice for Earthworks (2009)[36].

12.3 Assessment Methodology

Previous Ground Investigations

12.3.1 A limited ground investigation was undertaken by LGC between the 2nd and 5th of March 2015, comprising five cable percussive boreholes to a maximum depth of 20 metres below ground level (mbgl) and six hand dug trial pits to a maximum depth of 1.2mbgl. The 2015 GIR was completed for a different development scheme comprising four areas of potential extension to the existing retail units. The exploratory holes were positioned to provide information on the ground conditions and existing foundations specific to the four aforementioned zones of proposed development under the former scheme.

12.3.2 The 2015 ground investigation was advanced in 2016 with a site wide ground investigation under the current scheme. The site wide ground investigation referred to in the 2016 GIR was undertaken to characterise the ground conditions, identify the potential presence of soil contamination and discussed the geotechnical implications with regards to the Development. An additional twenty-seven exploratory holes were undertaken between the 25th and 28th of January 2016. The 2016 ground

investigation comprised three trial pits to a maximum depth of 3.0mbgl, twelve continuous tube sample boreholes to a maximum depth of 6.0mbgl, seven cable percussive boreholes to a maximum depth of 25.0mbgl and five dynamic probe holes.

12.3.3 Following completion of the ground investigations, selected boreholes were installed with groundwater/ground gas monitoring standpipes with targeted response zones from 1mbgl to 6mbgl within the Made Ground. The stratum encountered within the exploratory holes is set out in Section 12.4.6, Geology.

12.3.4 In total, across the two ground investigations, seventeen samples were screened against a suite including heavy metals, general inorganics, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH) and asbestos identification. In addition, four samples were submitted for waste acceptance criteria (WAC) analysis. The laboratory analysis is discussed in Sections 12.4.8 to 12.4.12.

12.3.5 Over the course of the two ground investigations, two exploratory holes have been monitored for ground gas on six occasions between the 11th of March 2015 to the 10th of March 2016, whilst four other exploratory holes were monitored on four occasions between the 4th of February and 10th of March 2016. The results are summarised in Sections 12.4.18 to 12.4.22.

Consultation

12.3.6 Consultation with agencies, authorities and organisations for their records relating to the Site was undertaken by LGC as part of both the 2015 and 2016 GIRs, which are contained in Appendix 12.1 and Appendix 12.2. In addition, the EIA Scoping Report was submitted to the London Borough of Barnet (LBB) on 8th April 2016 (see Appendix 2.1 of Volume 2 of this ES). The formal Scoping Opinion was issued by the LBB on the 28th July 2016 (see Appendix 2.2 of Volume 2 of this ES) which included comments from LBB and the Environment Agency. No further consultation was deemed necessary as part of the assessment. The consultation responses are contained in Table 12.1.

Table 12.1: Consultation Response Summary

Consultation Comment	Response
Scoping Opinion	
The LBB recommend that developers should adhere to a number of legislation and guidance within Section 4.2 – Topography and Ground Conditions.	The legislation and guidance referred to in the Scoping Opinion are included in Sections 12.2 and 12.2.12 and have been considered as part of this assessment.
Lankmark	
As part of the LGC GIRs, consultation was made with Lankmark who collate information from a number of third party sources including the Environment Agency, Natural England, National Geoscience	The information provided from the environmental search has been used to assess the potential contamination sources and receptors present at and within the vicinity of the Site.

Consultation Comment	Response
Information Service, Public Health England, Centre for Ecology and Hydrology, British Geological Survey, Contemporary Trade Directories, Historical Ordnance Survey maps and Unexploded Ordnance maps.	
Zetica	
As part of the baseline, a UXO hazard map for North London was requested from Zetica.	The information contained within the report has been used to assess the potential for unexploded ordnance at the Site.

Scope of Assessment

12.3.7 The LGC 2015 and 2016 GIRs have been used for information on the baseline conditions of the Site. In addition, publicly available information held by the Environment Agency and British Geological Survey has been reviewed to inform this assessment.

Spatial Scope

12.3.8 The Site assessment will consider effects to receptors within the Site, as well as potential effects on off-site receptors depending on their sensitivity and vicinity to the Site.

Temporal Scope

12.3.9 The assessment has been undertaken for the Site over the demolition and construction phases of the Development, as well as the completed and occupied Development.

Technical Scope

12.3.10 The scope of the ground conditions assessment comprises:

- Assessment of the potential for contaminated soil or groundwater (sources) to be present at the Site;
- Assessment of the potential environmental impact of these sources upon sensitive receptors and the subsequent effect and its significance; and
- Discussion of potential measures which can be used to mitigate negative effects, together with the resulting anticipated residual effects.

Identification of Effects

12.3.11 In line with current guidance on contaminated land assessment, a Conceptual Site Model (CSM) for the Site demolition and construction phase and the completed and occupied Development will be established, which will summarise the pollutant linkages between a potentially hazardous source and

a sensitive receptor via an exposure pathway. Through the development of a CSM the potential effects which could arise as part of the Development will be identified.

12.3.12 Where potential sources of contamination have been identified, each of the sensitive receptors has been considered. However, where a plausible pathway cannot be established from the source to receptor, a risk is not deemed to be present and therefore the potential effect is not considered further.

12.3.13 The potential effects that have been identified for inclusion in the assessment are as follows:

Construction Phase

- Disturbance of contaminated ground during the demolition and construction phase resulting in mobilisation of contaminants impacting groundwater;
- Disturbance of contaminated ground resulting in release of contaminated soil, dust to the surrounding environment and ground gas to confined spaces; and
- Potential exposure to contamination associated with the ground and effects on human health (e.g. construction workers and adjacent site users).

Completed and Occupied Development

- Potential exposure of future Site users to contamination and effects on human health;
- Potential risk of organic contaminants impacting potable water supplies and aggressive ground conditions to buried concrete;
- Potential risk of hazardous ground gas ingress into future properties and associated effects on human health of future Site users and adjacent site users; and
- Potential release/migration of contamination to controlled waters (underlying aquifers).

12.3.14 As shown above, potential effects have been identified for the completed and occupied Development. However, these effects are mitigated by design measures implemented during construction which remove the plausible pathway, thereby negating the risk and the need for further assessment. The details of the design and management measures are provided in Section 12.5.

Assumptions and Limitations

12.3.15 The LGC 2015 and 2016 GIRs and information from a number of external sources has been used to inform the baseline section. Where possible, Ramboll Environ has endeavoured to assess its quality,

however Ramboll Environ cannot offer any guarantees or warranties for the completeness or accuracy of information relied upon.

12.3.16 Due to the development proposals of the former scheme on part of the Site, LGC's 2015 ground investigation was limited to the four development zones identified by that former scheme. In addition, due to the operational activities of the retail facilities currently on Site, the 2016 ground investigation was restricted to accessible external areas surrounding the operational buildings (as show in 'Exploratory Hole Location Plan – Existing Site Layout' plan attached in Appendix A of the 2016 LGC 2016 GIR). Therefore, the areas situated below the retail buildings have not been subject to a ground investigation.

Significance Criteria

12.3.17 The assessment of likely significant effects as a result of the Development has taken into account both the demolition and construction phase and once the Development is completed and occupied. The significance level attributed to each effect has been assessed based on the magnitude of change due to the Development and the sensitivity of the affected receptor / resource to change, as well as a number of other factors that are outlined in more detail in Chapter 2: EIA Methodology. Magnitude of change is assessed on a scale of high, medium, low and negligible whilst the sensitivity of the affected receptor / resource is assessed on a scale of high, medium, and low (as shown in Chapter 2: EIA Methodology).

Sensitivity of Receptor

12.3.18 Guidance on the categories and definitions of value and/or sensitivity that will be used in the assessment are given in Table 12.2. Where a receptor could reasonably be placed within more than one value and sensitivity rating, conservative professional judgment has been used to determine which rating would be applicable.

Table 12.2 Definitions of Receptor Sensitivity

Sensitivity / Value	Definition
High	▪ Resources/features which are unique and if lost cannot be replaced or relocated, including water resources used for water supply, generally at national level. ▪ Receptors including human health and water resources which are of ecological importance. ▪ Human Health, including, that of construction and maintenance workers, future site users/occupants and third party neighbours. ▪ Sensitive water receptors such as Principal Aquifers, Aquifers within groundwater source protection zones (GSPZs) and surface water features adjacent the Site or with significant hydraulic continuity to the Site. ▪ Water bodies of very good and good status as defined by the Water Framework Directive. ▪ Sites of Special Scientific Interest with geological features.
Medium	▪ Resources/features of important consideration at a regional or district scale. ▪ Receptors vulnerable to changes in land quality/contamination levels. ▪ Built development – business/residential, agricultural land holdings, allotments and gardens and/or amenity/open green space areas. ▪ Secondary Aquifers not within groundwater source protection zones. ▪ Other water features or water resources at or within 250 metre (m) of the Site which are not classed as 'High' value.
Low	▪ Features important at a local scale. ▪ Receptors with a moderate sensitivity to changes in land quality/contamination levels. ▪ Other land uses which pose no threat to human health or Controlled Waters, e.g. forestry or derelict land.

Magnitude of Effect

12.3.19 This will be based on an assessment of the scale of change the consequences of the proposed Development would have upon sensitive or valued receptor/ resource. The scale of change would be considered both spatially and /or temporally when categorising the magnitude of an effect and would be categorised as high, medium, low or negligible. The definitions of the magnitude of an effect are provided in Table 12.3.

Table 12.3 Definitions of Magnitude of Effect

Sensitivity / Value	Definition
High	The proposed Development would cause a major change to existing environmental conditions. Loss of existing/creation of new resource. Extensive, long term deterioration/improvement in conditions or circumstances (either local or widespread), such as: ▪ Construction phase release of contaminants which causes a significant effect on identified receptors; and ▪ Elimination and/or mitigation of existing pollutant linkages.
Medium	The proposed Development would cause a noticeable change to existing environmental conditions including long term impacts, such as: ▪ Minor release of contaminants during the construction phase; and ▪ Elimination and/or mitigation of limited existing impacts upon identified receptors during the completed development phase.

Sensitivity / Value	Definition
Low	The proposed Development would cause a small change to existing environmental conditions generally in the short term, such as: ▪ Limited, temporary contaminant release associated with construction phase; and ▪ Temporary creation/elimination of pollution pathways during the construction phase.
Negligible	The proposed Development would cause no discernible change to existing environmental conditions.

12.4 Baseline Conditions

Current Baseline

12.4.1 As outlined within Chapter 1: Introduction, the Site comprises a retail park with an operational restaurant located on the southern boundary. Several larger commercial warehouses occupy the northern section of the Site with adjoining car parking to the south. To the north of the warehouses a service yard is present whilst a triangular soft landscaped area occupies the northern extent of the Site.

Site History

12.4.2 A detailed review of the Site history, including historical maps, is set out in the GIRs (LGC, 2015 and 2016). A summary is provided in sections 12.4.3 – 12.4.5.

12.4.3 Early editions of OS maps from 1882 show the Site to be undeveloped land occupied by fields. Minimal changes occur on the Site until the early 1930's, whereby a large proportion of the eastern section of the Site becomes demarcated as an embankment associated with the A1. By 1964 the northern section of the Site comprises allotments, while a drain crosses the centre of the Site aligned from north east to south west. During this period an unmarked structure also becomes identifiable on the central western boundary of the Site. OS map editions from 1976 show the embankment on the western boundary is no longer present, this is considered to be as a result of level raises across the Site associated with the adjacent M1 construction works. An area of cutting is also now visible on the north eastern boundary related with the formation of Bunns Lane. By 1990 the Site resembles the configuration that remains at present day with the warehouses now present.

12.4.4 The areas surrounding the Site remain undeveloped until the 1930's with the exception of the M1 and A1. By this point residential development is visible 50m to the east, while sports grounds are present

to the south east and west. Further residential development occurs to the west and north in the 1980s and by 1990 the fuel station to the south of the Site is present.

12.4.5 With reference to British Geological Survey, Environment Agency and Local Authority records, much of the Site was used as a landfill site referred to as 'K Garage' which accepted waste until 1965. No details are provided on the quantity and type of waste the landfill accepted, nonetheless it is considered likely the Site will contain a substantial thickness of Made Ground based on the former filling operations.

Geology

12.4.6 Ground conditions at the Site were identified by LGC to comprise 8.5m to 11.0m of Made Ground (where proven) overlying London Clay which was proven to a depth of 20mbgl. The Made Ground was largely identified to comprise brown and grey gravelly sandy Clays with brick, concrete, Granite, Chalk, Flint and clinker gravel and plastic, glass and wood inclusions. In the southern section of the Site around the existing restaurant, an area of shallower Made Ground was identified extending to 4.3m to 5.1mbgl. A number of exploratory holes encountered unknown obstructions throughout the Made Ground resulting in refusals or the requirement to chisel. The London Clay was identified to comprise a stiff brown to grey slightly sandy Clay.

12.4.7 Whilst not encountered within LGC 2015 ground investigation, with reference to BGS records, underlying the London Clay is the Lambeth Group which overlies the Thanet Sands (locally present) and White Chalk Subgroup.

Contamination

12.4.8 Visual evidence of contamination was restricted to the aforementioned anthropogenic inclusions within the Made Ground. No olfactory evidence of contamination is mentioned within LGC's GIRs (2015 and 2016) nor contained within the exploratory hole logs.

12.4.9 Within each of the GIRs (LGC, 2015 and 2016), LGC selected Generic Assessment Criteria (GAC) from Category 4 Screening Levels (C4SLs) and Suitable 4 Use Levels (S4ULs) to assess the soil results against. The screening assessments undertaken by LGC identified exceedences of the adopted GAC for lead, benzo(b)fluoranthene and dibenzo(a,h)anthracene against a residential land use scenario. Asbestos containing materials (ACM) were also identified in the form of chrysotile fibres/clumps within the sample collected from TP6 at a depth of 0.5m, albeit below the limits of detection < 0.001%weight/weight (w/w) upon quantification analysis.

12.4.10 Within the 2016 GIR, LGC ran statistical analysis on the exceedences using the methodology set out in the CL:AIRE document 'Guidance on Comparing Soil Contamination Data with a Critical Concentration'[37]. The statistical analysis is undertaken to gain the 'true mean concentration' or upper confidence limit of 95% to assess against the GAC. Of the three determinands which initially failed the screening assessment, LGC used the true mean concentrations to show lead (124mg/kg) fall below the GAC (200mg/kg), whilst benzo(b)fluoranthene (3.1mg/kg) and dibenzo(a,h)anthracene (0.5mg/kg) remained above their respective GACs (2.6mg/kg and 0.24mg/kg respectively).

12.4.11 No soil leachate and groundwater analysis was undertaken as part of the LGC ground investigation. LGC reported that due to the lack of proximal receptors (i.e. surface water features or aquifers) no pollutant linkages can be established and therefore, LGC stated that there is no significant risk to Controlled Waters.

12.4.12 Potential off-site sources of contamination are described in brief in the LGC GIRs (2015 and 2016) and have been identified to be limited to light industry and a fuel station 81m south of the Site. As part of the 2016 ground investigation, LGC positioned BH104 on the southern boundary of the Site to assess the potential for migration of contaminants from the fuel station. No visual or olfactory evidence of contamination was identified within the borehole.

Hydrogeology

12.4.13 According to the Environment Agency, the Made Ground is unclassified and the London Clay is classified as Unproductive Strata. At depth, the Lambeth Group is classified as a Secondary A Aquifer, whilst the Thanet Sands (where present) and White Chalk Subgroup form the Principal Aquifer.

12.4.14 There are no groundwater abstraction licences within 1000m of the Site and the Site is not located within a Source Protection Zone (SPZ).

12.4.15 Perched water strikes were encountered during the LGC 2015 ground investigation at depths of between 0.5m to 9.0m. During the monitoring period, standing water levels were recorded at depths of between 2.1m to 6.2m. It is unknown whether perched water exists as part of a larger body or remains in isolated pockets.

12.4.16 The chemical composition of the perched water and underlying groundwater remains unknown.

Hydrology

12.4.17 There are no surface water features on the Site. LGC refer to a road side ditch located 21m north of the Site, however due to the non-sensitive nature of the feature it was not considered further by LGC. There are no other surface water features within 1 kilometre of the Site.

Ground Gas

12.4.18 The presence of a significant thickness of Made Ground beneath the Site offers the potential for ground gas generation.

12.4.19 The six rounds of ground gas monitoring undertaken by LGC throughout 2015 and 2016 recorded maximum carbon dioxide concentrations to be 12.1% volume/volume percent (v/v) whilst maximum methane concentrations were identified to be 8.6% v/v. The maximum flow rate recorded on each of the visits was 1.5 litres per hour (l/hr). Oxygen was recorded to a minimum concentration of 10.2% v/v.

12.4.20 The calculated gas screening value (GSV) using the maximum carbon dioxide (12.1% v/v) concentration and flow rate (1.5l/hr) equates to 0.19l/hr, a Characteristic Situation 2.

12.4.21 The ground gas regime has not been robustly characterised in line with CIRIA C665[29] and BS 8576:2013 Guidance on Investigations for Ground Gas procedures[31] based on the number of monitored locations, frequency of monitoring visits and the installations of the boreholes. However, LGC report within the 2016 GIR that in accordance with BS8485:2015 – Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, ventilated undercroft parking provides four points of gas protection which is suitable for a Characteristic Situation 3. Therefore, LGC deem no further gas monitoring is necessary as naturally ventilated undercroft parking has been incorporated into the design proposals.

12.4.22 The Envirocheck report contained within the LGC GIRs (2015 and 2016) utilises information from the National Geoscience Information Service and British Geological Survey to determine if the Site lies within a radon affected area. The report indicates that no radon gas protection is required for new buildings at the Site.

Unexploded Ordnance

12.4.23 The Zetica bomb damage map (included within Appendix 12.3) shows that the area around the Site is of low risk. However, when referring to BombSight[38], one high-explosive bomb fell on Bunn's Lane

circa 350m east from the Site whilst two further high-explosive bombs fell near Woodcroft Avenue approximately 650m to the west.

12.4.24 Within the 2015 GIR (LGC, 2015), LGC state that an Unexploded Ordnance (UXO) Preliminary Risk Review had been undertaken which identified the following:

- No military history was found for the Site;
- No records were found to indicate that the Site was subjected to aerial bombardment by the Luftwaffe during World War II;
- No records were found to indicate that items of UXO have been found or recovered from the Site;
- The footprint of the Site has undergone extensive redevelopment since 1945.

12.4.25 As such, LGC report the Preliminary Risk Review conclusions to be that the UXO risk is low for the Site.

Identified Sensitive Receptors

12.4.26 The relevant site specific receptors which have been identified for the assessment of contaminated land have been selected based upon those which may be sensitive to ground which is impacted by contamination. The key potential receptors have been identified as follows:

Table 12.4: Identified Sensitive Receptors

Receptor Group	Receptor	Description	Sensitivity
Human Health	Future site users	The residential and retail end users of the completed and occupied Development.	Human Health receptors have been identified to be of high sensitivity which could be impacted on a local scale by the Development.
	Construction workers	Any workers coming into contact with ground, or material impacted by any contamination, with particular reference to potentially impacted Made Ground and perched water and confined spaces in which gases can accumulate.	
	Adjacent site users	Predominately off-site residential areas with limited retail to the south, and schools/nurseries to the north-west and north, which could be effected during the demolition and construction phase and once the Development is completed and occupied.	
Environmental	Controlled Waters	Secondary A Aquifer of the Lambeth Group, Principal Aquifer of the Thanet Sands and White Chalk Subgroup.	The Secondary A Aquifer of the Lambeth Group and Principal Aquifer of the Thanet Sands and White Chalk Subgroup are considered to be of medium and high receptor sensitivity

Receptor Group	Receptor	Description	Sensitivity
			respectively which could be impacted on a district scale by the Site. Whilst the receptor sensitivity differs for the separate aquifers, the Secondary A Aquifer and Principal Aquifer are likely to be in hydraulic connectivity. Therefore, the risk is assessed for the Controlled Waters encompassing each aquifer with a collective high receptor sensitivity.
	Flora and Fauna	Existing and proposed flora and fauna present on the Site.	Flora and fauna is considered to be of a low receptor sensitivity which could be impacted on a district scale by the Site.
	Building and Construction Materials	Including building materials used below ground such as foundations, services, and water supply lines.	The sensitivity of building and construction materials as a receptor is dependent on the impact which is posed. For instance, the receptor sensitivity of building piles from chemical attack is considered to be medium, however the receptor sensitivity of a building from the ignition of explosive gases which have accumulated within a confined space is considered to be high. The potential effects to building and construction materials are discussed within the following section.

12.5 Environmental Design and Management

12.5.1 A number of environmental mitigation measures are expected to be employed as standard to minimise impacts to both human health and controlled waters during the demolition and construction phase of the Proposed Development.

12.5.2 A number of potential environmental impacts that will be avoided, prevented, reduced or offset through these mitigation measures include:

- Human exposure through direct contact / inhalation / dermal uptake of contaminants;
- Creation of preferential pathways and mobilisation of contamination;
- Contamination of natural soils, driving of contamination into an aquifer during piling, contamination of groundwater with concrete, paste or grout;
- Pollution and degradation of water quality of any underlying aquifer;
- Infiltration and / or run off into the local drainage / sewerage network - pollution of drainage and sewerage network and any adjacent surface water features;

- Run off and infiltration of contaminants from material stockpiles;
- Contamination of drainage and sewerage network and / or groundwater; and
- Spread of nuisance dusts and soils to the wider environment and local roads.

12.5.3 Table 12.5 lists the environmental design and management and standard mitigation measures that will be employed throughout the demolition and construction process. These environmental design and management measures are being considered at this early stage in this chapter to avoid the consideration of impact assessment scenarios that are unrealistic and are covered by industry standard construction techniques. In addition, Table 12.5 outlines the design measures in place that were outlined in the LGC 2016 GIR as 'Remedial Measures' to be protective of human health. It is of note that a number of the measures included in the following tables are to be implemented at the construction phase but are included to mitigate effects that would be realised during the completed and occupied Development.

Table 12.5: Demolition and Construction Environmental Design and Management Measures

Design Measures
1. The inclusion of naturally ventilated undercroft car parking within the proposed Development provides an inherent level of protection from ground gases which will mitigate the risk to future site users and Building and Construction Materials during the completed development phase. 2. A Cover System should be implemented within proposed soft landscaped areas comprising materials that are suitable for use both chemically and geotechnically.

Management Measures
Regulatory / Guidance
1. Work will be carried out in accordance with relevant Construction Design Management (CDM) Regulations 2015, details of these measures will be presented within the Health and Safety Plan (H&SP), and the Construction Logistics Plan (CLP).
2. A Construction Environmental Management Plan (CEMP) will be prepared.
3. The CEMP will be prepared and approved by LBB prior to commencement of works. It will set out the management, monitoring, auditing and training procedures, and the mitigation measures that will be put in place during demolition and construction, to maintain compliance with the applicable regulations. In order to reduce the likelihood of contamination and protect human health and controlled waters from effects related to ground conditions, the CEMP will include mitigation measures such as those presented here.
4. A competent/licensed contractor will survey (presite preparation survey as defined by the HSE) and remove asbestos containing materials and other materials and structures contaminated with asbestos fibres.
5. A Pollution Response Plan/unforeseen contamination protocol will be included within the CEMP prior to the commencement of works on-site. The plan will outline key pollution management measures including a Control of Substances Hazardous to Health (COSHH) / fuel inventory and key contacts to be notified in the event of a significant pollution incident, which may subsequently lead to the contamination of controlled waters. Directly and indirectly purchased bulk fuel and COSHH items will be stored in accordance with the relevant Environment Agency Pollution Prevention Guidance notes. Tanks and dispensing pumps will be locked when not in use to prevent unauthorised access. Information regarding spill prevention and disposal of COSHH items will be provided as part of the standard site induction presentations and during regular toolbox talks and the works progress.
6. Piling will be carried out in accordance with Environmental Agency Guidance Note on Piling / Penetrative Ground Improvement Methods on Land Affected by Contamination and ground investigations will inform the

Foundation / Piling Works Risk Assessment which will define the appropriate piling methods and foundation design to mitigate risk.
7. Specification of concrete used in foundations and building structures will be selected based on the results of the chemical composition of the Site soil and groundwater. Guidance is provided by the Building Research Establishment (BRE) series 'Concrete in Aggressive Ground'.
8. Installation of service pipes will be suitable to the Site ground conditions to ensure that drinking water supplies are not tainted by organic contaminants. This is to be done with consultation to the water supply company who may recommend mitigation measures pertaining to the use of barrier pipe.
9. Decommissioning of boreholes from previous ground investigations will need to be completed in accordance with the EA document 'Good Practice on Decommissioning Redundant Boreholes and Wells'[39] , in order to remove any potential pathways for migration of contaminated waters.
10. Should perched water within excavations be identified as contaminated from visual/olfactory assessment, the unexpected contamination protocol must be adopted. Potentially impacted waters will need to be stored in controlled manner for subsequent testing and characterisation prior to disposal in accordance with the industry good practice procedures.
11. Preparation of a detailed materials management plan (MMP) under the provisions of the CL:AIRE Definition of Waste: Development Industry Code of Practice (CoP) [34].
Waste
1. Waste materials will be disposed of by the contractor/s to appropriate recycling facilities or appropriately licensed landfills in line with the Waste Management Plan (WMP) which will form part of the CEMP. The appropriate landfill for the disposal of any contaminated soil off-site will depend on the waste classification determined from the chemical analysis or Waste Acceptance Criteria testing as necessary.
2. Waste effluent will be tested for appropriate physical and chemical parameters and where necessary, disposed of at the correctly licensed facility by a licensed specialist contractor/s.
3. Complaints about dust will be investigated at the earliest opportunity and appropriate action taken to control the source or remedy the impact as appropriate.
4. Access roads will be regularly cleaned and damped down with water.
5. All vehicles entering and leaving the Site during the demolition and construction period will pass through a wheel washing facility. Vehicles used to transport materials and aggregates will be enclosed or covered in a tarpaulin. Vehicle movements will be kept to a minimum and vehicle speeds within the Site will be limited.
6. Appropriate use of PPE and implementation and adherence to Health & Safety Protocols, Plans and Procedures. Demolition and construction workers will remain vigilant of ground conditions at all times and will report to the Principal Contractor, any suspect areas of potential contamination.
7. Potentially contaminated made ground will be removed from excavations.
8. Advice should be sought by an environmental specialist should materials suspected of being contaminated be uncovered.
Demolition and Construction Related
1. Oils and hydrocarbons will be stored in designated locations with specific measures to prevent leakage and release of their contents, include the siting of storage area away from surface water drains, on an impermeable base with an impermeable bund that has no outflow and is of adequate capacity to contain 110% of the contents. Valves and trigger guns will be protected from vandalism and kept locked up when not in use. Details of appropriate storage and handling measures will be presented within the CEMP.
2. Vehicles should be well maintained to prevent accidental pollution from leaks. Static machinery and plant should include drip trays beneath oil tanks/engines/gearboxes/hydraulics, which will be checked and emptied regularly via a licensed waste disposal operator.
3. The appropriate utility company will be consulted on the potential requirement for an oil interceptor and sediment trap at the point where Site surface water runoff enters the sewerage network.
4. A spillage Emergency Response Plan (ERP) will be produced, forming part of the CEMP, which site staff will be required to have read and understood. On-site provisions will be made to contain a serious spill or leak through the use of booms, bunding and absorbent material.
5. Appropriate handling and disposal of pile arisings, concrete, pastes and/or grouts during the laying of foundations.
6. During both the demolition and construction stages of work, the contractor/s will employ dust suppression measures when necessary to prevent the potential mobilisation of contaminated dust particles and their migration off site.

7. Stockpiles and material handling areas will be kept as clean as practicable to avoid nuisance from dust. Dusty materials will be dampened down using water sprays in dry weather or covered.
8. The length of time materials are stockpiled on-site before being removed for re-use, recycling or disposal is to be kept to a minimum and stockpiles are to be covered with tarpaulins prior to disposal
9. Any site-won soils to be re-used on site will be demonstrated to be suitable for use both chemically and geotechnically suitable for use.
10. Dust generating equipment e.g. mobile crushing and screening equipment will be located to minimise potential nuisance impacts to receptors, as far as practicable.

12.6 Demolition and Construction

Assessment of Effects

12.6.1 This section provides a description of the potential effects of construction of the Development on the environment.

Disturbance/Mobilisation of Contaminated Material &/or Contaminants

12.6.2 The ground investigations undertaken by LGC encountered benzo(b)fluoranthene and dibenzo(a,h)anthracene above GAC and ACM within the Made Ground soils. There is also the potential for contamination to be present in areas which haven't been investigated. Consequently, it is considered that there is the potential for impacts to arise during the demolition and construction phase from the disturbance and/ or mobilisation of contaminated material and/ or contaminants, or from encountering underground obstructions. There is the potential for human health receptors (construction workers involved in demolition and construction works) to be exposed to contaminants whilst the underlying aquifers could be impacted from the creation of preferential pathways through installation of piles and the mobilisation of contaminants.

12.6.3 A potential pathway has been identified for the following potentially sensitive receptors:

- Human health receptors, including: adjacent site users and construction workers – High receptor sensitivity/value;
- Controlled waters, including the Secondary A Aquifer (Lambeth Group) and Principal Aquifer (Thanet Sands and White Chalk Subgroup) – High receptor sensitivity/value.

12.6.4 The magnitude of impact, prior to any required mitigation is conservatively considered to be high for human health and medium to controlled waters.

12.6.5 For human health, as a result of the high magnitude of impact and high receptor sensitivity/value it is considered that there would potentially be a major adverse effect in the absence of appropriate mitigation. This effect would be irreversible and long-term in nature.

12.6.6 For Controlled Waters, with a high receptor sensitivity and medium magnitude of impact, there is likely to be a major adverse effect that would be temporary and medium term.

12.6.7 However, with adherence to the standard management measures outlined in Table 12.5, in the event that known or previously unforeseen contamination is encountered, a protocol will be in place to ensure the risks are managed effectively. As a result of the aforementioned standard management measures there will be a Negligible effect to human health and controlled waters.

Ground Gas and Vapours

12.6.8 Due to significant depths of Made Ground and the Site's historical use as a landfill site, hazardous ground gases and vapours have the potential to accumulate in confined spaces during the demolition and construction phases. This could result in impacts to construction workers and to building and construction materials through asphyxiation and the ignition of explosive gases. Based on the ground gas monitoring undertaken during the LCG investigations, the calculated GSV equates to a Characteristic Situation 2. The inclusion of ventilated undercroft car park within the proposed Development provides an inherent level of protection from ground gases once the Development is completed and occupied.

12.6.9 The magnitude of impact for all of these scenarios is considered to be high.

12.6.10 A pathway has been identified to the following potentially sensitive receptors:

- Human health receptors, including construction workers– high receptor sensitivity/value;
- Building and construction materials – medium receptor sensitivity/value.

12.6.11 The magnitude of the impact is classified as high and the sensitivity of human health and building and construction materials is high and medium respectively, therefore, the potential effect would be major adverse and would be irreversible and long-term in nature.

12.6.12 However, these potential effects are mitigated to negligible provided the health and safety precautions discussed in Table 12.5 are implemented.

Creation of Pathways for Contaminant Migration

12.6.13 During enabling/construction works, there is the potential that preferential pathways could be created allowing the migration of contaminants. Preferential pathways can be created through the introduction of piles or penetration of relatively impermeable stratum including the London Clay. No soil leachate or perched water analysis was undertaken during the LGC ground investigations. Based

on the considerable thickness of Made Ground present at the Site and the Site's former use as a landfill, the presence of leachable contaminants or impacted perched water cannot be ruled out. In addition, the presence of soft landscaping areas has the potential to expose future site users and adjacent site users to the direct contact and inhalation pathways with contaminated soils and dusts, including ACM. Flora and Fauna has the potential to be impacted from plant uptake of phytotoxic contaminants.

12.6.14 The human health, controlled waters and ecology are all identified as potential sensitive receptors and are addressed in turn with regard to the relevant potential pathways for contaminant migration.

Human Health, Flora and Fauna

12.6.15 The proposed Development includes soft landscaped areas at podium level. The risk to human health and flora and fauna within these areas is eliminated providing materials used for the build-up of the soft landscaped areas are imported and deemed suitable for use, in line with the recommendations of the LGC 2016 GIR and stated in Table 12.5. Suitable materials will be used, which will result in a beneficial effect to human health and flora and fauna.

12.6.16 The receptor sensitivity is high for human health and low for flora and fauna, whilst the magnitude of effect is considered to be low resulting in a moderate beneficial effect to human health and negligible effect to flora and fauna which would be long term and permanent providing soils remain suitable for use.

Controlled Waters

12.6.17 Should piling activities associated with the proposed Development penetrate through the London Clay into the permeable strata of the Lambeth Group and Thanet Sands, there is the potential for the migration of contaminants to the underlying aquifers via preferential pathways. Based on the foundation solutions included within the LGC 2016 GIR, it is recommended by LGC that piles should be founded in the clay. In this event, the pathway to the underlying aquifers is eliminated.

12.6.18 The receptor sensitivity of the Secondary A Aquifer and Principal Aquifer is high. The magnitude of impact is considered to be medium resulting in a major adverse effect which would be temporary and medium term.

12.6.19 Providing piling is undertaken in accordance with Environmental Agency guidance, soils/perched groundwater are effectively managed and redundant boreholes are decommissioned in line with the mitigation discussed in Table 12.5, the pathway for contaminants to the underlying aquifers is eliminated resulting in negligible effects to controlled waters.

Leakages and Spillages of Substances

12.6.20 During the demolition and construction phase, it is likely that substances and waste materials will need to be stored on-Site.

12.6.21 There is potential for leakages and spillages of such chemicals and/or waste liquids to occur which would adversely affect soil and groundwater quality should preferential pathways to the underlying aquifers be created through piling activities.

12.6.22 The potential receptors are identified as the controlled waters at and adjacent to the site which are of a high receptor sensitivity. In the event of a significant leakage/spillage incident, the magnitude of impact would be low which would result in a moderate adverse effect that would be medium term and temporary. However, with adherence to principles set out in the CEMP regarding the storage, use and emergency response of chemical substances, the potential effect is mitigated to negligible.

Chemical Attack

12.6.23 Existing ground conditions pose a potential risk of chemical attack to buried structures. The concrete classification based on the water soluble sulphate concentrations was calculated as part of the LGC GIRs (2015 and 2016) and was reported to be worst case Design Sulphate Class-2 (DS-2) and Aggressive Chemical Environment for Concrete Class-2 (AC-2).

12.6.24 The receptor sensitivity is Medium and the magnitude of the impact would be low resulting in a minor adverse effect which would be long term and permanent. This is mitigated to negligible with suitable specification of concrete to the ground conditions as discussed in Table 12.5.

Tainting

12.6.25 During the construction phase new potable water pipes will be installed. Should adequate protection measures not be put in place, organic contaminants within the Made Ground have the potential to taint water supplies as a result of chemical attack on the pipes.

12.6.26 The pipe receptor sensitivity has been assessed as low and the magnitude of the impact would be classified as low resulting in an adverse negligible effect which would be long-term and permanent in nature.

12.6.27 As a consequence of the pipes carrying potable water supplies indirect impacts would also occur on human health receptors including future Site users. the receptor sensitivity would be high and the

magnitude of the impact would still be classified as low. Therefore, a moderate adverse effect could occur which would be long term and permanent in nature.

12.6.28 Potential effects arising from the tainting of water supply pipes are mitigated to negligible providing they are installed with consideration of the ground conditions using necessary precautions such as barrier pipe.

Generation of Arisings from the Ground (e.g. soil)

12.6.29 Piling activities and basement excavations are likely to result in a significant quantity of material to be removed from the Site. The arisings are likely to be stored onsite before subsequently being taken to an appropriately licenced facility.

12.6.30 With no mitigation in place, the unsuitable storage of arisings has the potential to result in the mobilisation of contaminated dusts or airborne contaminants including asbestos fibres. This has the potential to impact on the human health of construction workers and adjacent site users which have a high receptor sensitivity. The magnitude of effect is classified as medium resulting in a major adverse effect which would be long term and permanent.

12.6.31 Waste products, and in particular contaminated soil arisings, have the potential to cause adverse environmental impacts at the site to controlled waters. The receptor sensitivity has been assessed as high to medium and the effect would be classified as low. Therefore, a moderate adverse effect could occur which is likely to be temporary and medium term.

12.6.32 In accordance with the measures outlined within Table 12.5 including the suitable use of dust suppression and suitable storage of waste, the potential effects arising from waste materials are mitigated to negligible.

Mitigation Measures and Residual Effects

12.6.33 Providing the environmental design and management measures outlined within Table 12.5 is adhered to and incorporated in the proposed Development, the potential adverse effects as identified within section 12.6 are all mitigated to negligible. Therefore, there are no residual effects or specific mitigation measures required for the construction and demolition phase of the Development.

12.7 Completed Development

Assessment of Effects

12.7.1 The potential completed Development phase effects which have been identified as part of the assessment are considered to be addressed at the construction phase and therefore no further action is deemed necessary.

12.7.2 Measures adopted to mitigate potential completed Development phase effects comprise:

- The breaking of pathways to controlled waters though the adoption of suitable piling techniques (to be investigated as part of a piling risk assessment) and decommissioning of redundant boreholes to prevent effects being realised during the completed Development phase;
- The use of chemically suitable materials within proposed soft landscaped areas to prevent effects to the human health of future site users and flora and fauna;
- The incorporation of ventilated undercroft parking within the proposed development which provides ground gas protection to the human health of future Site users and building and construction materials during the completed Development phase; and
- The selection of suitable below ground concrete and water supply pipes depending on the ground conditions.

12.8 Cumulative Effects

Demolition and Construction

12.8.1 Effects relating to ground conditions and contamination are typically site specific. Because of this, it is considered highly unlikely that there will be any cumulative residual effects resulting from the proposed Development and the cumulative schemes. Additionally, the remediation of land contamination on this Site, combined with any remediation on other sites should provide a cumulative benefit to the land quality in the area. The potential for contamination and the associated risks and effects would be identified by the applications of all cumulative schemes and would ensure that each cumulative scheme would be suitable for use in accordance with the legislative requirements under Part IIA of the Environmental Protection Act 1990. During works all demolition and construction activities would also be tightly controlled and managed via the implementation of both relevant legislative requirements and good practice guidance to minimise contamination risks and effects to the environment (including human health) to an acceptable level.

12.8.2 The likely demolition and construction effects from ground conditions and contamination effects on cumulative schemes would therefore be negligible.

Completed Development

12.8.3 As noted above, effects relating to ground conditions and contamination are typically site specific. The proposed Development and all surrounding cumulative schemes would have to adhere to mandatory legislative requirements to ensure that the proposed Developments end use and the cumulative schemes do not cause unacceptable contamination risks and effects to the environment.

12.8.4 The likely completed Development construction effects from ground conditions and contamination on cumulative schemes would therefore be negligible.

12.9 Summary

Table 12.5 Summary of Effects of the Development

Potential Effect	Geographical Level of Importance[1]					Significance of Effect	Mitigation Measures	Residual Effect
	I	N	R	D	L			
Construction								
Disturbance/Mobilisation of Contaminated Material &/or Contaminants - Human Health					L	Major Adverse	Removal of underground obstructions; CEMP	Negligible
Disturbance/Mobilisation of Contaminated Material &/or Contaminants - Controlled Waters				D		Major Adverse	Removal of underground obstructions; Dewatering excavations; CEMP	Negligible
Ground Gas and Vapours – Human Health and Building and Construction Materials					L	Major Adverse	CEMP	Negligible
Creation of Pathways for Contaminant Migration – Human Health					L	Moderate Beneficial	Materials used in landscaped areas are required to be deemed suitable for use	Moderate Beneficial
Creation of Pathways for Contaminant Migration – Flora and Fauna					L	Negligible	Materials used in landscaped areas are required to be deemed suitable for use	Negligible
Creation of Pathways for Contaminant Migration – Controlled Waters				D		Major Adverse	Dewatering excavations; Material/Waste Soil Management; Foundation Methodology; Decommissioning of redundant boreholes	Negligible
Leakages and Spillages of Substances – Controlled Waters				D		Moderate Adverse	Decommissioning of ASTs and USTs CEMP	Negligible
Chemical Attack and Tainting – Building and Construction Materials					L	Minor to Negligible Adverse	Below Ground Concrete Specification; Specification of Water Supply Pipes	Negligible

[1] Key: I – International; N – National; R – Regional; D – District; L – Local

Potential Effect	Geographical Level of Importance[1]					Significance of Effect	Mitigation Measures	Residual Effect
	I	N	R	D	L			
Tainting – Human Health					L	Moderate Adverse	Specification of Water Supply Pipes	Negligible
Generation of Arisings from the Ground (e.g. soil) – Human Health					L	Major Adverse	CEMP	Negligible
Generation of Arisings from the Ground (e.g. soil) – Controlled Waters				D		Moderate Adverse	CEMP	Negligible

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14 DAYLIGHT, SUNLIGHT & OVERSHADOWING

14.1 Introduction

14.1.1 This chapter of the Environmental Statement (ES) has been prepared by Delva Patman Redler LLP and assesses the potential effect that the Pentavia Retail Park (the 'Development') will have on daylight, sunlight, overshadowing and solar glare to neighbouring properties.

14.1.2 The chapter is accompanied by the following Appendices:

- Appendix 14.1: Location Plans and Spot Height Drawings;
- Appendix 14.2: Daylight and Sunlight Results;
- Appendix 14.3: Overshadowing Assessment; and
- Appendix 14.4: Solar Glare Assessment.

14.2 Legislation, Planning Policy and Guidance

Legislation Context

14.2.1 There is no relevant legislation that directly references the BRE Guide for daylight, sunlight, overshadowing and solar glare.

National Planning Policy

National Planning Policy Framework, 2012

14.2.1 This chapter has considered the National Planning Policy Framework[1] (NPPF) in conjunction with the BRE Guide. There is no national policy specifically relevant to daylight, sunlight and overshadowing, although, guidance seeks to ensure that new development results in an acceptable level of amenity.

Planning Practice Guidance, 2014

14.2.2 The Planning Practice Guidance[2] (PPG) states that Local Planning Authorities should secure design quality through the policies adopted in their Local Plans. Paragraph 027 states that account should be taken of local climatic conditions, including daylight and sunlight.

Regional Planning Policy

The London Plan, Spatial Development Strategy for Greater London

14.2.3 The London Plan[3] does not specifically reference daylight, sunlight, overshadowing and solar glare, but does reference the National Planning Policy Framework. Policy 7.6 however, states that proposed developments should not cause unacceptable harm to the amenity of surrounding land and buildings.

Local Planning Policy

London Borough of Barnet's Local Plan Core Strategy, Development Plan Document

14.2.4 The LBB Core Strategy[4] does not specifically refer to daylight, sunlight, overshadowing and solar glare, however it does state that, overall the design of the new development schemes will be expected to enhance the qualities of their immediate location and wider setting, as well as improve the quality of life for those people living and working in the area.

Guidance

Building Research Establishment Guidelines 'Site Layout Planning for Daylight and Sunlight. A Guide to Good Practice' (2011)

14.2.5 The BRE guide[5] is intended for building designers and their clients, consultants and planning officials. The advice given is not mandatory and the report should not be seen as a part of planning policy. Its aim is to help rather than constrain the designer. Although it gives numerical guidelines, these should be interpreted flexibly because natural lighting is only one of the many factors in site layout design. In certain circumstances the developer or planning authority may wish to use alternative target values.

14.2.6 Whilst technical analysis can be carried out in accordance with numerical guidelines and reported factually by comparison with those guidelines, the final assessment as to whether affected dwellings are left with acceptable amounts of daylight and sunlight in an inner city context where the findings are to be interpreted in a flexible manner is a matter of subjective opinion.

14.3 Assessment Methodology

Consultation

14.3.1 Consultation has been undertaken with relevant stakeholders. The EIA Scoping Report was submitted to the London Borough of Barnet (LBB) on 8th April 2016 (see Appendix 2.1 of Volume 2 of this ES), the

formal Scoping Opinion was issued by the LBB on the 28th July 2016 (see Appendix 2.2 of Volume 2 of this ES) which included comments from LBB in respect to daylight, sunlight, overshadowing and solar glare. No further consultation was deemed necessary as part of the assessment. The consultation responses are contained in Table 14.1.

Table 14.1 Consultation Response Summary

Consultation Comment	Response
Scoping Opinion	
The Applicant originally scoped this issue out of the EIA. The applicant did however propose to submit with the planning application a daylight, sunlight and overshadowing report, as required by policy, which will include the following: • Daylight and sunlight assessment of neighbouring residential properties; • Overshadowing assessment of neighbouring amenity spaces, as well as, the new amenity space within the proposed scheme; • Daylight assessment of new habitable within the proposed scheme on the ground and first floors to show compliance; and • Solar Glare assessment of the neighbouring roads and key junctions. The submission of a daylight, sunlight and overshadowing report is considered to be an acceptable approach to assessing these issues. However, due to the significant massing and height of the proposed scheme, there may be impacts that will occur from the new development that are detrimental to the surroundings. Until the data, evidence and details have been submitted to show the impact, this issue cannot be scoped out of the EIA. The applicant has agreed to scope this issue in to the EIA, for full assessment.	Daylight, sunlight, overshadowing and solar glare has been included within the EIA as Chapter 14 of the ES. The ES Chapter presents the results of the assessment for: • Daylight and sunlight assessment of neighbouring residential properties; • Overshadowing assessment of neighbouring amenity spaces, as well as, the new amenity space within the proposed scheme; and • Solar Glare assessment of the neighbouring roads and key junctions. An internal daylight assessment of new habitable rooms within the proposed scheme on the ground and first floors to show compliance with BRE has been prepared as a standalone report and is submitted in support of the planning application.

Scope of Assessment

Methodology for Determining Baseline Conditions and Sensitive Receptors

Daylight, Sunlight and Overshadowing

14.3.2 The baseline conditions and scope was based on an initial desk-top study, followed by a site inspection and external inspection of the neighbouring residential properties.

14.3.3 The residential properties are located quite far away from the Site. To show compliance with the relevant BRE target values a sample of residential properties have been assessed to the west along Grahame Park Way and to the properties situated to the south of Bunns Lane to the east. The new residential properties to the north have also been considered (Churchill Place).

The neighbouring residential properties considered for the daylight, sunlight and overshadowing assessment are shown on drawing 16336/LOC/DS/800 in Appendix 14.1.

Solar Glare

14.3.4 The baseline condition and scope was based on an initial desk top study, followed by a site inspection of the relevant neighbouring roads and key junctions.

Methodology for Determining Demolition and Construction Effects

14.3.5 Owing to the evolving and changing conditions at the Site during demolition and construction activities, the assessment of potential effects during demolition and construction of the proposed Development on daylight, sunlight, overshadowing and solar glare to surrounding properties has not been modelled. Instead, a qualitative assessment has been undertaken using professional judgement and experience.

14.3.6 Since the potential daylight, sunlight, overshadowing and solar glare effects relating to demolition and construction works will vary throughout the construction programme and gradually increase to the potential effects identified for the completed proposed Development, the interim construction effects are not assessed quantitatively as it is considered that the completed proposed Development represents the worst case assessment in terms of likely daylight, sunlight, overshadowing, solar glare and light pollution effects.

Methodology for Determining Effects of the Proposed Development

14.3.7 The following approaches are undertaken to assess the effect on the sensitive receptors of surrounding properties when the Proposed Development is completed and operational:

- Daylight:
  - Vertical Sky Component (VSC);
  - No Sky Line (NSL) Method; and
  - Average Daylight Light Factor (ADF).

- Sunlight - Annual Probable Sunlight Hours (APSH).

14.3.8 The effect of transient overshadowing is assessed on amenity areas and the effect of solar glare is assessed in regards to surrounding road users and surrounding occupants of buildings.

14.3.9 The properties identified in the scope assessment have been assessed by calculating the daylight, sunlight and overshadowing based on the template drawings provided within the BRE Guide. A detailed 3D computer study of the proposed Development and neighbouring properties for daylight, sunlight and overshadowing effects was undertaken with external drawings derived from:

- Existing and surrounding buildings: Zmapping context model; and
- Proposed Scheme: Arney Fender Katsalidis Architects: 3D model provided 19 August 2016.

Daylight

14.3.10 The BRE guidelines states that:

> ***"…In special circumstances the developer or planning authority may wish to use different target values. For example, in an historic city centre a higher degree of obstruction may be unavoidable…"***

The report guidelines add that:

> ***"…Different criteria may be used, based on the requirements for daylighting in an area viewed against other site layout constraints."***

14.3.11 The BRE guidelines propose several methods for calculating daylight. The three main methods adopted within this report are the Vertical Sky Component (VSC), the No Sky Line (NSL) and the Average Daylight Factor assessment (ADF).

14.3.12 The VSC calculation is a general test of potential for daylight to a building, measuring the light available on the outside plane of windows. The BRE states that if a room has two or more windows, the mean of their VSC may be taken.

14.3.13 The NSL divides those areas of the working plane which can receive direct skylight, from those which cannot. It provides an indication of how good the daylight distribution is within a room.

14.3.14 The ADF assesses the amount of daylight within a room served by a window and takes into account the VSC value, the size and number of the windows and room and the use to which the room is put. ADF assesses the overall amount of daylight within a defined room area whereas the VSC considers

potential light. British Standard 8206, Code of Practice for Daylighting[6] recommends ADF values of 1% in bedrooms, 1.5% in living rooms and 2% in kitchens. For other uses, where it is expected that supplementary electric lighting will be used throughout the daytime, such as in offices, the ADF value should be at least 2%. There is no general requirement within the BRE guidelines to assess ADF values, other than for neighbouring residential buildings or sensitive receptors such as museums or schools.

Sunlight

14.3.15 The BRE have produced sunlight templates for London, Manchester and Edinburgh indicating the Annual Probable Sunlight Hours (APSH) for these regions. The London template has been selected for this study as the London indicator template is the closest of the three available from BRE in terms of latitude.

14.3.16 Sunlight analysis is undertaken by measuring annual probable sunlight hours (APSH) for the main windows of rooms which face within 90° of due south. The maximum number of annual probable sunlight hours for the London orientation is 1,486 hours. The BRE guidelines propose that the appropriate date for undertaking a sunlight assessment is on 21st March, being the spring equinox. Calculations of both summer and winter availability are made with the winter analysis (WPSH) covering the period from the 21st September to 21st March. For residential accommodation, the main requirement for sunlight is in living rooms and it is regarded as less important in bedrooms and kitchens. This report has assessed sunlight to all rooms that face within 90° of due south.

Overshadowing

14.3.17 The BRE advises that amenity spaces such as gardens, parks, children's playgrounds should be considered for overshadowing assessments. It recommends that at least half of the amenity areas should receive at least two hours of sunlight on 21st March, between the hours 7am-5pm.

For the purposes of this assessment, we have considered the following amenity spaces.

- New proposed amenity space within the Development; and
- Amenity space to the east of the Nursey located within Churchill Place (50m north of the Site).

Solar Glare

14.3.18 Solar glare principally occurs when the sun is low in the sky and dazzles the eye either directly or indirectly via a reflected surface. Solar glare is a highly localised and short term effect dependent on the direction of an individual's view, the position of the sun relative to the viewer and reflecting

surface, together with localised weather conditions. Glare can affect all road users to include pedestrians and drivers. The effect of solar glare, the reflected image of the sun on the glass façade of the Development was analysed at specific locations chosen on the basis that they are most likely to be significantly affected by any Development generated glare. Key locations are generally considered to be relevant adjacent local traffic junctions and sections of road likely to be affected due to their orientation and direction of traffic flow in relation to the Site. These locations included in the solar glare assessments are as follows:

- Test Point 1: M1 heading north;
- Test Point 2: Watford Way heading north;
- Test Point 3: Watford Way heading south; and,
- Test Point 4: M1 heading south.

14.3.19 The solar glare assessments, attached as Appendix 14.4 in Volume 2 of ES, were carried out by reference to the BRE Information Paper 'Solar dazzle reflected from sloping glazed facades'[7]. This paper presents a technique that can be used to predict solar reflection at the design stage. At the heart of the technique is the mathematical modelling of reflection from a sloping plane. For this assessment, the analysis was carried out using the 3D model of the Development and surrounding area and specialist lighting calculations to identify where, when and whether any glare would occur and whether the glare would be likely to create a safety issue to local pedestrian and vehicular daytime traffic.

Assumptions and Limitations

14.3.20 The neighbouring residential window and room sizes and positions have been based on external inspection.

Significance Criteria

14.3.21 The BRE Guide provide criteria and methods for calculating daylight and sunlight levels. These criteria have been used to assess the likely levels of light to habitable rooms both within the Development and the surrounding properties. Compliance with the BRE Guide is achieved if the levels of daylight /

sunlight within the habitable spaces of the Development and the surrounding properties are equal to or over the values established by the Guide.

14.3.22 Compliance with the BRE Guide is also achieved for the habitable spaces of the surrounding properties if the ratio of impact between the baseline and the Development is 0.80 or higher, i.e. the reduction in daylight or sunlight hours is 20% or less. An additional criterion of overall annual loss for APSH values also needs to be satisfied to comply with the recommended BRE guidelines.

14.3.23 A negligible magnitude of change is established if compliance with the BRE criteria is met.

14.3.24 For the affected receptors that lie below the recommended BRE guidelines, the magnitude of change has been classified using professional judgement depending on the ratio of impact between the 'Baseline Scenario' and the 'Proposed Scenario' (i.e. the completed Development).

Sensitivity of Receptor

14.3.25 The BRE Guide advises that daylight levels should be assessed for the main habitable rooms of neighbouring residential properties. Habitable rooms in residential properties are defined as kitchens, living rooms, dining rooms and bedrooms. Bedrooms are considered less important as they are mainly occupied at night time.

14.3.26 The BRE guidelines are principally set up for residential properties. It is common practice to test only residential properties unless the neighbouring buildings have a reasonable expectation of daylight such as schools or hospitals.

Table 14.2 Definitions of Receptor Sensitivity

Sensitivity / Value	Definition
High	Residential Properties
Medium	Listed Buildings, Schools, Hospitals
Low	Commercial Buildings

Magnitude of Effect

14.3.27 The criteria used for determining the magnitude of change for the VSC, NSL, ADF, APSH and WPSH results has been detailed in Tables 14.3 to 14.7.

Table 14.3 Definitions of Magnitude of Effect for VSC Results

Sensitivity / Value	Definition
High	In excess of 40% of existing baseline condition
Medium	Between 30% - 40% of existing baseline condition
Low	Between 20%-30% of existing baseline condition
Negligible	Within 20% of existing baseline condition or above 27% sky visibility

Table 14.4 Definitions of Magnitude of Effect for NSL Results

Sensitivity / Value	Definition
High	In excess of 40% of existing baseline condition
Medium	Between 30% - 40% of existing baseline condition
Low	Between 20%-30% of existing baseline condition
Negligible	Within 20% of existing baseline condition or above 80% overall room coverage

Table 14.5 Definitions of Magnitude of Effect for ADF Results

Sensitivity / Value	Definition
High	In excess of 40% of existing baseline condition
Medium	Between 30% - 40% of existing baseline condition
Low	Between 20%-30% of existing baseline condition
Negligible	Within 20% of existing baseline condition or above 1% for bedrooms, 1.5% for living rooms and 2% for kitchens

Table 14.6 Definitions of Magnitude of Effect for APSH Results

Sensitivity / Value	Definition
High	In excess of 40% of existing baseline condition
Medium	Between 30% - 40% of existing baseline condition
Low	Between 20%-30% of existing baseline condition
Negligible	Within 20% of existing baseline condition or above 25% APSH

Table 14.7 Definitions of Magnitude of Effect for WPSH Results

Sensitivity / Value	Definition
High	In excess of 40% of existing baseline condition
Medium	Between 30% - 40% of existing baseline condition
Low	Between 20%-30% of existing baseline condition
Negligible	Within 20% of existing baseline condition or above 5% WPSH

14.3.28 The BRE guidance is summarised in Table 14.8 and this has been used as the basis for the criteria used in the assessment of daylight, sunlight and overshadowing impacts.

Table 14.8 Daylight, Sunlight and Overshadowing Guidance in the Assessment

Issue	Criteria
Daylight	A window may be affected if the VSC measured at the centre of the window is less than 27% and less than 0.8 times its former value.
	A room may be adversely affected if a significant area of the room is beyond the NSL and is less than 0.8 times its former value.
	A room may be adversely affected if the ADF is less than 1% for a bedroom, 1.5% for a living room or 2% for a kitchen. For offices a minimum figure of 2% is required.
Sunlight	A window may be adversely affected if a point at the centre of the window receives in the year less than 25% of the annual probable sunlight hours including at least 5% of the APSH during the winter months (21 September to 21 March) and less than 0.8 times its former sunlight hours during either period.
Overshadowing	For it to appear adequately sunlit throughout the year at least half of a garden or amenity area should receive at least two hours of sunlight on 21 March. If as a result of new development an existing garden or amenity area does not meet the above, and the area which can receive two hours of sun on 21 march is less than 0.8 times its former value, then the loss of light is likely to be noticeable. If a detailed calculation cannot be carried out, it is recommended that the centre of the area should receive at least two hours of sunlight on 21 March.

14.3.29 There are no numerical significance values available for solar glare effects affecting sensitive receptors. Instead, key locations are identified where glare may cause safety to be compromised for pedestrian and vehicular traffic. Views are analysed from these locations to ascertain whether there would be any glare. Professional judgement was applied to conclude significance. It is unreasonable to expect complete avoidance of solar glare; however, prolonged periods of glare may be regarded as a significant effect.

Evaluation of Significance

14.3.30 Table 14.9 demonstrates how the proposed significance of potential effects is justified against the magnitude of effects and the sensitivity of the receptor.

Table 14.9 Significance Matrix

Sensitivity/Value of Receptor	Magnitude of Effect			
	High	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible

14.4 Baseline Conditions

14.4.1 In order to assess the potential effects of the Development, it is necessary to determine the environmental conditions, resources and sensitive receptors that currently exist on the Site and surrounding area. The impact of the existing buildings against which to compare any potential impact arising from the development have been undertaken based on Drawing 16336/SPT/800 shown in Appendix 14.1.

14.4.2 The Site currently comprises one large retail building (class use A1/ A4) in the north of the Site and a smaller restaurant building (class use A3) in the south of the Site with associated car parking in between. The site is situated in the middle of the M1 to the west and the A1 to east. As a result of this, the relevant neighbouring residential properties are situated quite far away from the Development, and benefit from good levels of natural light.

14.4.3 An analysis of the existing daylight levels enjoyed by the relevant neighbouring properties has been undertaken in order to provide a baseline against which the impacts arising from the Development can be assessed. The detailed results of this analysis are presented in Appendix 14.2.

14.5 Environmental Design and Management

14.5.1 Delva Patman Redler LLP have undertaken daylight, sunlight and overshadowing assessments for several scheme iterations to inform the design evolution in regards to the effects on the surrounding buildings and environment.

14.5.2 Consideration has also been given within the design to the potential for reflection and thus solar glare, by incorporating materials that reduce the potential for solar glare to occur.

14.6 Construction

Assessment of Effects

14.6.1 The effect to the daylight, sunlight, overshadowing and solar glare on the surrounding properties would vary throughout any demolition and construction phase, depending on the level of obstruction caused. The effects during the demolition and construction would almost certainly be less than that of the Proposed Development, given that the extent of permanent massing would increase throughout the construction phase, until the buildings is complete.

14.6.2 The assessment of the effects of the completed and occupied Development (see below) provides a 'worst case' assessment of construction effects. Therefore, reference should be made to the assessments of the proposed Development discussed in the sections below.

Mitigation Measures and Residual Effects

14.6.3 No mitigation measures are required in terms of daylight, sunlight, overshadowing and solar glare during the construction phase.

14.7 Completed Development

Assessment of Effects

Daylight

Daylight – Vertical Sky Component (VSC)

14.7.1 The full results of the daylight analyses are presented in Appendix 14.2 in graphical and tabular form. A summary of the results of the VSC analysis on the relevant overlooking windows/rooms are presented in Table 14.10. This identifies where habitable windows/rooms are left with adequate light.

Table 14.10 Number of Windows Experiencing Daylight Impacts (VSC Method)

Address	Number of Windows Tested	Number of Windows Experiencing Adverse Impacts			
		Negligible Levels of Light Loss (<20% Difference)	Minor Light Loss (20-30% Difference)	Moderate Light Loss (30-40% Difference)	Major Light Losses (>40% Difference)
Palmerstone Court	12	10	2	0	0
17 Grahame Park	2	2	0	0	0

19 Grahame Park	2	2	0	0	0
Farm House Court	12	12		0	0
Total	**28**	**26**	**2**	**0**	**0**

14.7.2 Table 14.10 indicates that of the 28 windows assessed 26 (92.8%) will fully comply with the BRE target values for the VSC method of assessment. None of the windows assessed will experience no more than a minor light loss as a result of the Development.

Daylight – No Sky Line (NSL)

14.7.3 The full results of the daylight analysis are presented in Appendix 14.2 in tabular form. A summary of the results of the NSL analysis on the relevant overlooking rooms are presented in Table 14.11. This identifies where habitable rooms are left with adequate light.

Table 14.11 Number of Rooms Experiencing Daylight Impacts (NSL Method)

Address	Total Number of Rooms Tested	Number of Rooms Experiencing Adverse Impacts			
		Negligible Levels of Light Loss (<20% Difference)	Minor Light Loss (20-30% Difference)	Moderate Light Loss (30-40% Difference)	Major Light Losses (>40% Difference)
Palmerstone Court	6	6	0	0	0
17 Grahame Park	2	2	0	0	0
19 Grahame Park	2	2	0	0	0
Farm House Court	12	12	0	0	0
Total	**22**	**22**	**0**	**0**	**0**

14.7.4 Table 14.11 indicates that all of the windows assessed will fully comply with the BRE target values for the NSL method of assessment.

Overall Daylight Evaluation

14.7.5 Overall, the VSC and NSL methods of assessment show that the Development will not have a significant effect on the quality, quantity and distribution of light that the neighbouring properties currently receive, and therefore the Development is not of an excessive scale for the immediate surrounding areas in daylight terms. The VSC results demonstrate that the Development will have no more than a minor light loss effect on all of the windows assessed within the neighbouring properties. The NSL

results show that all of the windows assessed fully comply with the BRE target values in NSL terms. The Development is therefore considered acceptable in terms of neighbouring daylight impact.

Sunlight – Annual Probable Sunlight Hours (APSH)

14.7.6 The full results of the sunlight analyses are presented in Appendix 14.1 in tabular form. A summary of the results of the APSH analysis on the relevant overlooking windows are presented in Table 14.12.

Table 14.12 Number of Windows Experiencing Daylight Impacts (APSH Method)

Address	Total Number of Rooms Tested	Rooms Meeting BRE Guidelines for APSH	Number of Rooms Experiencing Impacts beyond BRE Guidance
Palmerstone Court	12	12	0
Farm House Court	12	12	0
Total	**24**	**24**	**0**

14.7.7 Table 14.12 indicates that all of the windows assessed will fully comply with the BRE target values for the APSH method of assessment.

Overshadowing

14.7.8 The drawings 16336/SHA/501-506 in Appendix 14.4 show the hourly images of the transient shadow on March 21st for the new amenity areas within the Development. Drawing 16336/SHA/507 shows the areas of the Development that have been considered for assessment, and highlights the areas that receive at 2 hours of direct sunlight on March 21st.

14.7.9 The shadow analysis indicates that the new amenity space with the Development will fully comply with the BRE target values.

Solar Glare

14.7.10 The glass facades of the Development would produce some solar glare as any building with glass or bright, shiny surfaces would at some point throughout the year. The Development is situated in between the M1 to the west and the A1 to the east. The immediate surrounding area is open and as a result there is the potential for solar glare to effect the neighbouring roads. Technical assessment drawings 16336/GLR/301-304 shown in Appendix 14.4 show the periods where glare would be created at the four assessment points.

Test Point 1: M1 Heading North

14.7.11 The tinted zones on the Sunlight Availability Indicator on drawing 16336/GLR/301 in Appendix 14.4 show the results of the solar glare for Test Point 1.

14.7.12 The assessment indicates that reflected solar glare could occur between around 17.15 and 19.30 hours GMT, from March to September (Zone 1), and again between 7.30 and 9.30 hours GMT from mid-February to October (Zone 2) and also between 10.30 and 11.30 hours GMT in December (Zone 3), totalling around 570 hours per year. The sun availability protector (as set out in the BRE Information Paper 'Solar dazzle reflected from sloping glazed facades') indicates that during these periods sunlight is obtained for between 10% and 30% of the time.

14.7.13 Therefore, solar dazzle could occur at Test Point 1 for around 84 hours per year. This is considered to be a minor adverse, highly localised periodic effect.

Test Point 2: Watford Way Heading North

14.7.14 The tinted zones on the Sunlight Availability Indicator on drawing 16336/GLR/302in Appendix 14.4 show the results of the solar glare for Test Point 2.

14.7.15 The assessment indicates that reflected solar glare could occur between around 6.15 and 7.00 hours GMT, from March to September (Zone 1), and again between 11.30 and 12.30 hours GMT from mid-October to mid-February (Zone 2), totalling around 240 hours per year. The sun availability protector (as set out in the BRE Information Paper 'Solar dazzle reflected from sloping glazed facades') indicates that during these periods sunlight is obtained for between 10% and 30% of the time.

14.7.16 Therefore, solar dazzle could occur at Test Point 2 for around 75 hours per year. This is considered to be a minor adverse, highly localised periodic effect.

Test Point 3: Watford Way Heading South

14.7.17 The tinted zones on the Sunlight Availability Indicator on drawing 16336/GLR/303 in Appendix 14.4 show the results of the solar glare for Test Point 3.

14.7.18 The assessment indicates that reflected solar glare could occur between around 5.00 and 11.30 hours GMT, for each day of the year, totalling around 2,372.5 hours per year. The sun availability protector (as set out in the BRE Information Paper 'Solar dazzle reflected from sloping glazed facades') indicates that during these periods sunlight is obtained for between 10% and 30% of the time.

14.7.19 Therefore, solar dazzle could occur at Test Point 3 for around 474.5 hours per year. This could be considered to be a minor adverse, highly localised periodic effect.

Test Point 4: M1 Heading South

14.7.20 The tinted zones on the Sunlight Availability Indicator on drawing 16336/GLR/304 in Appendix 14.4 show the results of the solar glare for Test Point 4.

14.7.21 The assessment indicates that reflected solar glare could occur between 5.00 and 7.30 hours GMT from February to October (Zones 1-3), and again between 8.45 and 15.30 hours GMT from late October and early February (Zone 2), totalling around 1,215 hours per year. The sun availability protector (as set out in the BRE Information Paper 'Solar dazzle reflected from sloping glazed facades') indicates that during these periods sunlight is obtained for between 10% and 30% of the time.

14.7.22 Therefore, solar dazzle could occur at Test Point 4 for around 243 hours per year. This could be considered to be a minor adverse, highly localised periodic effect.

Overall Solar Glare Evaluation

14.7.23 The technical analysis undertaken only considers main building façades to assess the worst case scenario. The analysis does not take into account specific design features to mitigate the potential for solar glare, for example building materials that do not produce or limit the effect of glare. The true effect on solar glare would therefore be much lower than that actually assessed.

14.7.24 The technical analysis shows that for the majority of the year there would be a negligible solar glare effect. The nature of the proposed glazed cladding does mean that reflected solar glare would be unavoidable at certain times of the day, assuming that there are actually clear skies at these times to allow the sun to reflect off the building façades. The analysis shows, however, that at worst this would be a highly local, short term potential effect of minor adverse significance, lasting only a few hours at any one time.

14.7.25 The analysis shows that there would be a potentially localised short term minor adverse effect from solar glare, and that this would not be detrimental to the safe movement of pedestrians and vehicular users on the pavements and roads surrounding the Development. Overall, the solar glare assessment indicates that the proposed scheme will have a negligible effect on the relevant neighbouring roads and junctions.

Mitigation Measures and Residual Effects

14.7.26 There are no mitigation measures required in terms of daylight, sunlight, overshadowing and solar glare once the Development is complete. Therefore, the residual effects are as stated in the Assessment of Effects section above.

14.8 Cumulative Effects

Construction

14.8.1 The cumulative assessment of the effects of the completed and occupied Development (see below) provides a 'worst case' assessment of construction effects. Therefore, reference should be made to the Completed Development cumulative effects section below.

Completed Development

14.8.2 There are no developments in the area that could impact or alter the daylight, sunlight, overshadowing and solar glare results reported in the Complete Development Assessment of Effects section above.

14.9 Summary

Table 14.13 Summary of Effects of the Development

Potential Effect	Geographical Level of Importance[1]					Significance of Effect	Mitigation Measures	Residual Effect
	I	N	R	D	L			
Construction								
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Completed Development								
Daylighting to neighbouring residential properties						Low	None	Negligible
Sunlight to neighbouring residential properties						Low	None	Negligible
Overshadowing to private and public amenity space						Low	None	Negligible
Solar Glare						Low	Non-reflective glazing or amendments to louvre detail.	Negligible
Cumulative Effects								
N/A						N/A	N/A	N/A

[1] Key: I – International; N – National; R – Regional; D – District; L – Local

REFERENCES

[1] Department for Communities and Local Government (DCLG), 2012. National Planning Policy Framework.

[2] DCLG, 2014. Planning Practice Guidance.

[3] Greater London Authority, 2016. The London Plan: The Spatial Development Strategy for London Consolidated with Alterations since 2011. March 2016.

[4] Greater London Authority (GLA), 2015. The London Plan: The Spatial Development Strategy for Greater London Consolidated with Alternations since 2011.

[5] Building Research Establishment (BRE). Site Layout Planning for Daylight and Sunlight: A Guide to Good Practice (the BRE Guide).

[6] British Standard, (2008). BS 8206-2:2008 Lighting for buildings. Code of Practice for Daylighting.

[7] British Research Establishment, 1987. Information Paper 3/87 'Solar dazzle reflected from sloping glazed facades.