



Ballymore Properties Limited

**Blyth Road, Hayes,
Middlesex**

*Geotechnical and Geoenvironmental
Interpretative Report*

April, 2013



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EXECUTIVE SUMMARY

CGL has been commissioned by Ballymore Properties Ltd. to undertake a desk study and intrusive investigation at Blyth Road, Hayes, Middlesex to provide information for future purchasers. Preliminary development proposals for the site indicate that the site will be used for residential purposes.

The site is currently used as storage for portacabins and is surrounded by residential developments to the north, a railway to the south and commercial buildings to the east and west. A review of historical maps shows that the site has been in use as an industrial site since at least 1934, with no other land use evident. The geology is anticipated to comprise Brickearth underlain by River Terrace Deposits and London Clay and the site is underlain by a principal aquifer.

An intrusive investigation comprising 7 window sampler boreholes and 2 cable percussion boreholes was undertaken on 20th and 27th February 2013. Gas and groundwater monitoring standpipes were installed in 4 boreholes, with monitoring carried out on the 6th March 2013. The ground conditions encountered on site broadly corresponded to published geology and were found to comprise a layer of Made Ground, consisting predominately of clayey sandy gravel, underlain by the firm dark sandy clay of the Brickearth, the sandy gravel of the River Terrace Deposits and the stiff dark grey silty clay of the London Clay Formation.

Based on the ground conditions encountered and assuming that future development will be comprised of high-rise residential accommodation, it is considered that bored cast in-situ or Continuous Flight Auger (CFA) piled foundations will be most appropriate for this site with suspended floor slabs. Based on the pH and sulfate concentrations within the soil and groundwater, and generally in accordance with the BRE Special Digest 1 guidance¹, buried concrete at the site should be designed to Design Class DS-2 with an ACEC class of AC-2 in the Made Ground and Design Class DS-3 with an ACEC class of AC-3 at depth.

The single round of gas monitoring indicated insignificant levels of carbon dioxide and flow and no methane. It is anticipated that no fewer than 3 further visits for ground gas and groundwater monitoring may be required in order to satisfy the local planning authority or building warrantor. This will also allow the ground gas concentrations to be determined and appropriate remediation measures designed if required.

¹ BRE Construction Division. *Concrete in aggressive ground*. Special Digest 1:2005 3rd Ed. 2005

The levels of contamination found within the soils at the site indicate that the site poses a risk to human health due to overall low concentrations of arsenic in the Made Ground, a 'hotspot' of nickel around BH2 and the presence of PAHs in the north-east area of the site. The contamination risks will be reduced if any Made Ground is stripped during site preparation and residual risks will be mitigated by construction of hard and soft capping layers across the site during development.

The results of groundwater analysis indicate a likely plume of organic contamination containing TPH, phenols and xylene, associated with black odourous water encountered in WS06. This plume of contamination is significantly shallower than the surrounding groundwater elsewhere on the site, and further investigation is recommended to further assess the plume. This will inform negotiations with the Environment Agency to be able to ascertain whether a detailed quantitative risk assessment is required to assess remediation requirements, if any.

Due to the presence of asbestos found in one sample, a watching brief is recommended during works with implementation of good dust suppression practice, and provision of appropriate personal protective equipment (PPE). Similarly, observation is required during earthworks around WS06, to check for the source of the underlying groundwater contamination.

Soakaways may be possible within the RTD, avoiding known areas of groundwater contamination subject to confirmation of infiltration rates and agreement with the Environment Agency. Barrier pipes will be required for water supply.

A review of the chemical data for the Made Ground indicates that some of the Made Ground would be classified as hazardous waste if disposed off site to landfill. The material is acceptable to landfill, with simple pre-treatment comprising selective excavation. The remainder of the Made Ground would be classified as non-hazardous, but not inert. This would include the material containing small amounts of asbestos, although the receiving facility would have to be informed accordingly to ensure it is permitted to accept such waste. Unimpacted natural arisings are deemed to be 'listed inert wastes'. Where soils are deemed hazardous due to hydrocarbon content, disposal via a soil treatment facility is advised, where possible, as landfill tax does not apply.

Further investigative works are required for the area of land adjacent to the railway which at the time of the site works was separated from the rest of the site by a metal fence and could not be accessed.

1. INTRODUCTION

CGL has been commissioned by Ballymore Properties Ltd to undertake a geotechnical and geoenvironmental intrusive investigation of the site.

The objectives of the investigation are to confirm the ground conditions such that the implications on future development can be identified. To this end, this investigation:

- provides information on the ground conditions, including the presence or absence of contamination within soils or groundwater;
- includes a generic quantitative risk assessment and conceptual site model;
- provides recommendations relating to soil, gas and groundwater contamination, if necessary.

The information is required to inform potential future purchasers and support future planning applications.

This interpretative report discusses the work undertaken and presents the findings and recommendations with respect to future residential development.

The desk study section of this report has been developed from the previous desk-based investigation for this site undertaken by CGL in 2008 and updated in 2011.

2. DESK STUDY

2.1 Site location and description

The site is located to the south of Blyth Road in Hayes, adjacent to the Bristol to Paddington railway line. A plan showing the location of the site is shown in Figure 1.

The site covers an area of approximately 4200 m² and is an irregular polygon shape. The southern area of the site is a CrossRail safeguarded area and lies on and immediately adjacent to an embankment associated with the railway line. The rest of the site is generally flat.

There are 3 bunkers in the embankment on the southern edge of the site, adjacent to the railway. These are understood to be former air-raid shelter; however it is not known whether they have been infilled.

The southern and eastern edges of the site are noted to be vegetated. It is understood that Japanese Knotweed was present in this location but has been treated. However, no records are available as proof of evidence.

It is understood that there were some tanks situated in the southern part of the site which have been removed, the contents of which are not known but are anticipated to have contained fuel oils.

During the 2013 site works, the majority of the site was covered by hard standing and used for the storage of portacabins. A site layout plan is presented in Figure 2.

2.2 Proposed Development

The proposed development for the site is understood to comprise:

- Multi-storey duplex apartments and affordable housing to the north of the site,
- A 14-storey residential development with undercroft parking to the south of the site,
- Commercial units, with flats above, in the north east of the site,
- Hard standing over the majority of the site, with isolated planting.

Selected development plans are presented in Appendix A.

2.3 Historical development

2.3.1 Sources of information

The historical development of the site has been traced from Ordnance Survey maps dating from 1868 of 1:10, 560 – 1:1, 250 scales. Selected historical maps are presented in Appendix B.

2.3.2 Summary of development

The earliest available map, 1868, shows the site to be partially located within a *Brick Field*. The southern part of the site is undeveloped with railway tracks running close to the southern edge. A well is indicated some 25m to the north of the site.

By 1895 the brick field is no longer indicated and the site is shown to be undeveloped with no specific evidence of workings. The nearby railway station has been constructed and additional tracks have been laid. The area surrounding the site has been extensively developed with residential and industrial developments to the north and west.

The 1934 map indicates the first major development on the site, with a building in the western part. This building is shown on the 1965 map to have been extended to the east and is described as an engineering works. Shelters are indicated along the northern boundary. Similarly, the site to the immediate west has been developed and is described as a depot.

The site continues to be identified as 'engineering works' or 'works' on all subsequent maps. No significant changes are noted until the demolition of the existing buildings in the mid-2000's.

2.4 Environmental disclosure report

A GroundSure EnviroInsight report for the area was obtained in 2011 to provide information on the environmental setting of the site and possible sources of contamination. A summary of the key points is set out below and the full report can be found in Appendix C.

- There were no records of List 1 Dangerous Substances Inventory sites within 500m of the site. The former *Damont Audio Limited* works, which was present on site, was registered as a List 2 Dangerous Substance Inventory site due to its use of chromium and nickel in its record manufacturing processes. However, the activity has ceased and the works have been demolished.

- There have been 7 pollution incidents within 250m of the site, which have all been classified as 'minor incidents'. The most recent of these incidents occurred 138m northeast in 2003 when biodegradable material/waste caused a minor impact to water 138m north east of the site.
- There were 32 current industrial land uses within a 250m radius around the site. Active trades operating within this area included manufacturers, works, garage services, printers, electrical substations, MOT testing centres, transport, and storage and delivery industries.
- The nearest surface water and groundwater abstraction points were over 500m from the site. There were no potable water abstraction points within 2000m of the site.

2.5 Anticipated ground conditions

2.5.1 Published and unpublished geology

According to the British Geological Survey Sheet 269¹, the site lies on an area of Brickearth deposits. The Brickearth is indicated to be underlain by London Clay although the River Terrace Deposits are expected to underlie the Brickearth deposits in this area. The Brickearth typically comprises clayey silt or silty clay. The River Terrace Deposits consist mainly of gravels with a high proportion of sand and some flints¹.

The London Clay consists mainly of stiff blue/grey fissured clays. The top of the London Clay can be recognised by a characteristic brown weathering. At the base of the London Clay beds of sandy clay can be found².

Borehole records were obtained from the British Geological Survey (BGS) relating specifically to the site and the surrounding area. Four borehole logs were obtained, one of which is located in the north east corner of the site. The other three records relate to boreholes located immediately outside the north east boundary of the site and adjacent to the western boundary of the site. This borehole comprises a well record. The borehole records are presented in Appendix D.

Based on the information contained in the BGS boreholes within and near the site, the expected ground conditions beneath the site are summarised in Table 1.

² Geological Survey of Great Britain, Windsor, 1:50 000 series, England and Wales Sheet 269. Solid and Drift., NERC, 1981.

Table 1. Summary of ground conditions based on BGS borehole records.

Stratum	Depth to top of stratum (m)	Typical thickness (m)
Made Ground/filled ground and topsoil. [MADE GROUND AND TOPSOIL]	0	0.3 to 1.7
Brown silty clay with gravel. [BRICKEARTH]	0.3-1.7	0.3-1.7
Sand and gravel (Ballast). [RIVER TERRACE DEPOSITS]	2.0-3.35	0.5-2.4
Brown/blue CLAY [LONDON CLAY]	4.9-5.18	42.37 Not proven in boreholes 15,16 and 17
Mottled clay/sandy clay/blue clay/black clay/flints [READING BEDS]	56.08	21.18
Chalk and flints [UPPER CHALK]	68.12	Proven to 74.53

2.5.2 Hydrogeology and hydrology

The nearest surface water to the site is the Grand Union Canal which is approximately 150m north of the site. The canal is likely to be lined and so should not be in hydraulic continuity the groundwater. Measured groundwater levels were recorded in Borehole 15 (TQ07NE15), just outside the north east boundary of the site, as being at approximately 4mbgl within the River Terrace Deposits.

The groundwater vulnerability map for this area shows that the site is underlain by the River Terrace Gravels which are a principal aquifer with high permeability. The soils are classified as being of high leaching potential.

The site and the surrounding area are not susceptible to flooding or extreme flooding and there are no flood defences in the area. The site is not within a groundwater protection zone.

2.5.3 Radon

The EnviroInsight Report indicated that the site is not at risk from radon with less than 1% of homes above the action level. No protection measures are therefore required in the construction of new buildings or extensions.

2.6 Regulatory enquiries

Information provided to CGL in 2008 by the Local Authority stated that no land in the London Borough of Hillingdon had been identified as contaminated land under Part IIA.

The Local Authority held records of a boiler being present on site but there were no reports of contamination issues. The Council also stated that the Made Ground on site could contain contaminated materials.

The Environmental Health Officer and Building Control Officer of the Local Authority were contacted again in connection with the 2011 revision of the desk study report. The Council held no new or significant information for the site additional to that received in 2008.

3. PRELIMINARY CONCEPTUAL SITE MODEL

3.1 Introduction

There is a moderate potential for contamination hazards related to the past use of the site as an engineering works, record manufacturer and possibly a brickfield, and the presence of the railway lines close to the site.

The presence of the railway on a low height embankment at the southern edge of the site since prior to 1868 may have resulted in a variety of potential contaminants in the soil and groundwater which may have migrated onto the site. Typical contaminants associated with railway land may include ash, heavy metals, phenols, sulfates and polycyclic aromatic hydrocarbons (PAHs); fuel oil and lubricating oils. Bacteriological contamination may also be present and the historic presence of tanks on the site may have given rise to localised contamination.

Asbestos fibres may be present in the soil derived mainly from the demolition of the previous buildings at the site in the 1960s.

The presence of 3 bunkers used as air-raid shelters on site (along the southern section) may contain materials of unknown origin. They are to be removed in the near future. Japanese Knotweed was also found to be present in the south west corner of the site and, at the time of the 2008 walkover, was being treated.

In accordance with current UK guidance, in order to establish possible human health or environmental risks, a preliminary conceptual site model has been developed for contamination that may potentially exist at the site and is presented in Figure 3.

3.2 Sources

The potential sources of contamination identified for the site are;

- Contaminates from the railway land, including heavy metals and organics.
- Contaminates within the Made Ground.
- Asbestos from previous demolition works.

3.3 Pathways

The likely pathways are;

- *Ingestion & inhalation* – contamination within Made Ground or impacted shallow soils may result in the ingestion, either directly or via food produce, or inhalation of contaminated soils.
- *Direct contact* – direct contact with contaminated soils or surface water can result in the uptake of contaminants through the skin.
- *Root uptake* – uptake of contamination by plants.
- *Soil gas migration* – if there is an appreciable organic content within the ground, there may be a potential for soil gases which could migrate through the soil matrix.
- *Groundwater* – There is the potential for leaching/ infiltration of contaminants into the groundwater and for water-borne contaminants to migrate into the gravel aquifer.

3.4 Receptors

The anticipated receptors are;

- *Future site occupants* – primarily at risk from direct contact, inhalation or ingestion of home-grown produce.
- *Buildings & structures* – buried concrete and services, such as plastic water supply pipes, can be at risk from chemically aggressive ground. Soil gases and vapours may also permeate through the soils and accumulate in buildings and structures, presenting an explosive or asphyxiation risk.
- *Groundwater* – at risk from the migration of contaminants such as hydrocarbons through infiltration or surface run-off.
- *Vegetation & plants* – primarily at risk from phototoxic contaminants such as copper and zinc, if present.
- *Construction Workers* - primarily at risk from direct contact, inhalation or ingestion.

3.5 Qualitative risk assessment

A qualitative risk assessment has been undertaken based on the findings of the Conceptual Site Model and the potential pollutant linkages that may exist at the site in accordance with Contaminated Land Report (CLR) 11³. The risks identified are in accordance with the DEFRA and Contaminated Land Report (CLR) 6⁴, site prioritisation and categorisation rating system which is summarised in Table 2 below.

Table 2. Risk rating terminology.

Risk Rating	Description
High Risk	Contaminants very likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Enforcement action possible, Urgent action required
Medium Risk	Contaminants likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Action required in the medium term
Low Risk	Contaminants may be present but unlikely to create unacceptable risk to identified targets Site probably suitable for proposed use Action unlikely to be needed whilst site remains in current use
Negligible Risk	If contamination sources are present they are considered to be minor in nature and extent Site suitable for proposed use No further action required.

Based on the above terminology an assessment of the risks posed by the potential pollutant linkages at the site is outlined in Table 3.

³ The Environment Agency. (2004). *Model Procedures for the Management of Land Contamination*. CLR 11.

⁴ M.J. Carter Associates. (1995). *Prioritisation and Categorisation Procedure for Sites which may be Contaminated*. Department of the Environment. CLR 6

Table 3. Qualitative risk assessment.

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
Contaminates originating from the railway land (including heavy metals, phenols, sulphates and polycyclic aromatic hydrocarbons (PAHs); fuel oil and lubricating oils)	Current/future site occupants	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Low – medium
	Construction workers	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Low – medium
	Buildings & structures (incl. services)	Direct contact and accumulation of vapours within building spaces	Low – medium
	Vegetation & plants	Root uptake by vegetation/plants in landscaped area	Low
	Groundwater	Migration of contaminants to the underlying groundwater	Low – medium
Contaminates within the Made Ground (including heavy metals, fuel oils and lubricating oils)	Current/future site occupants	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Low – medium
	Buildings & structures (incl. services)	Direct contact and accumulation of vapours within building spaces	Low – medium
	Vegetation & plants	Root uptake by vegetation/plants in landscaped area	Low
	Groundwater	Migration of contaminants to the underlying groundwater	Low – medium
Asbestos from previous demolition works	Current/future site occupants	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Medium

The risks due to contamination at the site are generally anticipated to be low to medium for all potential receptors.

4. PRESENT GROUND INVESTIGATION

4.1 Fieldwork

An intrusive investigation comprising 7 window sampler boreholes (WS01 to WS07) and 2 cable percussion boreholes (BH1 and BH2) was undertaken in order to determine the ground conditions at the site. The window sampling was undertaken on 20th February 2013 with the cable percussion boreholes commencing the following week on the 27th February 2013. Installations were constructed in WS03, WS06, BH1 and BH2. Dual standpipes were installed in both boreholes with deep and shallow response zones.

All positions were cleared by a service location crew before any intrusive excavation works commenced.

In order to obtain samples for laboratory testing, and to fully characterise the near surface ground conditions across the site, borehole arisings were recorded, logged and representatively sampled for laboratory testing by a suitably qualified engineer from CGL.

Access to the area of shrubbery adjacent to the railway was not possible during the site works as it is railway land and separated from the site by a metal fence.

Borehole logs are presented in Appendix E.

4.2 Laboratory testing

4.2.1 Chemical analysis

Representative soil samples were sent to i2 Analytical Limited (a UKAS and MCERTS accredited laboratory) for chemical testing. The analysis included the following potential contaminants;

- Soil Organic Matter (SOM);
- Heavy metals including; arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc;
- Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAH);
- Total Monohydric Phenols;
- Total Cyanide;

- Sulfide and sulfate (including soluble sulfate);
- pH determination;
- Waste acceptance criteria.

The results are presented in Appendix F.

4.2.2 Geotechnical analysis

Geotechnical analysis was undertaken on representative samples for particle size distribution, Atterberg limits and moisture content and undrained shear strength. The results are presented in Appendix G.

4.3 Monitoring

One round of ground gas and groundwater monitoring was undertaken on 6th March 2013. The monitoring records are presented in Appendix H.

5. GROUND AND GROUNDWATER CONDITIONS

5.1 Summary

The ground conditions encountered during the site investigation broadly corresponded to published geology and were found to comprise Made Ground over Brickearth and River Terrace Deposits with London Clay at depth. Table 4 summarises the ground conditions recorded at the site.

Table 4. Summary of ground conditions.

Strata	Thickness (m)	Depth to top (mbgl)	Level at top (m AOD)
Concrete. [MADE GROUND]	0.18-0.25	0	31.48-31.72
Medium dense dark brown clayey sandy gravel. Sand is fine to medium. Gravel is fine to coarse subrounded to subangular of flint, brick and chalk. Occasional cobbles of red brick. [MADE GROUND]	0.1-0.9	0.18-0.25	31.30-31.47
Firm to stiff dark orange brown sandy CLAY. [BRICKEARTH]	0.3-0.9	0.3-0.9	30.57-31.20
Dense dark brown sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse, rounded to subangular of flint. Occasional cobbles of flint. [RIVER TERRACE DEPOSITS]	3.4-4.8	0.8-1.25	30.27-30.30
Stiff dark brown mottled grey silty CLAY. [WEATHERED LONDON CLAY]	0.4-1.0	4.3-6.1	25.50-26.87
Stiff, becoming very stiff with depth, dark grey silty CLAY. [LONDON CLAY] Moderately weak dark grey CLAYSTONE bands between 22.1mbgl-22.3mbgl and 26.7mbgl-26.9mbgl*	22.9-25.3	4.7-7.1	25.10-35.87

* Only encountered in borehole BH2.

5.2 Soils

5.2.1 Made Ground - Concrete

Much of the site was overlain by the concrete floor slab of the building previously situated on site. The concrete was found to be approximately 0.2m thick with 8mm bottom steel reinforcement bars.

5.2.2 Made Ground

In areas with no concrete cover, the site was underlain by 0.1-0.9m of medium dense dark grey sandy clayey gravel. The sand was fine to coarse and the gravel was fine to coarse, subrounded to subangular of flint. A hydrocarbon odour was recorded in BH2.

Black water with a hydrocarbon odour was noted within the granular Made Ground in WS06.

5.2.3 Brickearth

Underlying the Made Ground across much of the site was a 0.3-0.9m thick layer of Brickearth comprising stiff dark orange brown silty sandy clay. The sand was fine to medium.

Two SPT tests were undertaken in this stratum with 'N' values of 50 recorded in both (see Appendix F) which are likely to represent strikes on flints within this horizon.

5.2.4 River Terrace Deposits

The Brickearth and Made Ground are underlain by River Terrace Deposits (RTD), comprising dense dark orange brown sandy gravel. Both the sand and gravel were fine to coarse, with the gravel being rounded to subangular of flint. This stratum is approximately 3.4-4.8m thick.

SPT tests in the RTD resulted in 'N' values ranging from 50 to 30, decreasing with depth.

Particle size distribution testing showed the RTD to be poorly graded with less than 10% sand or silt in BH1 and less than 17% sand or silt in BH2 (see Appendix G).

5.2.5 Weathered London Clay

A 0.4-1.0m thick layer of Weathered London Clay was encountered in both boreholes at the base of the River Terrace Deposits. This comprised stiff dark brown mottled grey silty clay.

Two SPT test were undertaken in the Weathered London Clay, giving 'N' values of 40 and 13 (see Appendix G).

5.2.6 London Clay

The London Clay is a stiff dark grey silty clay, becoming very stiff to hard with depth, and was found to underlie the Weathered London Clay at both borehole locations, lying 12.9-17.4m thick.

SPT tests in the London Clay resulted in 'N' values of 14 to 47, increasing with depth. One sample of London Clay was tested for particle size distribution and was shown to be a well-graded silty clay containing less than 6% sand.

Quick Undrained Triaxial Compression tests carried out on five samples showed the shear stress at failure to range from 158kPa to 277kPa and was shown to increase with depth.

The plasticity indices and moisture content of four samples was analysed with a further five samples tested for their moisture content only. The plasticity index of the soils was found to be in the range 38-42% with moisture contents ranging from 20% to 31% (see Appendix G).

Two 0.2m thick bands of Claystone were encountered within the London Clay, at 22.1mbgl and 26.7mbgl. These comprised moderately weak dark grey Claystone.

5.3 Groundwater

Groundwater strikes were encountered during excavation at 4.6mbgl and 4.2mbgl in boreholes BH1 and BH2 respectively within the River Terrace Deposits. The groundwater monitoring visit measured the water levels to be approximately 3.0mbgl in BH2 and BH1. The last two wells (BH2B and WS03) were found to be dry, as they are shallow.

The standing water level in WS06 was at 0.8mbgl which is significantly higher than recorded elsewhere on site. This water was observed to have an oily sheen during monitoring.

5.4 Soil gas

One round of ground gas monitoring took place on 6th March 2013 during a period of atmospheric pressure of 996mb, falling to 995mb. The findings of the monitoring are summarised below and a copy of the monitoring record is presented in Appendix H.

- Maximum carbon dioxide concentration: 2.2 % v/v
- Maximum methane concentration: -0.1 % v/v
- Maximum flow rate: 0.1l/hr
- Minimum oxygen concentration: 12.1 % v/v

6. CONTAMINATION

6.1 Soil Assessment

Soil Guideline Values (SGVs) have not been issued by the Environment Agency for the “*Residential (without plant uptake)*” land-use category. The soil results have therefore been compared to *Generic Assessment Criteria* (GACs) that have been derived in-house by CGL using the *Contaminated Land Exposure Assessment (CLEA)* model⁵ and version 1.06 of the CLEA software to assess the risk to human health from chemical contamination in the soils.

The GACs represent conservative screening criteria and have been calculated using the default parameters for the standard land use scenario set out in the CLEA technical report and toxicological inputs in line with the requirements of *Science Report SC050021/SR2*⁶ and, in the case of petroleum hydrocarbons, *Science Report P5-080/TR3*⁷. In the case of selenium, mercury, arsenic, nickel and the BTEX compounds, SGVs have been issued by the Environment Agency for other land-use categories and the physical-chemical and toxicological inputs have been taken from the published SGV reports.

The GACs have been generated assuming a sandy loam soil type and a Soil Organic Matter (SOM) of 2.5%, which are suitable assumptions for the site in question, with a measured range of 0.6-5.6%. More detailed information on the derivation of the CGL GACs can be provided upon request.

The results of the assessment are set out below in Table 5. Assessment against the SGVs and GACs is carried out at the 95th percentile on the sample mean (designated US₉₅), which is considered to represent a reasonable worst-case scenario. Statistical assessment of the results has been completed in accordance with the recommendations set out in the recently published CL:AIRE guidance⁸. In this regard, an assessment of the normality of the data has been undertaken. Where datasets are normally distributed the *one sample t-test* has been applied to calculate the US₉₅. In the case of non-parametric datasets, the Chebychev Theorem has been applied. The Grubbs Test has also been used to identify

⁵ Environment Agency. (January 2009). *Updated technical background to the CLEA model*. Science Report SC050021/SR3.

⁶ Environment Agency. (January 2009). *Human health toxicological assessment of contaminants in soil*. Science Report SC050021/SR2.

⁷ Environment Agency. (February 2005). *The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils*. Science Report P5-080/TR3.

⁸ J. Lowe et al. (May 2008). *Guidance on comparing soil contamination data with a critical concentration*. CL:AIRE, CIEH & SAGTA.

potential outliers within datasets. Copies of the relevant statistical analysis are available on request.

Table 5a Summary of soil contamination (risks to human health).

Contaminant	SGV or GAC @ 2.5% SOM for Residential (without plant uptake) land-use (mg/kg)	Notes on soil saturation limits (SSL) ¹	Measured range (6 samples) (mg/kg)	US ₉₅ (mg/kg)	US ₉₅ > Assessment Criteria? (Y/N) #- outlier detected
SOM (%)	* ²		0.6 – 5.6	*	*
Arsenic	35 ³	-	7.9-48	38.12	Y
Cadmium	85 ³	-	<0.2-2.3	1.51	N
Chromium (total)	38	-	24-160	150.68	Y #
Chromium (III)	1,100	-	41-160	-	N
Chromium (VI)	4.2	-	<1.2	-	N
Lead	450	-	35-470	306.28	N
Mercury (inorganic)	240 ³	-	<0.3-0.9	0.84	N #
Selenium	600 ³	-	<1-3	3.44	N
Boron	*		<0.2-2.7	2.45	*
Copper	6,700	-	48-3400	3104.65	N
Nickel	130 ³	-	20-800	725.28	Y #
Zinc	20,000	-	64-500	400.64	N
Barium	*		110-440	318.71	*
Beryllium	26	-	1-1.9	1.57	N #
Vanadium	210	-	42-79	67.79	N
Phenols ⁴	420 ³	-	<2	2	N
Cyanide	*		<1	1	*
BTEX compounds					
Benzene	0.50 ⁵	-	0.001	0.001	N
Toluene	1,300 ⁵	-	0.001	0.001	N
Ethyl benzene	380 ⁵	-	0.001	0.001	N
o-xylene ⁶	140 ⁵	-	0.001	0.001	N
p-xylene ⁶	130 ⁵	-	0.001	0.001	N

Notes:

- = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.
- * = no value currently defined
- Based on the published Soil Guideline Value (Environment Agency, 2009), adjusted for no plant uptake and 2.5% SOM
- GAC relates to Phenol (C₆H₅OH) only.
- Based on the published SGVs for BTEX at 6% SOM (Environment Agency, 2009), adjusted for 2.5% SOM and no plant uptake
- Concentrations for total xylenes should be compared to the value for m-xylene for fresh spills and to o-xylene for all other cases.

Table 5b Summary of soil contamination (risks to human health) cont.

Contaminant	SGV or GAC @ 2.5% SOM for Residential (without plant uptake) land-use (mg/kg)	Notes on soil saturation limits (SSL) ¹	Measured range (6 samples) (mg/kg)	US ₉₅ (mg/kg)	US95 > Assessment Criteria? (Y/N) #- outlier detected
Total Petroleum Hydrocarbons (TPH)					
TPH aliphatic EC5-6	41	-	<0.1	0.1	N
TPH aliphatic EC>6-8	100	-	<0.1	0.1	N
TPH aliphatic EC>8-10	25	-	<0.1	0.1	N
TPH aliphatic EC>10-12	540	(B)	<1-8.5	7.82	N #
TPH aliphatic EC>12-16	4,300	(B)	<2-320	292.54	N
TPH aliphatic EC>16-35	89,000	(B)	138-3010	1848.22	N
TPH aromatic EC5-7	0.50	-	<0.1	0.1	N
TPH aromatic EC>7-8	1,300	-	<0.1	0.1	N
TPH aromatic EC>8-10	41	-	<0.1	0.1	N
TPH aromatic EC>10-12	210	-	<1-3.8	4.29	N
TPH aromatic EC>12-16	1,500	(B)	<2-150	164.05	N
TPH aromatic EC>16-21	1,100 [150]	(A)	<10-1100	1007.78	N
TPH aromatic EC>21-35	1,300 [12]	(A)	<10-2000	1292.3	N
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenathene	4,500	(b)	<0.1-25	22.41	N #
Anthracene	23,000 [19]	(a)	<0.1-68	60.99	N
Benzo(a)anthracene	13 [4.3]	(a)	0.22-180	162.35	Y
Benzo(a)pyrene	2.4 [2.3]	(a)	0.21-140	126.51	Y
Benzo(b)fluoranthene	24 [3.0]	(a)	0.22-170	153.25	Y
Benzo(g,h,i)perylene	250 [0.05]	(a)	<0.05-79	71.36	N
Benzo(k)fluoranthene	24 [1.7]	(a)	<0.2-67	61.02	Y
Chrysene	210 [1.1]	(a)	0.17-130	117.30	N
Dibenzo(a,h)anthracene	2.3 [0.01]	(a)	<0.2-12	10.87	Y #
Fluoranthene	3,200 [47]	(a)	0.39-370	332.78	N
Fluorene	3,100	(b)	<0.2-21	18.83	N #
Indeno(1,2,3-cd)pyrene	23 [0.15]	(a)	<0.2-68	61.45	Y
Naphthalene	3.9	-	<0.05-2.3	2.2	N
Pyrene	2,400 [5.5]	(a)	0.37-300	270.23	N

Notes:

- = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.
- Hazard Index = Σ (hazard quotients for each fraction); Hazard quotient = Fraction concentration $\div$ AC

Inspection of the above tables indicates that a number of the contaminant concentrations fail against the assessment criteria. Elevated levels of arsenic were encountered in several samples of the Made Ground, which are indicative of an underlying concentration of arsenic across the site. Elevated concentrations of nickel were also present in the Made Ground at BH2, which appears to represent a contamination 'hotspot'.

The sample of Made Ground at 0.1mbgl from WS02 also showed elevated concentrations of Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene and Indeno(1,2,3-cd)pyrene. This may represent tarmac within the sample and may not be indicative of conditions at the location. Elsewhere only Benzo(a)anthracene and Benzo(a)pyrene, were measured at elevated concentrations in the samples of Made Ground at 0.5mbgl from WS02 and 0.25mbgl from WS01, which indicates that PAHs are likely to be present across the north-eastern area of the site.

Results for total chromium suggest that this substance may be present at elevated concentrations. However, assessment of Chromium III and VI indicates that the chromium present is Cr III and therefore does not exceed the relevant assessment criteria and does not pose a risk.

Asbestos screening was also undertaken in the samples from BH2 at 0.2mbgl and 0.6mbgl, with fragments of chrysotile insulation board found in the sample at 0.2mbgl. No visual evidence of asbestos was noted during the site works. It is therefore considered unlikely that there is greater than 0.1% by weight of asbestos in the soil at this location, but asbestos may be present elsewhere.

Where tested, no PCBS were detected.

6.2 Risks from dissolved contaminants

Three water samples were retrieved from the installations and sent for chemical analysis. The results have been compared to the EQS and DWS as an initial screen of water quality and are summarised in Table 6, below. As the site is not within a groundwater source protection zone and the groundwater is not abstracted as potable water, the EQS is more applicable than the drinking water criteria in this context.

Table 6. Summary of groundwater results.

Contaminant	Freshwater EQS ¹ (µg/l)	EC Drinking Water Value (µg/l)	Measured range (µg/l)	No. of samples exceeding EQS	No. of samples exceeding Drinking Water Value
Arsenic	50	10	1.5 – 11	0	1
Cadmium	5	5	<0.1	0	0
Chromium	250	50	<0.4	0	0
Lead	250	10	<1.0 – 19	0	1
Mercury	1	1	<0.5	0	0
Selenium	* ²	10	<4.0	*	0
Boron	2000	1000	120 – 420	0	0
Copper	28	2000	<0.7 – 20	0	0
Nickel	200	20	3.4 – 220	1	2
Zinc	500	(5000) ³	<0.4 – 97	0	0
Barium	*	(1000) ³	30 – 96	*	0
Beryllium	(15) ⁴	*	<0.2	0	*
Vanadium	60	*	<1.7 – 19	0	*
Phenols	30	(0.5) ³	<10 – 96	1	3 ⁸
Cyanide	5 ⁵	50	<10	0 ⁸	0
Sulfate	400	250	74.4 – 425	1	1
PAH	*	0.1 ⁷	<0.04	*	0
Benzo(a)pyrene	*	0.01	<0.01	*	0
Naphthalene	10	*	<0.01 – 3.8	0	*
Benzene	30	1	<1.0	0	0
Toluene	50	*	<1.0 – 44	0	*
Ethylbenzene	*	*	<1.0	*	*
Xylenes	30	*	<1.0 – 80	1	*
TPH	*	(10) ³	<20-6700	*	3
Hardness (mg/l CaCO ₃)	*	*	355 - 1010	*	*
pH	6.0 - 9.0	6.5 - 10.0	7.4 – 7.8	0	0

Notes:

- EQS varies with water hardness where range given. Evaluated against appropriate band.
- * = No values defined or given
- Concentration formerly prescribed within the Water Supply (Water Quality) Regulations 1989
- Dutch Indication Level of Serious Contamination
- EQS based on free cyanide which is more toxic than total cyanide.
- EQS based on highly toxic undissociated (gaseous) hydrogen sulphide (H₂S)
- Sum concentration of 4 PAH comprising benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene and indeno(1,2,3-cd)pyrene.
- As the laboratory limit of detection of these contaminates is above the EQS or Drinking Water Value, an exceedance is not indicative of contamination.

Phenols were measured at below the limit of detection in BH1 and BH2A within the River Terrace Deposits(RTD). Although the limit of detection of this contaminate is in excess of the guideline value, consultation with the laboratory indicates that no levels of this contaminate were detected and their statement of limit of detection is part of their MCERTs quality management system. A clear exceedance was, however, recorded in the sample from WS06.

Sulfates were also measured at slightly elevated concentrations in WS06, as was nickel in BH2 in the RTD. These are local and not considered to pose a major risk to groundwater.

TPH, phenol and xylene were recorded in one sample of black odorous water in WS06 at a standing level of 0.8mbgl.

6.3 Waste Classification

A preliminary review of the chemical data for the Made Ground indicates that some of the material is likely to be classified as 'hazardous' with respect to waste disposal. Samples of Made Ground from WS01(0.25), WS02(0.1) and WS04(0.1) failed against the criteria for hydrocarbons in the range C28+ (lubrication oils), with WS06 (0.8) and BH2 (0.2)failing against the criteria for phytotoxic metals.

Additionally, samples from three locations (WS01 at 0.25mbgl, WS06 at 0.8mbgl, both Made Ground ; classified as hazardous wastes) and BH2 at 0.6mbgl (Made Ground : not hazardous) were analysed for Waste Acceptability Criteria to assess their suitability for disposal at landfill sites. The Made Ground sample from WS01 is acceptable to a hazardous landfill. The sample from WS06 contains 6.1% TOC (cf limit of 6%) but the DOC is much lower than the limit (240mg/kg cf 1000mg/kg) therefore this material should also be acceptable to a hazardous landfill subject to agreement with the facility. The sample from BH2 is not hazardous but also not acceptable to an inert facility.

7. UPDATED CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

An updated conceptual site model has been compiled for the site based the information gathered during the intrusive investigation and is presented in Figure 5.

7.1 Sources

The identified sources of contamination identified for the site are;

- Contaminates from historic tanks, including Hydrocarbons.
- Contaminates within the Made Ground including Heavy Metals and asbestos.

7.2 Pathways

The identified pathways are;

- *Ingestion & inhalation* – contamination within Made Ground or impacted shallow soils may result in the ingestion, either directly or via food produce, or inhalation of contaminated soils and dusts.
- *Direct contact* – direct contact with contaminated soils or surface water can result in the uptake of contaminants through the skin.
- *Root uptake* – uptake of contamination by plants.
- *Soil gas migration* – if there is an appreciable organic content within the ground, there may be a potential for soil gases which could migrate through the soil matrix.
- *Groundwater* –There is the potential for water-borne contaminants to move through the groundwater or surface water.

7.3 Receptors

The identified receptors are;

- *Future site occupants* – primarily at risk from direct contact, inhalation or ingestion of home-grown produce.
- *Buildings & structures* – buried concrete and services, such as plastic water supply pipes, can be at risk from chemically aggressive ground. Soil gases and vapours may also accumulate in buildings and structures, presenting an explosive or asphyxiation risk.
- *Groundwater* – at risk from the migration of contaminants such as hydrocarbons through infiltration or surface run-off.
- *Vegetation & plants* – primarily at risk from phototoxic contaminants such as copper and zinc, if present.

7.4 Qualitative risk assessment

A qualitative risk assessment has been undertaken based on the findings of the Conceptual Site Model and the potential pollutant linkages that may exist at the site in accordance with Contaminated Land Report (CLR) 11⁹. The risks identified are in accordance with the DEFRA and Contaminated Land Report (CLR) 6¹⁰, site prioritisation and categorisation rating system which is summarised in Table 2, Section 3.5.

An assessment of the risks posed by the potential pollutant linkages at the site is outlined in Table 7.

⁹ The Environment Agency. (2004). *Model Procedures for the Management of Land Contamination*. CLR 11.

¹⁰ M.J. Carter Associates. (1995). *Prioritisation and Categorisation Procedure for Sites which may be Contaminated*. Department of the Environment. CLR 6

Table 7. Qualitative risk assessment.

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
Contaminates originating from historic tanks, including hydrocarbons	Current/future site occupants	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Low
	Buildings & structures (incl. services)	Direct contact and accumulation of vapours within building spaces	Low-Medium
	Vegetation & plants	Root uptake by vegetation/plants in landscaped area	Low
	Groundwater	Migration of contaminants to the underlying groundwater	Medium
Contaminates within the Made Ground, including Heavy Metals	Current/future site occupants	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Negligible -Low
	Buildings & structures (incl. services)	Direct contact and accumulation of vapours within building spaces	Low
	Vegetation & plants	Root uptake by vegetation/plants in landscaped area	Low
	Groundwater	Migration of contaminants to the underlying groundwater	Low-medium
Asbestos from previous demolition works	Current/future site occupants	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Low-medium

The risk assessment should be revised if unexpected ground conditions or further potential contaminative sources are encountered.

The majority of the site is proposed to be covered in hard standing with some isolated areas of planting. The primary areas of soft landscaping will primarily be rooftop terraces, constructed with imported material. The risk of the inhalation or ingestion of contaminants by future site occupants or uptake by vegetation is therefore considered to be low. The risk to groundwater and buildings or structures is greater as they may be in contact with the contaminated soils.

The stripping of some Made Ground during site preparation works will reduce the risks due to contaminants in the soil, but residual risks may have to be addressed, noting that areas of hard standing and buildings across the majority of the site will act as a barrier to break the pollutant linkage, and reduce these risks to low to negligible.

Asbestos has been identified one of a few samples tested. It was not visible and there may be further areas of Made Ground impacted with low concentrations of asbestos.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 General

The proposed development consists of multi-storey apartments and commercial units with undercroft parking benched into the railway embankment.

8.2 Geotechnical

Geotechnical design parameters have been provided below to support an appropriate foundation.

8.2.1 Geotechnical design parameters

Geotechnical design parameters are recommended based on the available information from the intrusive investigation and published information. They are summarised in Table 8. The values are unfactored (Serviceability Limit State) parameters and are considered to be characteristic values for the local soils.

Table 8. Geotechnical Design Parameters.

Stratum	Design top of stratum (mbgl)	Bulk Unit Weight γ_b (kN/m ³)	Undrained Cohesion C_u (kPa) [c']	Friction Angle ϕ' (°)	Young's Modulus E_u (MPa) [E']
Made Ground	0	19	0	30	[20]
River Terrace Deposits	0.7	19	0	40	0 [90]
London Clay	6.0	20	50+8.5z [5]	0 [24]	25+4.25z [18+3.2z]

A plot of SPT 'N' value against depth is presented in Figure 6, with a plot of C_u against depth presented in Figure 7.

8.2.2 Excavations

Excavations where undertaken within the Made Ground and River Terrace Deposits will require battering back or shoring as appropriate.

It is expected that slopes will be stable up to 1 in 2 in the short term within the River Terrace Deposits, although they may require maintenance and regrading.

Excavations should be planned and inspected regularly by a competent person. No operative should enter unshored or otherwise protected excavations identified as unstable by a competent person, regardless of their depth.

8.2.3 Foundations

Based on the anticipated structural loadings, shallow foundations are not considered to be appropriate. As such piled foundations are recommended for the development incorporating suspended ground beams/slabs spanning between piles/pile groups.

It is recommended that piled foundations, either bored cast in-situ or Continuous Flight Auger (CFA) piles, are constructed into the London Clay.

Table 9 shows indicative Working Loads (kN) for the site for pile diameters of 0.3, 0.45 and 0.6m and pile lengths of 15, 20 and 25m. The design factor of safety is taken to be 2.6.

Table 9. Indicative Pile Working Loads.

Pile Length (m)	Pile diameter (m)		
	0.3	0.45	0.6
15	200	330	470
20	350	560	790
25	540	880	1180

These calculations are based on the geotechnical design parameters presented in Table 8.

It is possible to reduce the factor of safety used in these calculations to approximately 2.2 if appropriate load tests are undertaken at the site prior to construction.

The final pile design should be undertaken by the specialist piling contractor engaged to undertake the works once the final building loads are known. The design should include appropriate consultation with all relevant regulatory bodies including the railway authorities.

8.3 Ground floor slabs

The Made Ground is not considered suitable for ground bearing floor slabs at ground floor level. Therefore, fully suspended floor slabs are recommended spanning between pile caps/ground beams.

8.4 Drainage

No permeability testing was undertaken during the site works. Based on the particle size distribution testing on the samples and observations of the ground on site, it is expected that soakaway drainage may be possible within the River Terrace Deposits, avoiding any known areas of groundwater contamination. The permeability of the stratum is likely to be in the range of 1×10^{-3} m/s to 1×10^{-5} m/s¹¹ however further testing is required to confirm this.

8.5 Buried concrete

Based on the pH and sulfate concentrations within the soil and groundwater, and generally in accordance with the BRE Special Digest 1 guidance¹², buried concrete at the site should be designed to Design Class DS-2 with an ACEC class of AC-2 up to approximately 1.0mbgl and Design Class DS-3 with an ACEC class of AC-3 at greater depths.

¹¹ CIRIA C515. *Groundwater control – design and practice*. London. 2000

¹² BRE Construction Division. *Concrete in aggressive ground*. Special Digest 1:2005 3rd Ed. 2005

8.6 Contamination and remediation

8.6.1 Soil

The exceedances identified in Table 5 indicate that the levels of ground contamination at the site do pose a risk to human health, with areas of PAH, arsenic and nickel identified within Made Ground.

As the site is due to be covered with a hard capping layer, the risks posed by the identified contaminants to future occupants or structures are greatly reduced. Some of the Made Ground across the site, containing the majority of the contamination, will also be removed during site preparation works for construction which will further reduce the risks. Where contaminated soil is buried below hardstanding and/or buildings the pollutant linkage is broken and no further soil remediation is required. Areas of landscaping will require an engineered capping layer incorporating a growth medium.

Disturbance of the soils in the vicinity of BH2 where very small amounts of asbestos were found should be limited and undertaken with care, including dust suppression measures and supply of suitable PPE to groundworkers. The presence of asbestos elsewhere on the site within the Made Ground cannot be ruled out and a watching brief should be maintained during groundworks and if necessary the dust control and safety measures extended across the site.

As the historic tanks have been removed and no significant concentrations of hydrocarbons were recorded in the soil around WS06, it is considered that no soil remediation works are required at WS06. However, a watching brief is recommended during groundworks in that area to identify and remove grossly impacted soils for treatment at an appropriate facility.

As the site history includes the use of tanks, probably containing fuel oils, and evidence has been found of PAH contamination within the Made Ground, PVC pipes are not be suitable for this site and barrier pipes are recommended. However, the final pipework specification for water supply pipes and other underground services should be agreed with the relevant water company.

8.6.2 Groundwater

The contamination encountered in WS06 could be indicative of historical spillage from the tank which previously existed in this area. The hydrocarbons appear to be predominantly C8-10 and could relate to heating oil. However, the historic tank contents are unknown

and given the samples also included phenols and xylene, the tank may have stored a variety mixture of substances over time or there may be a source of contamination associated with the railway above and adjacent to this location.

As the historic tanks have been removed, one possible primary source has been removed, but there still remains a possible plume of groundwater contamination, which requires more details assessment, ideally when the slabs have been lifted and the ground can be fully inspected. However, it is noted that although the gravels are a principal aquifer, they are not abstracted locally for water supply and there are no nearby water courses fed from the gravel aquifer. On this basis, we would recommend further investigation to delineate the plume. Once the plume is more fully understood, consultation with the Environment Agency can be instigated to determine if such contamination is of concern and whether a detailed risk assessment is required to establish whether remediation is necessary.

8.6.3 Soil gas

The measured gas ranges (see Section 5.4) are indicative of a Green/Characteristic Situation 1 site¹³, suggesting that no specific ground gas protection measures are likely to be required, subject to further confirmatory monitoring.

8.7 Material management and waste classification

Based on the total soils and WAC testing and subject to selective excavation of arisings to comply with the requirement for 'pre-treatment', Made Ground around WS01, WS02, WS04, WS6 and BH2 should be deemed hazardous for disposal purposes, and all other Made Ground is classified as non-hazardous, but not inert. However, consideration should be given to disposal of arisings containing hydrocarbons to a soil hospital, where soils can be treated and recycled as such disposal does not incur landfill tax.

Asbestos was found in one sample at BH2. However it was only found after laboratory analysis and no asbestos or asbestos-containing materials were noted by site operatives during the intrusive works indicating that the quantities of asbestos on site are likely to be less than 0.1% by weight and may be disposed of as non-hazardous waste. A watching brief is recommended during works within the Made Ground, along with implementation of good practice to avoid the generation of dust and use of appropriate PPE. Further testing may be required of Made Ground arisings for disposal to check for asbestos.

¹³ Wilson, S., Card, G. & Haines, S. (2009) *Ground Gas Handbook* Whittles Publishing

All material bound for disposal to landfill will require characterisation in accordance with the Hazardous Waste Regulations 2005 and disposal in accordance with the requirements of the Landfill Regulations (2002, as amended) and the Environmental Protection (Duty of Care) Regulations, 1991. All material taken off-site will require pre-treatment prior to disposal (either on-site at origin or off-site). This can include selective excavation and/or segregation on site.

It should be noted that in May/June 2012 HMRC issued Briefs 15/12 and 18/12 clarifying how construction spoil and excess soils will be assessed for landfill tax purposes. Detailed accurate descriptions of waste will be required for all wastes to support the landfill tax assessment. Uncontaminated naturally occurring soils will remain inert by default as listed inert wastes and are eligible for the lower rate of landfill tax.

If reuse of excavated soils at the site is preferred, this could be accomplished through waste exemptions or through the Development Industry Code of Practice¹⁴. The latter has been developed to enable earthworks on site using site won material and this is done in accordance with a Materials Management plan forming part of a Site Waste Management Plan, which will be required in due course for the proposed development.

8.8 Regulatory requirements

In addition to consultation with local planning authorities, the Environment Agency and building warrantors, the relevant railway authorities must be contacted regarding the embankment at the south of the site which is currently situated on railway land.

8.9 Health and safety

All site works should be undertaken in accordance with the guidelines prepared by the Health and Safety Executive (HSE, 1991)¹⁵. During the redevelopment, precautions should be taken to minimise exposure of workers and the general public to potentially harmful substances. Attention should also be paid to restricting possible off-site nuisance such as dust and odour emissions. Such precautions should include, but not be limited to:

1. Personal hygiene, washing and changing procedures.
2. Personal protective equipment, including disposable overalls, gloves, respiratory protective equipment etc.

¹⁴ CL:AIRE. *The Definition of Waste: Development Industry Code of Practice*. Contaminated Land: Application in Real Environments. Version 2. March 2011.

¹⁵ HSE (1991). *Protection of Workers and the General Public during the development of contaminated land*. Guidance Note HS(G)66, Health and Safety Executive, HMSO, 1991.

3. Measures to avoid surface water ponding and positive collection and disposal of all on-site run-off.
4. Regular cleaning of all site roads, access roads and the public highway including dust suppressions methods (e.g. water spraying), if necessary.
5. Dust mitigation, including damping down.

As asbestos was found in BH2 in the north west of the site, works in this area should include additional precautions such as a watching brief, dampening of the surrounding ground and protective equipment including face masks with appropriate filters.

If asbestos is encountered at any other location, it should be reported to a suitably qualified geoenvironmental engineer for on-going advice and the above precautions should be employed.

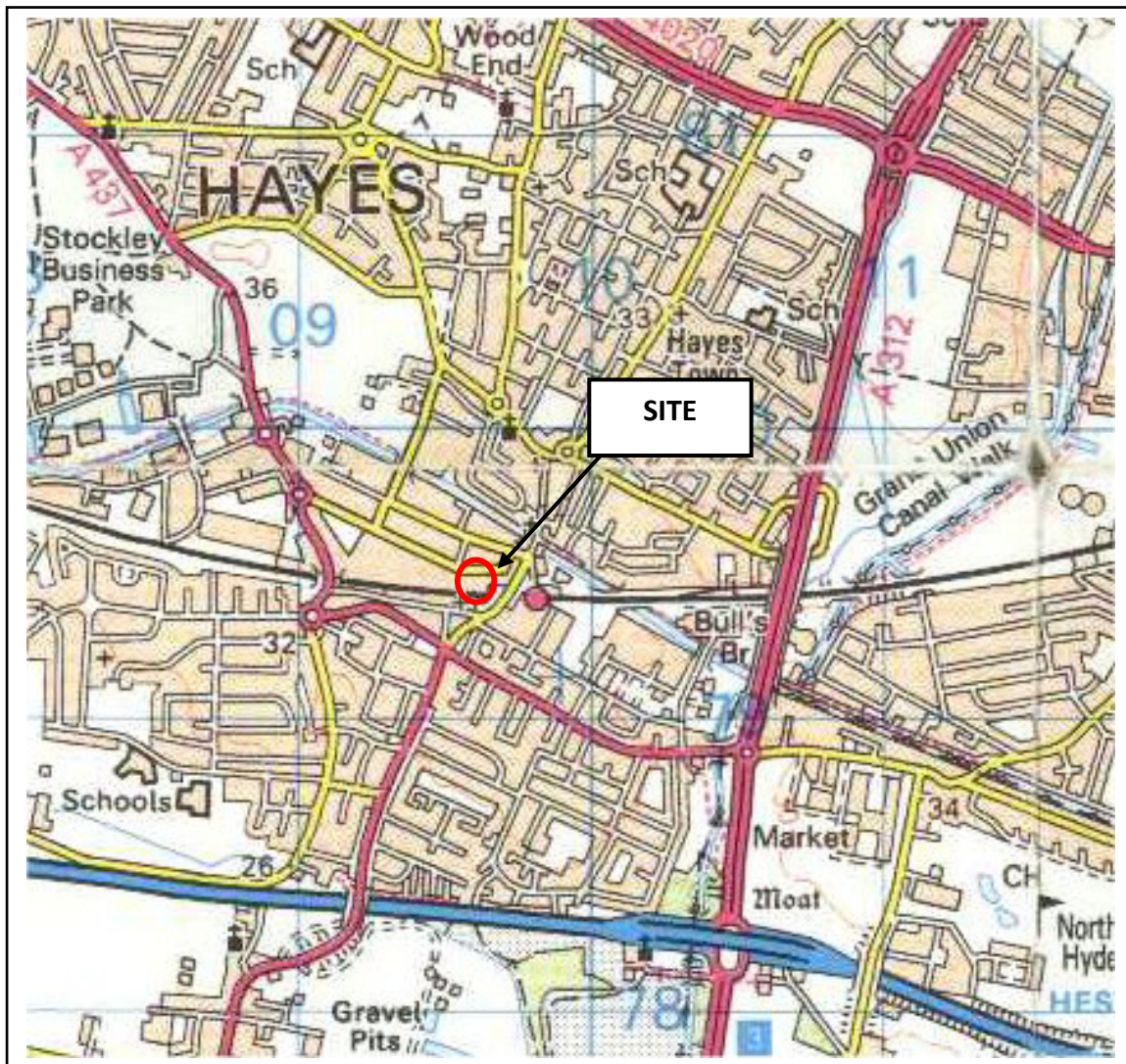
8.10 Further investigation

Access to the area of shrubs adjacent to the railway was not possible during the site works as it is railway land and is separated from the site by a metal fence. It is understood that part of the proposed development is to be situated along the embankment, which is to be supported by a retaining wall. Additional investigative works will be required to determine the nature of the soils comprising the embankment and to assess and remove the air raid shelters which are understood to be present within the embankment. Works should also be undertaken to determine the extent of potential contamination within the ground originating from the railway, given the proximity to WS06 where contaminated groundwater has been encountered.

A minimum of 3, and probably 5, further ground gas monitoring visits will be required in order to satisfy the local planning authority or building warrantor.

Infiltration testing is recommended to confirm the suitability of the underlying soils for soakaway drainage. Soakaways are unlikely to be permitted in Made Ground, especially around WS06 and would have to extend into the RTD below the Brickearth.

FIGURES

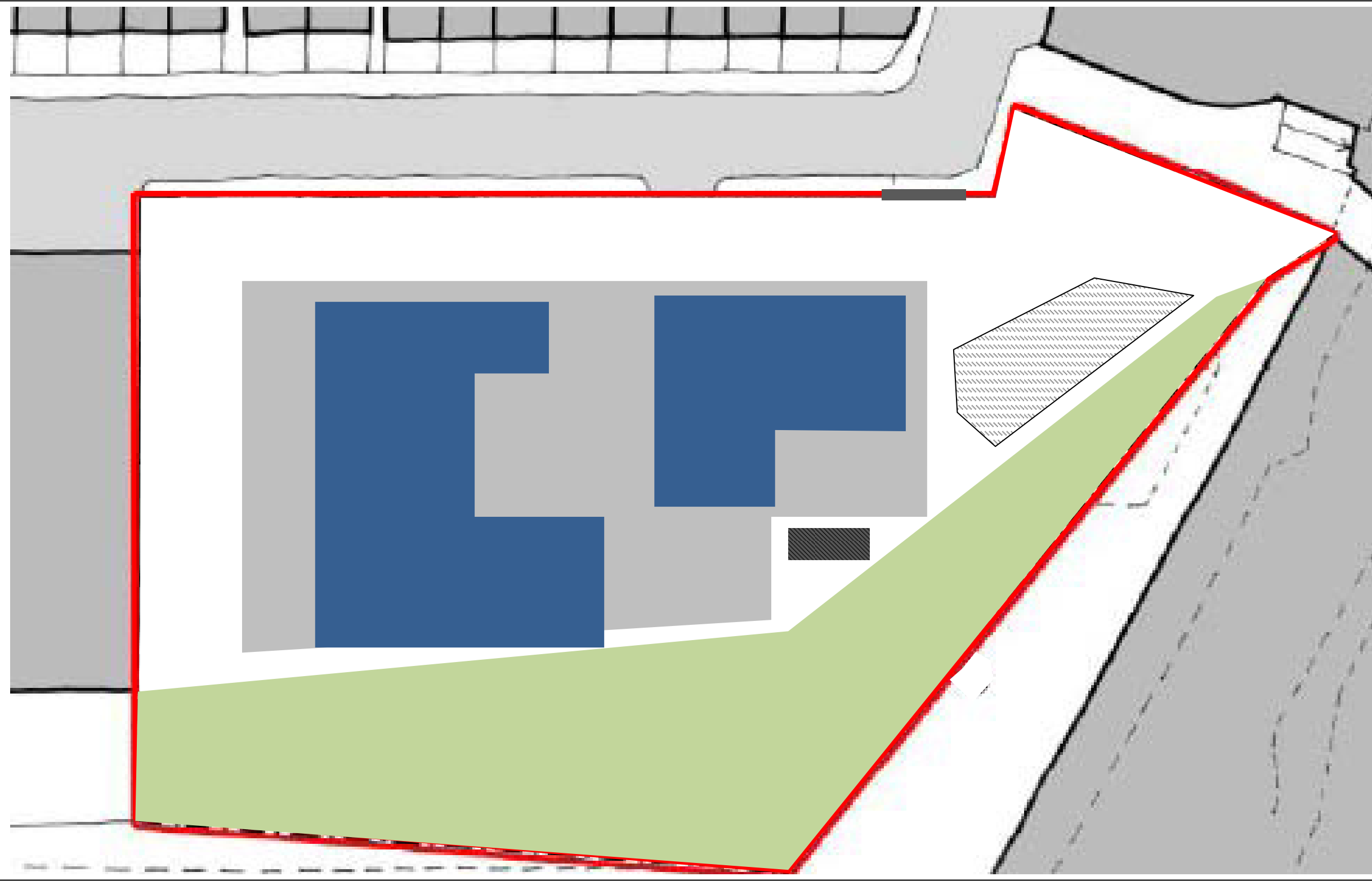


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Client Ballymore Properties Limited	Project Blyth Road, Hayes, Middlesex	Job No CG/4668C
	Title Site location plan	Figure 1



Client Ballymore Properties Limited	Project Blyth Road, Hayes, Middlesex	Job No CG/4668C
	Title Site layout plan	Figure 2

Potential sources

1. Railway land (ash and ballast)
2. Historic tanks
3. Asbestos from demolition works

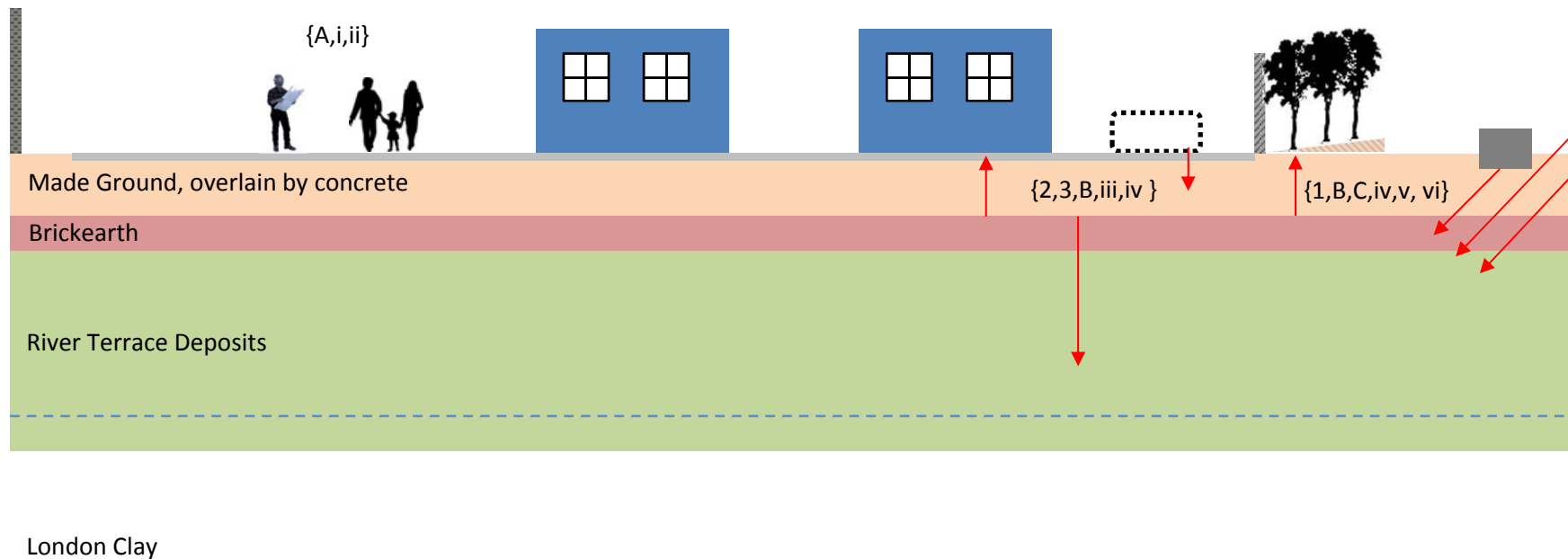
Potential Pathways

- A. Ingestion/inhalation
- B. Vertical/lateral migration
- C. Root uptake

Potential Receptors

- i. Construction workers
- ii. Future occupiers
- iii. Buildings and structures
- iv. Groundwater
- v. Vegetation
- vi. Animals/wildlife

Fence and railway embankment
with WW2 air raid shelters



Not to scale



Client

**Ballymore Properties
Limited**

Project

Blyth Road, Hayes, Middlesex

Job No

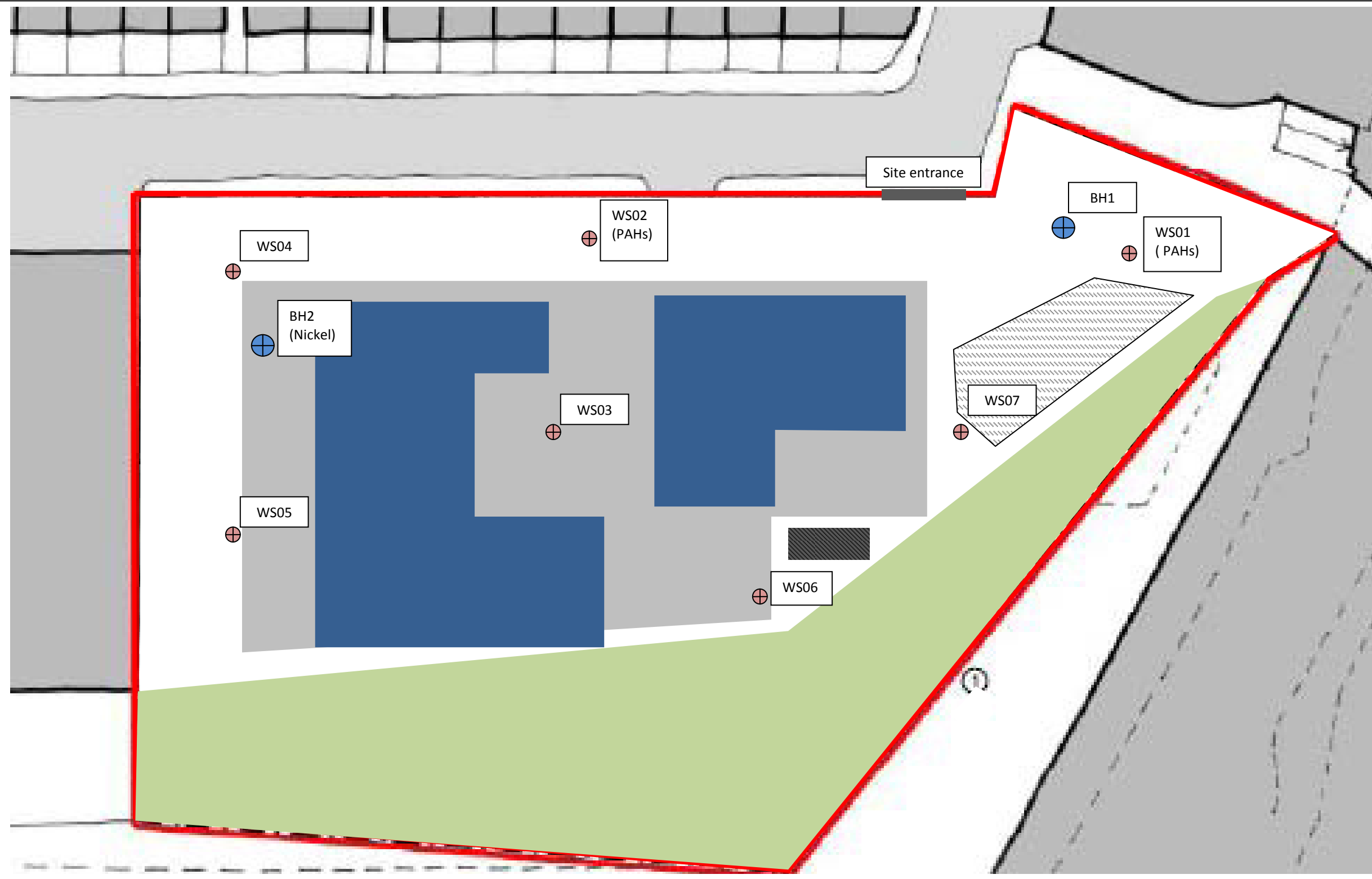
CG/4668C



Title

Preliminary conceptual site model

Figure 3



Not to scale

↑ North

- Site boundary
- Vegetated Area(railway land)
- Approximate area covered by portacabins
- Area of concrete floor slabs
- Area of historic tanks
- Bins and spoil

Arsenic likely present at ,low levels across whole site.

Client Ballymore Properties Limited	Project Blyth Road, Hayes, Middlesex	Job No CG/4668C
	Title Borehole location plan	Figure 4

Potential sources

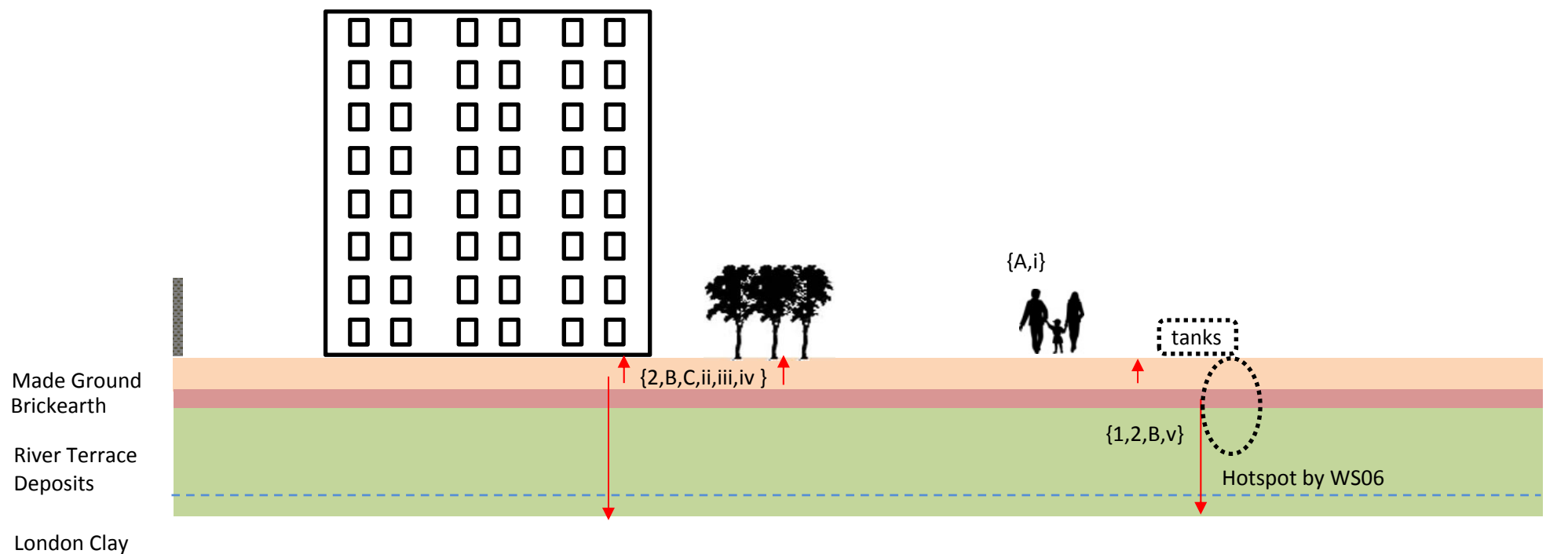
1. Contaminates from historic tanks
2. Contaminates within Made Ground, including hotspots and asbestos

Potential Pathways

- A. Ingestion/inhalation
- B. Vertical/lateral migration of gas or groundwater
- C. Root uptake

Potential Receptors

- i. Future occupiers
- ii. Buildings and structures
- iii. Groundwater
- iv. Vegetation



Not to scale



Client

**Ballymore Properties
Limited**

Project

Blyth Road, Hayes, Middlesex

Job No

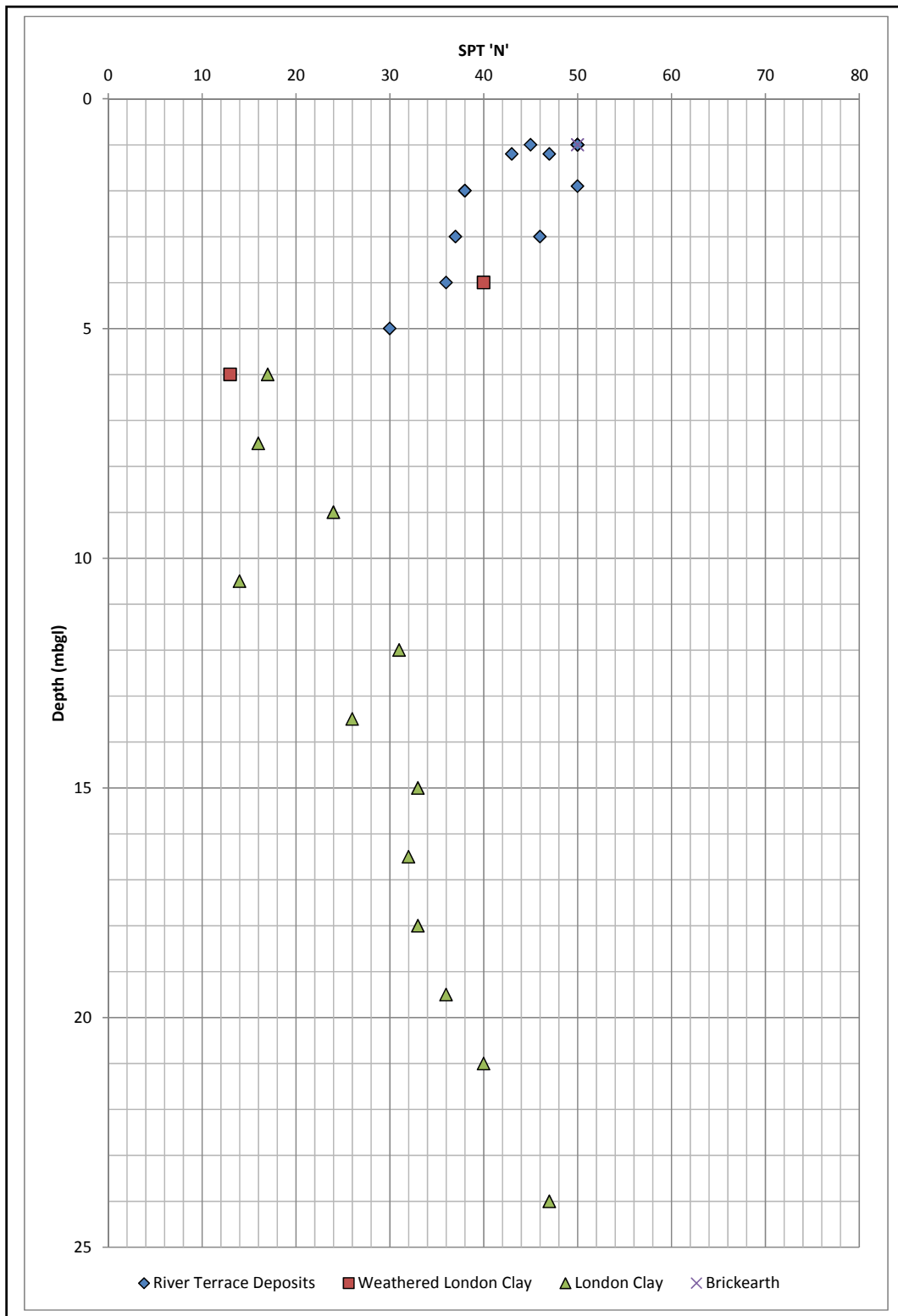
CG/4668C



Title

Conceptual Site Model

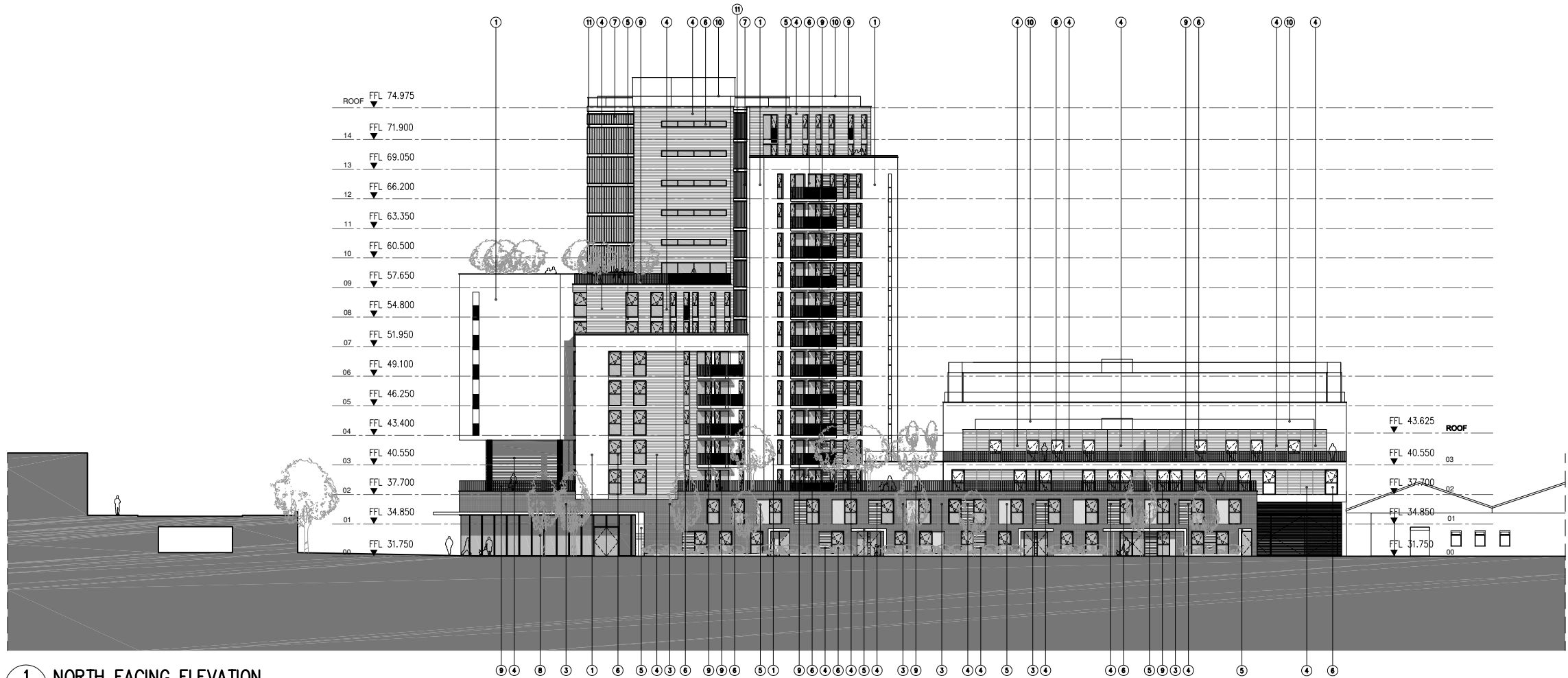
Figure 5



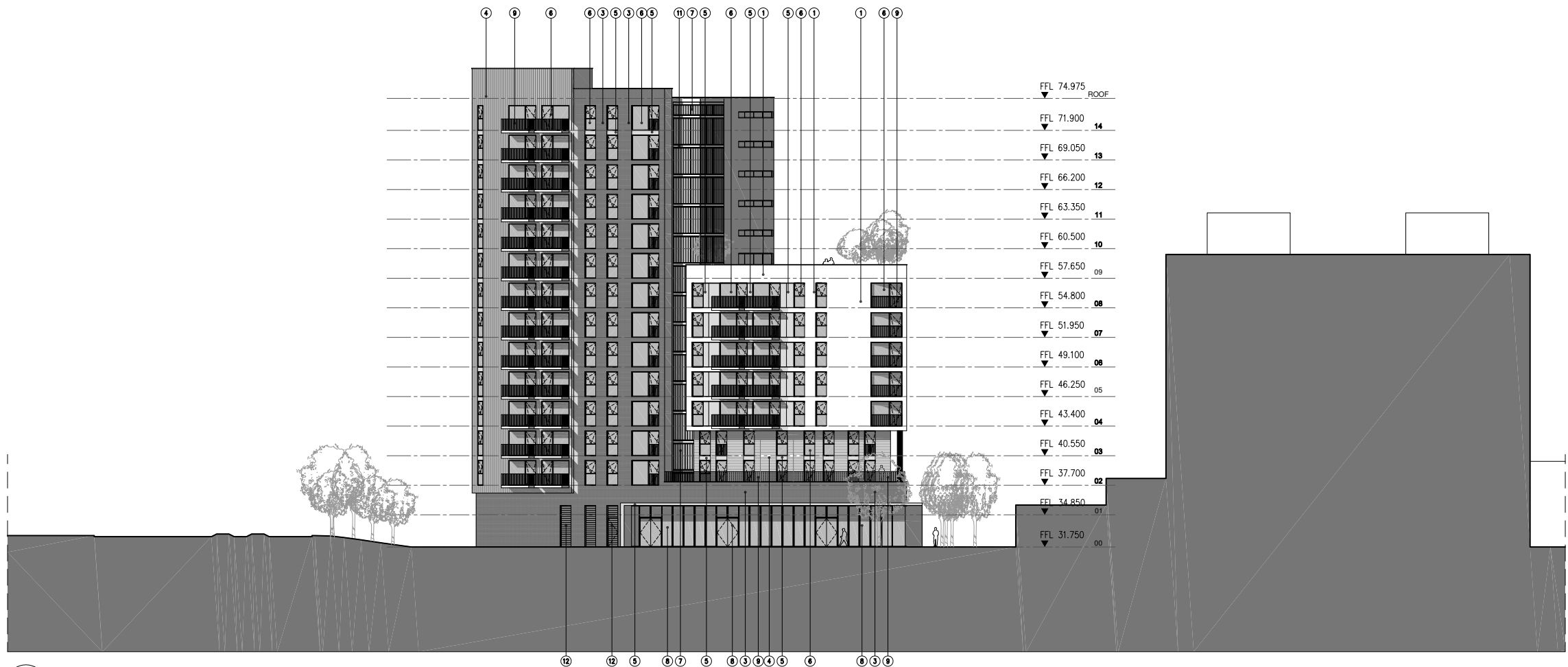
Client Ballymore Properties Limited	Project Blyth Road, Hayes, Middlesex	Job No CG/4668C
	Title SPT 'N' value against depth	Figure 6

APPENDIX A

Proposed Development



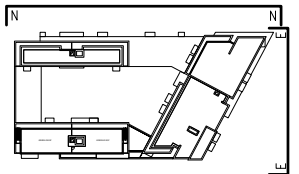
1 NORTH FACING ELEVATION
T(20)E03 SCALE: 1:250(A1)



2 EAST ELEVATION
T(20)E03 SCALE: 1:250(A1)

NOTES

- 1 The Contractor must check and confirm dimensions
- 2 All discrepancies must be reported and resolved by the Architect before works commence
- 3 This drawing is not to be scaled
- 4 All work and materials to be in accordance with current applicable Statutory Legislation and to comply with all relevant Codes of Practice and British Standards.



ELEMENT KEY

Facade Materials:

- 1) Render finished wall- colour 1.
- 2) Render finished wall- colour 2.
- 3) Brick.
- 4) Rainscreen timber cladding.
- 5) Rainscreen metal cladding.
- 6) Metal & Glass window.
- 7) Reglit.
- 8) Glass facade.
- 9) Metal balustrade with handrail.
- 10) Maintenance balustrade.
- 11) Feature channel.
- 12) Louvres
- 13) Gravel roof
- 14) Brown roof
- 15) Accessible landscaped terrace
- 16) Roof terrace / Balcony
- 17) Green roof

Rev | Date

ROLFE JUDD

PLANNING
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INTERIORS

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The Oval
London SW8 1NZ
Telephone: 020 7556 1500
Fax: 020 7556 1501
www.rolfe-judd.co.uk

Client

DOMAINE DEVELOPMENTS Ltd

Project

BLYTH ROAD

Drawing

NORTH FACING ELEVATION
EAST FACING ELEVATION

Scale

1:250 (A1)

Date

JAN 09

Drawn

MM

Drawing No

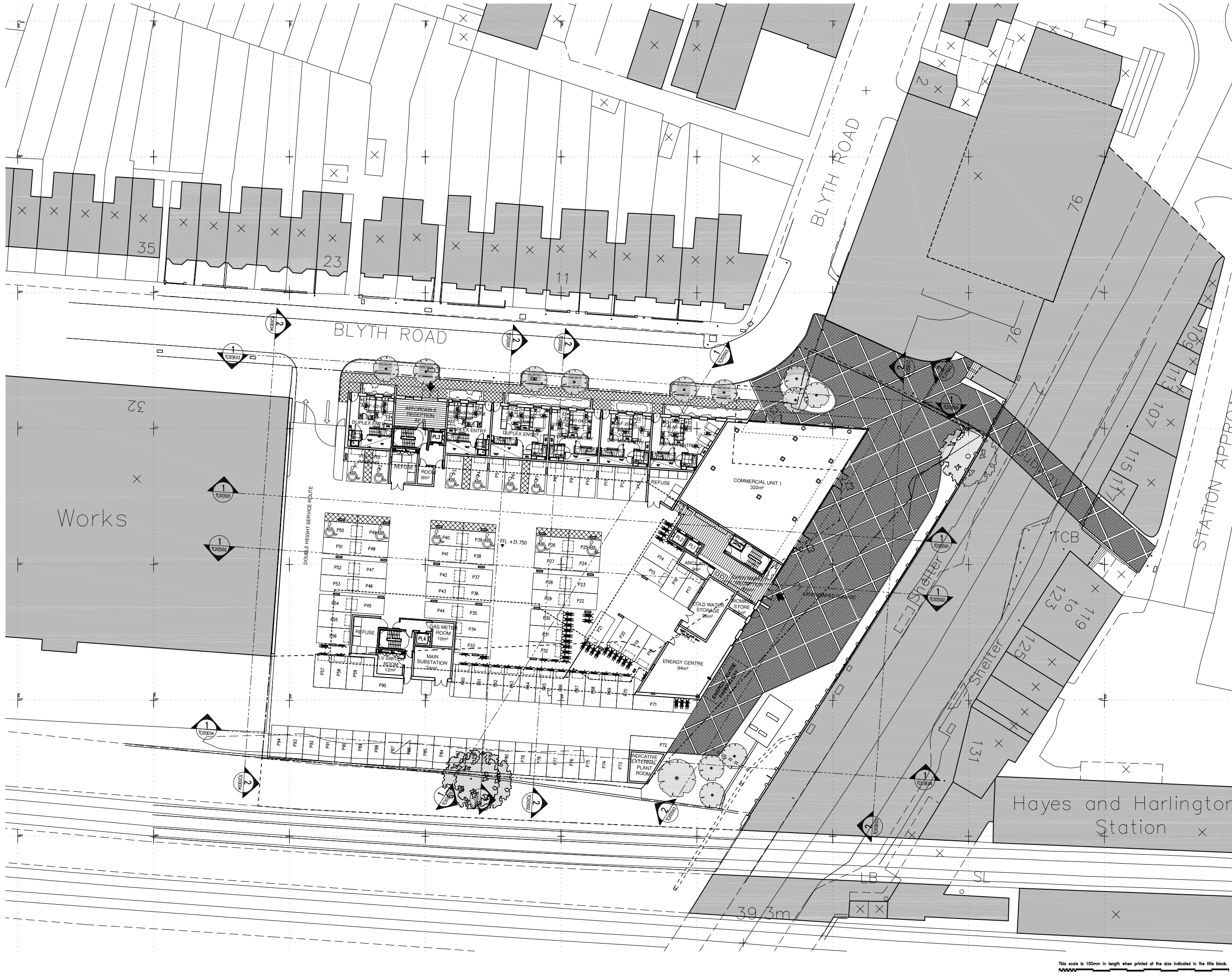
4710 / T(20)E03

CAD Ref No

G:\4710\T-Series\T20\T20E03

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NOTES

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- 4 All work and materials to be in accordance with current applicable Statutory Legislation and to comply with all relevant Codes of Practice and British Standards.

N

--- APPROXIMATE SITE BOUNDARY
- - - NETWORK RAIL SAFEGUARDED AREA

CAR PARK PROVISION

PARKING BAYS -83
WHEELCHAIR ACCESSIBLE BAYS -12
IN TOTAL -95

NUMBER OF CYCLE SPACES -170

P56 PARKING BAY WITH SOFFIT MOUNTED CYCLE HANGER (1 CYCLE)

PARKING BAY WITH FLOOR MOUNTED CYCLE RACK (2 CYCLES)

PARKING BAY WITH FLOOR TO FLOOR MOUNTED CYCLE HANGERS (2 CYCLES STACKING)

P1 & P2 - REFUSE BINS COLLECTION POINT ON THE DAY OF THE REFUSE COLLECTION ONLY

Rev | | Date

ROLFE JUDD

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Client
DOMAINE DEVELOPMENTS Ltd

Project
BLYTH ROAD

Drawing
GROUND FLOOR PLAN

Scale
1:250 (A1)

Date
JAN 09

Drawn
MM

Drawing No
4710 / T(20) P00

CAD Ref No
6:\4710\T_Series\T20\T20P00

Revision
-

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