

Appendix 11-2

Phase 1 Ground Condition Assessment

East Reading Mass Rapid Transit Scheme

Phase 1 Ground Condition Assessment (Contamination and Geotechnical)

On behalf of **Reading Borough Council**



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	Name	Position	Signature	Date
Prepared by:	Arie Zamler	Principal Engineer	<i>A. Zamler</i>	28/07/2016
Reviewed and Approved by	Richard Thomas	Senior Consultant	<i>R. Thomas</i>	28/07/2016
For and on behalf of Peter Brett Associates LLP				

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Summary

This report presents a Phase 1 Ground Condition Assessment (Contamination and Geotechnical) for the proposed MRT Scheme at East Reading.

Site Location The site is situated about 1.5 km to the northeast of Reading Town Centre. The proposed scheme is a new road link connecting Napier Road in the west to Thames Valley Park to the east. The scheme comprises a narrow corridor situated along the southern bank of the River Thames with a bridge over the River Kennet.

Historical Land Use Previously the western part of the site was raised with materials from unidentified sources and is defined by the Environment Agency as a historical landfill, and was used as railway land and fuel tanks. Subsequently, some of the western part of the site was redeveloped as part of the Tesco Superstore development. The eastern part of the site is undeveloped land with two historical gravel pits.

Ground Conditions The expected ground conditions comprise Alluvium, River Terrace Deposits and the White Chalk Subgroup at depth. It is expected that Made Ground is present associated with the landfill, historical pits, and former developments.

Preliminary Geoenvironmental Assessment The site has been divided in to a number of zones along the narrow corridor forming the route of the scheme. The potential for significant contamination to be present at the site associated with its industrial history is considered to be **Moderate** at worst in Zones A, B, C, D, and G. Elsewhere the potential for contamination to be present is **Very Low**.

Based on the proposed end use of the site, the findings of a qualitative risk assessment carried out to assess hazards and constraints posed by the existing site conditions for each part of the site to the proposed development are summarised in the following table.

Receptor	Risk Estimation
Human Health (Current Users)	Low
Human Health (Future Users)	Low
Neighbouring Human Health	Low
Construction Workers	Moderate
Groundwater	Superficial Deposits (Shallow Aquifer) Low
	Chalk (Deep Aquifer) Moderate
Surface Water	Moderate
Property (Buildings)	Low
Ecology	Very Low

The geoenvironmental risk assessment indicates that any potential contaminants are not themselves likely to represent an unacceptable risk to human health, controlled waters or ecology and wildlife associated with the development of the Site as currently proposed.

It is considered that a ground investigation and contamination assessment of the site as a whole will not be required to support the planning application, and this can be dealt with post consent during the ground investigations for design purposes. However, a limited geoenvironmental ground investigation and Tier 2 contamination assessment is recommended for the western area, identified as being of moderate contaminated land risk associated with the historical railway land and landfill and the risk to Controlled Waters associated with the proposed scheme.

It is considered unlikely that the local planning authority will designate the site as Contaminated Land under Part 2a of the Environmental Protection Act 1990.

Preliminary Ground Stability Risk Assessment A review of potential geological hazards has identified the risk of land instability or for potentially adverse foundation conditions to be present, in general, to be **Very Low**. The exception relates to the hazard potential in respect of vertical solution pipes and sinkholes that is considered to be **Low**.

The potential for running sand, and compressible soft materials in respect to the design and construction of foundations is considered to be **Moderate**.

Any excavation for temporary works at the site should be carried out considering the potential risk associated with the running sand hazard, whilst foundation solutions are likely to comprise piling.

The potential for sub-horizontal solution widened bedding planes and fissures in the Chalk needs to be taken into consideration for pile design and construction purposes. Allowance should be made for the potential loss of concrete in piling operations owing to the potential for sub-solution pipes in the Chalk.

Geotechnical Considerations It is currently proposed to construct approach embankments up to 120 m long and about 5.0 m high for the bridge abutments and viaduct. Conventional earthworks may be used to construct the approach embankments subject to there being adequate space to construct stable side slopes with the materials imported. Alternatively, steeper slopes can be constructed using reinforced soil techniques, or retaining structures.

It is expected that significant settlement will occur following the construction of the approach embankments. A transitional slab will be required to accommodate the relative settlement between the embankment and the proposed bridge abutment. Other settlement mitigation measures may be required including the use of preloading or surcharge, and/or the use of geogrids. Adequate drainage will need to be provided.

It is anticipated that the proposed bridge and viaduct structures will be supported on pile foundations extending into the Chalk. The actual pile capacity will need to be determined at detailed design stage using the findings of a site specific geotechnical ground investigation.

Cut and fill earthworks will be required to create a suitable sub-grade on which to construct the proposed road pavement. This will require information from a ground investigation and geotechnical assessment. Earthworks will need to be carried out in accordance with an Engineering Specification.

A supplementary site wide ground investigation will be required at a later stage as part of detailed design process to inform the design of the bridge foundations, approach embankment, any reinforced slopes or retaining structures and road design and to check for the presence of contamination.

The summary contains an overview of the key findings and conclusions. However no reliance should be placed on any part of the summary until the whole of the report has been read.

1 Introduction

1.1 Preamble

Peter Brett Associates LLP (PBA) has been instructed by Reading Borough Council (the Client) to undertake a Phase 1 Ground Condition Assessment for the proposed Mass Rapid Transit (MRT) Scheme at East Reading.

This report presents a Phase 1 ground condition assessment comprising a desk study, site walkover, Tier 1 preliminary qualitative contamination risk assessment, preliminary ground stability assessment, and a preliminary geotechnical assessment. The report has been prepared to support a planning application for the proposed scheme.

The assessment reviews readily available information in order to assess the existing ground conditions on the site and the potential for contamination to be present associated with previous and present uses of the site and the surrounding areas. This enables a qualitative assessment to be made of both geoenvironmental and geotechnical constraints such that informed decisions on the proposed development can be made and the risk and hazards associated with existing or potential future contamination and instability of the ground identified, with recommendations for further studies and/or mitigation as appropriate.

The report also includes advice on likely requirements for foundations and infrastructure, to assist with the conceptual design of the proposed scheme.

It should be noted that the Phase 1 is a land condition assessment and does not purport to be an ecological, flood risk or archaeological survey and additional specific surveys may be required to support the planning application.

1.2 Objectives

The primary aim of this assessment is to meet the requirements of the National Planning Policy Framework (DCLG, 2012) Clauses 120, 121 and 122. Under the definition 'Site Investigation Information' given in the NPPF glossary page 56, a Phase 1 ground stability risk assessment Desk Study, contamination risk and ground stability assessment is the minimum requirement under the NPPF to support any planning application on a site that might be potentially affected by contamination.

Similarly, a desk study and site reconnaissance is the minimum information that should be provided for a site potentially at risk from ground instability.

1.3 Scope of Work / Terms of Reference

1.3.1 Contamination

Guidance on ground condition assessment is given in CLR 11 Model Procedures for the Management of Contaminated Land (EA, 2004), that sets out a process based on a tiered risk assessment with increasing level of detail required to progress through the tiers.

This report presents a review of the acquired information, together with the development of a Preliminary Conceptual Site Model (CSM) and the associated Tier 1 risk assessment. PBA has undertaken the work in general accordance with our specification for a Phase 1 Ground Condition Assessment, a copy of which is presented in **Appendix 1**.

1.3.2 Ground Stability

The report also identifies the potential hazards and constraints to the proposed development of the site with regards to the risk of ground instability.

The objective of a ground stability assessment is to identify the likely ground conditions of a defined site and assess the information to identify potential issues that may have associated geotechnical liabilities or other ground engineering constraints that could affect the site development. This includes potential subsidence arising from artificial cavities, natural cavities - coal and non-coal (underground) mining / extraction activities, adverse foundation conditions (ranging from soft weak sediments to hard strong rocks), and landslides and slope instability.

1.3.3 Geotechnical

Current standards and guidance on site investigation and geotechnical engineering BS5930 (2015) and BS EN 1997-2 (2007) require that desk based research and site reconnaissance is carried out before intrusive geotechnical ground investigation is undertaken.

The objective of the study is to provide an early indication of geotechnical conditions, hazards, constraints and opportunities to feed into the project planning process and development budgets.

1.4 Methodology and Report Format

1.4.1 Contamination

The PBA methodology for ground condition assessment is presented in **Appendix 2**.

The underlying principle is the evaluation of *pollutant linkages* in order to assess whether the presence of a source of contamination could potentially lead to harmful consequences. A pollutant linkage consists of the following three elements:

- A source of contamination or hazard that has the potential to cause harm or pollution;
- A pathway for the hazard to move along / generate exposure; and
- A receptor which is affected by the hazard.

For each potential pollutant linkage identified the risk is estimated through consideration of the magnitude of the potential consequences and the likelihood or probability of an event occurring.

This report is divided into chapters identifying potential sources (hazard identification), potential pathway and receptor identification and risk estimation and assessment.

1.4.2 Ground Instability

The preliminary ground stability assessment methodology adopted by PBA follows the guidance on preliminary land stability assessment given in the Planning Practice Guidance for Land Stability published by the Department for Communities and Local Government (DCLG, 2014). The guidance at least requires a desk based study and a site inspection visit based on which the assessment is undertaken by an appropriately qualified person.

The desk based study comprises a review of existing readily available published sources of geological, geomorphological, hydrogeological and /or mining information on the site and its surroundings and a historical review including mapping and aerial imagery if appropriate.

The site inspection is undertaken to assess the presence of potential instability features on site such as back scars, tension fissures and lateral shears and evidence of soil creep; seepage lines and wet areas which might indicate groundwater emergence; vegetation types indicative of a high water table or changes in soil type and condition. The inspection looks for evidence of movement in existing structures and trees; evidence of past movement indicated by discrepancies between locations of features and field boundaries and those on past editions of Ordnance Survey maps or aerial photographs; evidence of movement due to mining or natural underground cavities; and evidence of previous changes to the structure of the site by infilling, man-made embankments or tips and cuttings e.g. for canals, reservoirs, roads, railways, quarries, mines etc.

The preliminary stability assessment includes, where relevant, a review of geological hazards for the site such as natural and man-made (mining) cavities, landslide, cambering and block movement, collapsible and compressible soils, running sand, and subsidence and heave due to volumetric change in the ground.

1.4.3 Geotechnical

The preliminary geotechnical assessment presents a review of the potential geotechnical conditions and constraints to the development of the Site. The assessment will consider potential constraints on temporary excavations and design for foundations, pavement and concrete slab, as well as the chemical attack on buried concrete.

The assessment will consider the known history of the site and the available data on the current ground conditions based on published geological maps, historical ground investigation reports and publicly available exploratory hole records.

1.5 Sources of Information

The following sources of information were used in the preparation of this report:-

- PBA walkover inspection – photographs are presented in **Appendix 5**.
- EmapSite™ was commissioned to provide historical maps and an EnviroInsight computerised data search. The historical maps are presented in **Appendix 3** and the EnviroInsight Report is presented in **Appendix 4**;
- Information published by the British Geological Survey (BGS) from 1:50,000 scale geological maps;
- Borehole records held by the British Geological Survey (BGS) database;
- Environment Agency web site “What’s in Your Back Yard?”, <http://maps.environment-agency.gov.uk>;
- The National Artificial and Natural Cavities Database managed and enhanced by Peter Brett Associates LLP (PBA); and
- Information provided by Reading Borough Council Environmental Health Team.

Attention is drawn to the Essential Guidance for Report Readers included as **Section 6** of this report.

2 Land Use Information

2.1 Introduction

This section presents a summary of current and historical land uses on and immediately adjacent to the site. Land use is used to inform the hazard identification element of the risk assessment.

2.2 Site Location

The site is situated about 1.5 km to the northeast of Reading Town Centre. The site comprises a narrow corridor about 1.1 km long along the line of a proposed new road link connecting Napier Road to the west and Thames Valley Park to the east. The scheme is located along the southern bank of the River Thames with a bridge over the River Kennet. The site is centred at National Grid Reference SU 730 738.

The site is situated between the River Thames to the north, the A3290 roundabout / access road to Thames Valley Business Park to the east, the Reading to London Great Western Railway Line to the south, and Napier Road to the west.

A site location plan is presented as **Figure 1**.

2.3 Site Description

The current land use information is based on a walkover inspection undertaken by an Engineer from PBA on the 22 March 2016.

For ease of reference the site has been divided into a number of zones along the narrow corridor of the scheme as shown on Figure 2. The description is from west to east along the corridor for each of the zones, as follows:

Zone A – About 80 m in length and between about 15 and 25 m wide, comprising carriageway, pavements, and associated landscaping along Napier Road leading to Tesco Superstore.

Zone B – Mostly landscaping, and an access road forming part of Tesco Superstore development – about 120 m in length and between about 30 and 70 m wide.

Zone C – Access roads and car parking areas serving Tesco Superstore and a narrow band of landscaping to the south – about 240 m in length and about 50 m wide. A recycling centre with a number of recycling bins is present in the eastern part of the car park.

Zone D – This triangular parcel of land about 140 m long and up to 90 m wide and is covered with dense vegetation including semi-mature and mature trees and shrubs. The Thames Towing Path is situated along the River Thames. In addition, a paved footpath connects between Tesco Superstore car park and the Thames Path through this land parcel.

Zone E – The River Kennet crosses the centre of the site flowing from south-west under the Kings Mead railway bridge and the Horseshoe Footbridge to the north-east where it joins the River Thames. The River Kennet mouth is about 30 m wide where it crosses the site. The horseshoe footbridge connects the Thames Towing Path between the Eastern and Western banks of the River Kennet. The footbridge is attached to the Railway Bridge that is an arch brick bridge over the River Kennet immediately to the south of the site.

Zone F – A narrow strip of land about 240 m long and typically between about 20 and 30 m wide situated immediately to the south of the River Thames and north of the railway line. This zone is situated on the flood plain of the river and includes the Thames Towing Path.

immediately to the south of the river. The land is covered with grass and a number of mature trees.

Zone G – The land parcel is some 270 m in length and between about 10 to 20 m wide. The land rises to the east by about 3 to 4 meters in height to a vacant parcel of land covered with scrub and dense vegetation, and then reaches the A3290 roundabout. This part of the site has uneven and undulating ground in places.

A small disused compound is present off the A3290 roundabout. There are a number of traffic signs, traffic cones, sand bags, road planings and lumps of tarmac and concrete that present in the disused compound. It is assumed that this area was a small highway maintenance yard.

This study also considers the land areas proposed for flood compensation which comprise two parcels of land referred to as “compensation areas East of Kennetmouth” situated in Zone F, and a parcel of land referred to as “compensation areas West of Kennetmouth” situated to the north of the Tesco superstore.

The layout of the site, extent of each of the zones, and salient notes from the walkover are presented as **Figure 2**. Photographs taken during the site walkover (Plates 1 to 10) are presented in **Appendix 5**.

2.4 Current Land Use – Off-Site

Western Part The site is bounded to the south by the Network Rail land with a metal fence present along the boundary. Kings Meadow recreation ground is present to the west, a housing development named Luscina View comprising a number of blocks of flats present to the north of Zone A. The Tesco Superstore including associated car park, and a petrol station is present on and beyond to the north part of Zone B. The River Thames is present along the northern site boundary where the site corridor widens along Zone C.

Eastern Part The River Thames forms the northern boundary of the site and Network Rail land defines the southern edge of Zone F. Zone G is bounded by scrubland. Thames Valley Park Rowing Club and Wokingham Waterside Centre are present along the southern bank of the River Thames to the north of Zone G. The Thames Valley and Sutton Park Avenue Business Parks are situated about 0.3 km to the east and 0.1 km to the south, respectively.

Compensation Areas West of Kennetmouth. This comprises a mound forming part of a landscaped area to the north of the Tesco superstore.

2.5 Historical Land Use

The history of the development of the site and surrounding area has been obtained from a number of readily available historical Ordnance Survey (OS) maps. Copies of the extracts from the historical and current OS maps are presented in **Appendix 3** (Emap, 2016); for ease of presentation the OS maps are presented at a reduced scale from A3 to A4. For ease of reference the description of the historical use of the site using historical OS mapping is presented for the Western and the Eastern parts of the site separately.

2.5.1 Pre OS Mapping

Historically the site was situated on the flood plain of the Rivers Thames and Kennet. The surrounding area was used for trade along the River Thames and the Kennet and Avon Canal.

According to available information in 1840 the railway line between Reading and London Paddington named The Great Western Railway was completed with a large embankment and a railway bridge crossing the River Kennet immediately to the south of the site.

2.5.2 Western Part

The first available historical OS map dates from the late 1870s. The site is situated in a semi-rural setting to the north-east of the town of Reading. The Western Part is shown to be undeveloped land labelled as 'liable to floods'. A ferry is recorded to cross the River Kennet connecting the tow path along the southern bank of the River Thames. Railway sidings, the Great Western Railway on an embankment and a railway bridge over the River Kennet are recorded immediately to the south of the site. A railway underpass is shown to cross the railway embankment connecting between the Huntley and Palmers Biscuit Factory and the gasworks, and rail sidings to the south and north of the railway embankment, respectively. The land at King's Mead situated immediately to the south of the railway embankment is mainly vacant with a stone depot recorded adjacent to the railway underpass.

The map dated 1899 records a small pavilion that was constructed in Zone A on the western part of the site. A number of rail sidings have been constructed immediately to the south of the site. Gasworks are constructed in King's Mead about 0.1 km to the south of the site.

By early 1910s the southern section of the site (Zones B and C) is occupied by railway sidings constructed on raised land. The land at King's Mead to the south of the railway embankment and west of the River Kennet about 0.1 km to the south of the site, is shown to be occupied by gasworks and a large gas holder.

The map dated 1932 shows that the land in most of Zones B, C and D was raised and is occupied by railway sidings. A number of goods and gas coal sheds have been constructed in Zones C and D. Electricity pylons with overhead cable are shown in the site orientated east to west.

The map dated 1956 shows that the majority of the railway sidings and the goods and gas coal sheds have been removed. The land along and beyond the northern boundary of the site is shown to be covered with trees.

The maps dating from the early 1970s label the western part of the site in Zones B and C as 'Depot'. Two bunded tanks and a rectangular shed appear in the north western part of Zone B with three larger bunded tanks to the north of the site. The tanks were connected using rail sidings with the main tracks to the south of the site. A 'wagon tippler', typically used to drop off coal loads from railway wagons, is recorded at the railway sidings. A number of structures and the railway sidings at the former gasworks and the former Biscuit Factory to the south of the railway embankment appear to have been removed.

By early 1980s the former Biscuit Factory and the majority of the former gasworks to the west of the River Kennet have been removed.

By the early 1990s the western part of the site at Zones A, B and C is shown to be vacant with the former tanks and rail sidings having been removed. Subsequently, by the mid 1990s a Tesco Superstore was constructed to the north of the site and some of the associated car parking areas and access roads occupy Zones B and Zones C of the site itself. A petrol station was constructed immediately to the north of Zone B. A number of depots were constructed in Forbury Industrial Park formerly occupied by the gasworks about 0.1 km to the south of the site.

By early 2000s a number of large pylons are recorded on the site with overhead cables shown to run from east to west parallel to the southern site boundary.

By 2010, the warehouse that was situated immediately to the north of Zone A of the site was demolished and a number of blocks of flats named Luscinia View Development were constructed at this location.

2.5.3 Eastern Part

The first available historical OS map dates from the late 1870s. Zone F comprises undeveloped flood plain, whilst Zone G is named Broken Brow comprises undeveloped land with two large gravel pits labelled as 'old gravel pits'. The Dreadnought Public House is shown on the southern bank of the River Thames immediately to the north of Zone G of the site. A number of historical and active gravel pits are recorded to the east of the site in the Broken Brow area and to the south-east of the Great Western Railway embankment.

The map dates 1889 shows that Sutton's Seed Trial Ground occupies the land to the south of the railway embankment about 0.1 km south of the site.

By early 1910s a boathouse was constructed adjacent to the Dreadnought Public House to the north of the site on the southern bank of the River Thames.

The map dates 1932 record three small boathouses immediately to the east of the River Kennet. Allotment gardens are shown in the centre of Zone G. A large gas holder was constructed to the south of the railway embankment, about 0.1 km to the south of the site.

The map dates 1956 record a number of mounds in the historical gravel pits to the north of Zone G. The allotments are no longer recorded. An additional large gas holder was constructed about 0.1 km to the south of the site. Subsequently, by the early 1960s a factory was constructed about 0.3 km to the east of the site. The Dreadnought Public House is recorded to be used as a boathouse.

By early 1970s a number of structures related to the gas holders were constructed to the south of the railway embankment, about 0.1 km to the south of the site. Subsequently, by early 1980s Suttons Business Park was constructed in the land formerly occupied by the Sutton's Seed Trial Ground to the south of the site.

By the 1990s the boathouses immediately to the east of the River Kennet were demolished. The factory to the east of the site was demolished. Subsequently, by early 2000s Thames Valley Business Park was constructed about 0.2 km to the east of the eastern site boundary.

Former Gravel Pits

Historical gravel pits are recorded in Zone G. By overlaying the alignment of the pit edges of the gravel pit from historical maps, it is apparent that the alignments of the pit edges have changed over time. From an overlay of the 1956 map edition (the last to show the pit edge) and the current topographical survey, it appears that part of the pit edge may have been buried and/or covered over.

The former gravel pit may have been used to provide materials for the construction of the Great Western Railway in the 1840s. Subsequently, it is known that the pit supplied aggregate and ballast that was transported by boats on the River Thames and the Kennet and Avon Canal.

It possible that material arising from excavations to facilitate the construction of the adjoining A3290 and the A329(M) may have been deposited over the old pit edge. The only section of the former pit edge that was visible at the time of the site visit is situated to the north of the site, at the rear of the Waterside Centre.

Compensation Area West of Kennetmouth

It is understood that the mound in the landscaped area to the north of Tesco superstore was placed at the time of construction of the superstore using soil arisings from the works. Information from Reading Borough Council indicates that the materials placed in this area may be potentially affected by contamination associated with the former railway land and the tanks within the development.

2.6 Proposed Development

It is understood that Reading Borough Council is proposing to construct a new link road connecting Napier Road in the west and the A3290 roundabout in the east via a bridge crossing over the River Kennet. The proposed scheme comprises an approach road off Napier Road, an approach embankment leading to the bridge abutment with a 59 m span bridge over the River Kennet. The road to the west of the River Kennet will be constructed on a viaduct to minimise the footprint of the proposed road over the flood plain of the River Thames. The road is proposed for the use of buses, with a cycleway and footpath alongside.

It is proposed to incorporate the three small areas into the works to 'compensate' for any losses in floodplain storage area owing to the proposed scheme. The proposed compensation works comprise lowering the ground level slightly below the existing surrounding levels to create an alternative storage area in the floodplain.

The proposed outline layout of the scheme is presented on **Figure 3**.

3 Environmental Setting

3.1 Introduction

Information on the environmental setting is presented in this Section and the data is used to inform the stability assessment in **Section 4.0** and the Contamination Risk Assessment presented in **Section 5.0**.

3.2 Geology

3.2.1 Geological Map

The 1:50 000 scale geological map of the area; Sheet 268 (BGS, 2000) indicates the majority of the site lies on superficial deposits comprising Alluvium, and the Kempton Park Gravel Member, which is a River Terrace Deposit. The Superficial Deposits are underlain by the Seaford Chalk Formation and the Newhaven Chalk Formation (undifferentiated) as part of the White Chalk Subgroup. The Superficial Deposits are absent in most eastern part of the site where the White Chalk is shown to outcrop.

According to the lexicon of Named Rock Units of the British Geological Survey the Alluvium generally comprise silty clay with occasional layers of silt, sand, peat and gravel, whilst the Kempton Park Gravel Member comprises primarily sand and gravel. The White Chalk Subgroup is described as white chalk with nodular and tabular flint seams and bands.

It is expected that locally Made Ground is present associated with current and past developments of the site.

3.2.2 Historical Borehole Records

The British Geological Survey archives contain records of a number of exploratory holes sunk during two ground investigations in 1986 and 1989 in the vicinity of the site mainly associated with earlier proposals for a bridge over the River Kennet approximately on the alignment of the current scheme. Copies of borehole records on and in the near vicinity of the site have been reproduced and enclosed with this report in **Appendix 6**.

The locations of the boreholes and the stratigraphy on schematic cross section are included in **Figure 3** of this report.

A summary of the ground conditions based on the historical borehole records in the vicinity of the site is presented in the table below.

Table 3.1 Summary of typical depths and strata descriptions

Strata	Approximate Depth to base (m bgl)	Approximate thickness (m)	Typical Description
Made Ground	0.3 to 3.0 typically 1.0 to 2.5	0.3 to 3.0 typically 1.0 to 2.5	Variable composition, typically CLAY with fragments of brick, clinker, concrete, chalk and flint, locally with ash and organic matter
Alluvium (present in majority of locations with the exception of	2.5 to 4.3 Typically about 3.5 to 4.0	0.2 to 3.7 typically about 2.0	CLAY and SILT locally peaty or organic with traces of decaying organic matter, flint gravel and shells. Locally with rare layers of peat (up to 2.1 m thick)

Strata	Approximate Depth to base (m bgl)	Approximate thickness (m)	Typical Description
eastern end)			
Kempton Park Gravel (present in majority of locations with the exception of eastern end)	3.8 to >10.0 Typically about 6.0	0.6 to 6.8, Typically about 3.0	SAND and GRAVEL in variable proportion locally with a thin layer of clayey sandy silt
White Chalk Subgroup	> 25	> 20	White Chalk with flints. Recovered as remoulded chalk with fragments of weak chalk becoming rubbly and blocky with depth

The Chalk was described in accordance with the Mundford weathering classification scheme as was used at the time. Grade V Chalk is typically present at the top of the Chalk and is described as a structureless remoulded chalk containing small lumps of intact chalk. The Chalk becomes more structured and less weathered with depth and is described as Grades IV to II in accordance with the Mundford system. Grade IV is rubbly partly weathered Chalk, Grade III is rubbly to blocky unweathered Chalk and Grade II Chalk blocky medium hard Chalk.

A number of large flints were recorded within the Chalk. One of the boreholes (SU77SW318) was terminated at 13.9 m below ground level at a large flint that formed an obstruction to the borehole.

Where recorded, groundwater strikes were recorded between 1.8 and 4.5 m below ground level and rose to between about 0.3 and 2.9 m below ground level.

3.3 Geological Hazards

An assessment of hazard potential from geological hazards that may give rise to contamination pathways, instability, adverse foundation or construction conditions as supplied by the British Geological Survey (BGS) from their National Geoscience Information Service (NGIS) is presented in the EnviroInsight Report reproduced in **Appendix 4**. The generic assessment is generated automatically based on digital geological maps and the scope and the accuracy is limited by the methods used to create the dataset and is therefore only indicative for the search area.

The information contained in the EnviroInsight Report has been reviewed and where considered necessary reassessed considering the specific information available for the site. The modified assessment of the potential for geological hazards to be present on the site is summarised in **Table 3.2** below.

Table 3.2 Summary of Geological Hazards and Hazard Potential

Description	BGS Assessed Hazard Potential	PBA Comment and Assessment
Coal Mining Affected Areas	Not in a coal mining area	PBA Agree with this assessment.

Description	BGS Assessed Hazard Potential	PBA Comment and Assessment
Collapsible Ground Hazards	Very Low	PBA Agree with this assessment.
Compressible Ground Hazards	Moderate	Assigned because of the presence of Alluvium and PBA Agree with this assessment.
Dissolution Hazard	Very Low	PBA does not agree with this assessment. The White Chalk Subgroup underlying the superficial deposits present a risk of dissolution hazard owing to the potential presence of solution pipes in the chalk. The likelihood of the hazard being to be present is assessed to be Moderate for sub-horizontal solution widened bedding plane fissures and Low for a sub-vertical solution pipes and sinkholes (see below).
Landslide Ground Stability	Very Low	PBA Agree with this assessment.
Running Sand	Low	PBA does not agree with this assessment. The Kempton Park Gravel typically comprises sand and gravel. The likelihood for internal erosion of the granular soil particles associated with groundwater flows into excavations is considered by PBA to be Moderate for excavations below the water table.
Shrinking or Swelling Clay	Very Low	PBA does not agree with this assessment. The Alluvium deposits may contain clay fraction with a low/moderate shrinkage or swelling potential, in respect of changes in moisture content, as such, the likelihood for the hazard to be present is assessed to be Low/Moderate.

PBA assess that the site has **Very Low/Low** potential for being affected by some geological hazards. The exceptions to this are **Moderate** potential for the site to be affected by running sand hazard in the River Terrace Deposits and for compressible ground in the Alluvium. In addition, the potential hazard associated with shrinking or swelling clays due to the presence of Alluvium is considered to be **Low/Moderate**.

Chalk is a soluble rock and this can give rise to a variety of solution features that can affect land stability and give rise to preferential pathways for contaminant migration. Vertical solution features and cavities can occur from the surface down sub-vertical joint systems and sub horizontal solution cavities can occur at depth along sub horizontal bedding and fissure systems.

Given the geological setting of the site and the groundwater conditions, the hazard potential in respect of vertical solution pipes (whether infilled with weak compressible sediment or not), and sinkholes, is considered to be **Low**.

The hazard potential in respect of sub-horizontal solution widened bedding planes and fissures is considered by PBA to be **Moderate** and it is known that preferentially widened open sub-horizontal fissure systems provide a very high permeability groundwater flow zones

in Chalk below and in the vicinity of the main river valleys. Besides giving rise to the potential for very rapid transport pathways for potential contaminants, such very high permeability zones can give rise to problems during the construction of piled foundations, as large volumes of concrete or grout can be “lost” into such systems.

3.4 Industrial Setting

Information on the industrial setting of the site is presented in the EnviroInsight report (Emap, 2016) and reproduced in **Appendix 4**. The results of the database search are summarised on the following table and discussed in the following sections.

Table 3.3 - Summary of Environmental and Industrial Setting

Data Type	Number on Site ⁽¹⁾	Number within 250m of Site ⁽¹⁾
Waste Regulation		
Landfill Sites	0 (1)	0 (1)
Licensed Waste Management Facilities	0 (0)	1 (0)
Statutory Permits/Authorisations		
Pollution Prevention and Control ⁽²⁾	0 (0)	0 (0)
Radioactive Substance Authorisations	0 (0)	0 (0)
Planning Hazardous Substances	0 (0)	1 (3)
COMAH Sites ⁽³⁾ and NIHHS Sites ⁽⁴⁾	0 (1)	0 (1)
Potential Contaminative Uses		
Fuel Stations	0 (0)	1 (0)
Trade Directory	3	43
List 1 Dangerous Substances Inventory Sites	0	0
List 2 Dangerous Substances Inventory Sites	0	0
Category 3 or 4 Radioactive Substances Authorisations	0	0
Licensed Discharge Consents	0	1
Pollution Records		
Discharge to the Public Sewer	0	0
Discharge to Controlled Waters	0	1 (6)
Part A(2) and Part B Activities and Enforcements	0	1
Sites Determined as Contaminated Land	0	0
Notes: 1) Numbers in brackets denotes number of authorisations, licences or permits that are lapsed, revoked, cancelled, superseded, defunct, surrendered, not applicable, withdrawn or not yet started. 2) Includes Integrated Pollution Controls, Integrated Pollution Prevention and Control, Local Authority Integrated Pollution Prevention and Control and Local Authority Pollution Prevention and Control permits. 3) COMAH denotes Control of Major Accident Hazards 4) NIHHS denotes Notification of Installations Handling Hazardous Substances		

3.4.1 Landfill and Waste Records

Landfill According to the EnviroInsight Report a historical landfill is situated within Zones C and D on the Western Part of the site. The landfill is recorded to have received inert and industrial wastes. The EnviroInsight Report provides no further information on the landfill. The historical landfill record corresponds with the area of land that was in the early 20th Century. The potential for contamination owing to the presence of this landfill and the adverse ground conditions this may give rise to the scheme have been taken forward and discussed further in **Sections 5 and 6**.

A licensed historical landfill is situated to the north of the River Thames about 0.1 km to the north of the site. The landfill was operated by Deans Farm with a licence issued in 1993 and surrendered in 2010. No further information is available in the EnviroInsight Report with regards to this landfill. The site is not situated downgradient for groundwater flow. The River Thames acts as a 'barrier' for any soil gas being produced, and, as such, the historical landfill to the north of the site is eliminated as a potential hazard in respect of this development and not considered further in this report.

Licensed Waste Management Facilities According to the EnviroInsight Report a planning consent was granted for a recycling facility situated about 50 m to the north of Zone C within the Tesco Superstore car park. The scheme comprises the replacement of the existing recycling units with a single automated recycling unit. This scheme had not been implemented at the time of the site walkover inspection.

The existing or the proposed recycling facility are not considered to represent a risk to the site or the proposed scheme. As such, this activity has not been carried forward as a potential source of contamination.

3.4.2 Statutory Permits or Authorisations

Part A(2) and Part B Activities and Enforcements there is a record of a Part B permit for the Tesco Filling Station situated about 30 m to the north of the site for 'Unloading of Petrol into Storage at Service Stations'.

Planning Hazardous Substances There is a record of a Planning Hazardous Substance Consents and Enforcements for the storage of natural gas in gas holders no.5 and no. 6 situated about 80 m to the south of the site. There are no further details with regards to this permit. The gas holders have been decommissioned and are no longer in use.

There is a record of a Planning Hazardous Substance Consents and Enforcements for the storage of natural gas in gas holder situated about 160 m to the south of the site. The gas holders were decommissioned and the permit was withdrawn in 2000.

COMAH Sites and NIHHS Sites The southern boundary of the site is situated within the influence zone of a historical Notification of Installations Handling Hazardous Substances (NIHHS) site for the gas holders situated to the south of the site. This permit is no longer in force.

The gas holders are situated about 50 m to the south to the western part of the site hold a historical Control of Major Accident Hazards (COMAH) permit. This permit is no longer in force.

Discharge to Controlled Waters There is a valid consent for the discharge of surface water from Tesco Superstore to the River Thames situated about 120 m to the north of the western part of the site.

3.4.3 Contemporary Trade Directory

The trade directory entries identified in the vicinity of the site typically relate to local light industrial and commercial activities, electrical and local infrastructure facilities.

Given their nature, size and/or distance from the site and considering the regulatory regime under which potentially contaminative industries operate, the majority of the activities listed are not considered to represent a particular risk of environmental hazard to the site or the proposed development.

The exception comprises the petrol filling station situated about 30 m to the north of the site. However, it is expected that groundwater flow is towards the River Thames and the site is not expected to be downgradient for groundwater flow. As such the potential for potential contamination to migrate on to the site is highly unlikely.

3.4.4 Information from Reading Borough Council Environmental Health Team

PBA made a request to Reading Borough Council for any geoenvironmental related information held by the Council for the site and its immediate surroundings.

The Senior Technical Officer for Environmental Protection of Reading Borough Council (Mr Ross Jarvis) carried out a search on the Council's database with relation to contamination records for the site. The letter refers to a number of records of potential source of contamination including former gas works, gravel pit, biscuit factory, railway sidings, a warehouse and a historical landfill. All of the records are referred to in the previous sections of this report.

A copy of the Environmental Information provided by the Council is reproduced in **Appendix 7** of this report.

3.4.5 Information from the Environment Agency

PBA made a request to the Environment Agency (EA) for any geoenvironmental related information held by the EA for the site and its immediate surroundings.

According to the documents provided by the EA the historical landfill at Napier Road has received 'semi-inert materials' including; wood, paper, cardboard, plasterboard and plastic. According to the documents that landfill has a soil cover.

The other documents provided include the following:

- Discharge consents within 1 km radius of the site
- Surface water quality records
- Pollution incidents within 250 m radius from the centre of the site
- A surrender notice for Deans Farm landfill situated about 0.2 km to the north of the site.

A copy of the environmental Information provided by the EA is reproduced in **Appendix 8** of this report.

3.5 Hydrogeology

The Seaford and Newhaven Chalk Formations is classified as Principal Aquifers. Principal Aquifers are defined as formations that may be highly productive and able to support large abstractions for public supply and other purposes.

The Kempton Park Gravel Member and the Alluvium are classified as Secondary A Aquifer. These are formations of variable permeability that, although seldom producing large quantities of water for abstraction, may be important for local supplies and in supplying base flow to rivers.

The presence of a Principal Aquifer and a Secondary A Aquifer need to be considered in assessing the effects of the built development on the hydrogeological regime and the risk associated with potential pollutants.

The latest indicative maps included in the EnviroInsight Report indicate that the Site is located within a groundwater Source Protection Zone 3 for a groundwater abstraction well situated about 2.2 km to the south of the site. Groundwater source protection zones are defined as the groundwater catchment zones for significant public water supply and private wells or boreholes that supply water to portable or equivalent standards. A total catchment (Zone 3) is defined by the Environment Agency as the area around a groundwater abstraction well within which groundwater recharge is presumed to provide water to the abstraction well.

The 1:100,000 Hydrogeological Map of South West Chilterns and the Berkshire and Marlborough Down (BGS, 1978) indicates the groundwater level in the Chalk in August 1976 is recorded at about 40 m AOD with the groundwater flowing in a general direction toward the River Thames.

Based on the borehole records in the vicinity of the site it is expected that the groundwater level in the superficial deposits is between about 0.5 to 3.0 m below ground level in the lower parts of the site corresponding to about 36 m OD. It is expected that the groundwater in the Alluvium, River Terrace Deposits and the White Chalk Subgroup are in hydraulic continuity with the water in the adjacent rivers and is roughly at the same level.

3.6 Hydrology

The River Thames and the River Kennet are classified by the Environment Agency as a Primary River of Very Good and Good (Grades A and B) Biological and Chemical Quality, respectively.

The chemistry grade is assigned by averaging results for biochemical oxygen demand (BOD), ammonia and dissolved oxygen measured by the Environment Agency until 2009.

3.7 Groundwater and Surface Water Control

The following table summarises information recorded in the EnviroInsight report regarding hydrology.

Table 3.4 Summary of Surface Water Related Information

Groundwater and Surface Water Controls	Number on site	Number within 500m of site
Abstraction	0 (0)	1 (6)
Pollution Incidents to Controlled Waters	0	16
Prosecutions Relating to Controlled Waters	0	0

Notes:

- 1) Numbers in brackets denotes number of authorisations, licences or permits that are lapsed, revoked, cancelled, superseded, defunct, surrendered, not applicable or not yet started.
- 2) Includes water impact entries on the Substantiated Pollution Incident Register.

Abstraction A groundwater abstraction well is situated about 30 m to the north of the Eastern Part of the site for the Wokingham Waterside Centre at Thames Valley Park Road. The abstraction well is recorded to supply water for drinking/cooking/sanitary/washing purposes for commercial/industrial/public services. The annual volume of water permitted is 2600 m³ and the maximum daily volume is 25 m³.

Pollution Incident There are 16 pollution incidents recorded in the vicinity of the site with the closest about 140 m to the south of the site. The incidents relate to sewage materials, oils and fuels, and general biodegradable materials and wastes. In general, the impact to water, land and air are recorded to be Category 3 and 4 (Minor or No Impact). The impact for a single incident dated April 2006 to water is classified as major, however no further details are given with regards to the type of pollutant or the pollution description.

3.8 Ecological Systems

There are no statutory designated areas of environmental sensitivity within 2 km of the site. The closest area of environmental sensitivity recorded is ancient woodland situated about 0.9 km to the north of the site.

A Local Wildlife Site known as “The Coal, Kennetmouth and Kings Meadow East” is situated between the Tesco Superstore and the River Thames.

The site area lies within a nitrate vulnerable zone. This designation is allocated to minimise nitrate contamination caused by agriculture activities into water bodies and is not relevant for the proposed development.

4 Ground Stability Risk Assessment

4.1 Introduction

In accordance with the requirements of the National Planning Policy Framework (DCLoG, 2012), the potential for the proposed development to contribute to or to be adversely affected by land instability has been assessed. Accordingly, consideration is given below to the potential risk of subsidence arising from Artificial Cavities; Natural Cavities; slope instability and Potential Adverse Foundation Conditions arising from existing ground conditions across the Site, as identified by the desk study.

4.2 Natural and Mining Cavities

The National Natural and Mining Cavities Database maintained and updated by PBA has been searched for relevant natural and mining cavity records.

4.2.1 Natural Cavities

There are 3 records of natural cavities within a 1.0 km radius of the Site. The cavity records are related to solution pipes and sinkholes with the nearest cavity is situated about 0.6 km to the south of the site.

Based on the available information as discussed in **Section 3.3** the risk associated with dissolution features of the Chalk has been assessed as **Low**.

4.2.2 Mining Cavities

There is a single record of a mining cavity within 1.0 km radius of the site. The mining cavity is related to Multiple Chalk Bellpit Workings situated about 1 km to the southeast of the centre of the site.

Whilst the absence of existing records does in the near vicinity of the site not, in itself, demonstrate that mining cavities are not present on the Site, however, the ground conditions together with the presence of groundwater at a relatively shallow depth is such that the potential for such features to be present at the site is considered to be **Very Low**.

4.3 Surface Quarrying

A large historical gravel pit is recorded on the historical OS maps in Zone G situated in the Eastern Part of the site. The pit may have been used to provide materials for the construction of the Great Western Railway in 1840s, or for ballast for vessels using the Rivers Thames and Kennett. Subsequently, the pit may have been used as a borrow pit for the supply of aggregate that was stored in piles within the historical pit. Historical quarrying might give rise to potential instability of steep side slopes within pits or at the land immediately adjacent to these slopes.

It is possible that material arisings from construction of the adjoining A3290 roundabout and the A329(M) in the 1980s were deposited over the old pit edge. Such infilling is unlikely to have been fully engineered, however, a significant degree of consolidation and settlement of the fill under its self-weight is likely to have taken place in the intervening period, as well as any additional consolidation and settlement from surface applied loads. The database and published records reviewed during the desk study works have identified no records of quarrying within the western part of the site. Therefore, the hazard to development arising from past surface quarrying occurrence on the site is considered to be **Very Low** with the exception of Zone G where it is assessed as **Low / Moderate**.

The potential for reuse of more recently deposited soils in the historical gravel pit will need to be investigated as part of detailed design.

4.4 Slope Instability

In general, the ground profile across the majority of the site is relatively flat with gradients of significantly less than 1 vertical in 10 horizontal.

The ground level in the meadow situated in the western part of the site was raised in the early 20th century to raise this part of the site out of the flood plain. The raised is up to about 1.5 m above the surrounding land with side slopes shallower than 1 vertical in 3.5 horizontal.

Slopes in the western part of Zone G fall from about 39.5 to 36.0 m OD, with a maximum side slope gradient of about 1 vertical in 6 horizontal.

Overall, the soils on site are considered to be stable at the existing slope gradients and the risk of major slope stability or landslide hazard being present is considered to be **Very Low**.

It should be noted that the site is situated alongside a large railway embankment. Any proposed excavations and other work as part of the proposed scheme will need to consider the short and long term stability of the adjacent embankment.

4.5 Potential Adverse Foundation Conditions

An assessment of potential geological hazards that may give rise to adverse foundation or construction conditions are discussed and presented in **Section 3.3**.

The potential for shrinkable soils hazard to be present is considered to be **Low/Moderate**. In order to minimise this risk, ground investigation and testing will need to be undertaken. Pending the outcome of the ground investigation, structures may need to be designed to accommodate movement at the near surface owing to swell and shrinkage owing to change in moisture content or be taken to a depth where the likelihood of damaging movement is low.

The potential for compressible ground to be present in the Alluvium has been assessed as **Moderate**. Alluvium has a relatively low strength and high compressibility that could result in excessive total and differential settlement. Settlement will need to be taken into consideration for the design and construction of the proposed scheme.

The potential for running sands that may develop in excavations below the groundwater table in the Kempton Park Gravel Member has been assessed to be **Moderate**. Allowance should be made for controlling groundwater inflows in excavations below the groundwater table.

The risk for solution cavities in the Chalk is assessed to be **Moderate** for widened open sub-horizontal fissure systems. Special foundation measures may be required to deal with the solution feature hazard, if potential presence is confirmed by ground investigation. The main span and the viaduct will be supported using piles constructed into the Chalk. Allowance should be made for the potential loss of concrete during pilling operations owing to the potential presence of sub-horizontal solution pipes in the Chalk.

Further details on the geotechnical considerations for the proposed scheme are presented in **Section 6.0**.

5 Tier 1 Preliminary Risk Assessment

5.1 Introduction

The methodology developed and adopted by PBA for contamination risk assessment is presented in **Appendix 2**.

The model procedures (also known as 'Contaminated Land Report 11' or 'CLR 11') have been developed to provide the technical framework for applying a risk management process when dealing with land affected by potential contamination (EA, 2004). In accordance with guidance presented in CLR 11, PBA adopt a staged approach to risk assessment and this report presents a Tier 1 preliminary (qualitative) assessment.

5.2 Conceptual Site Model

The underlying principle to ground condition assessment is the identification of *pollutant linkages* in order to evaluate whether the presence of a source of contamination could potentially lead to harmful consequences. For a pollutant linkage to be identified a connection between all three elements (source-pathway-receptor) is required.

The Tier 1 Preliminary Risk Assessment includes the development of a conceptual site model (CSM). The CSM describes the types and locations of potential contamination sources, the identification of potential receptors and the identification of potential transport/migration pathways.

5.3 Geoenvironmental Hazard Identification

5.3.1 On Site

Western Part The western part of the site had an industrial history with a number of industrial uses including a historical landfill, railway land, railway sheds, and large fuel tanks. By the 1990s the majority of this part of the site was redeveloped as part of the Tesco Superstore development.

It is expected that the land within Tesco ownership of the site was remediated or treated as part of the enabling works for the Tesco Superstore development to a certain degree in accordance with the standards of construction and environmental legislation at the time. Records of remediation or enabling works as part of the Tesco Superstore development were not made available at the time of writing of this report. As such, and until such records are made available, it had to be assumed that any potential sources of contamination on site have not been treated or removed. The potential for significant contamination to be present in the western part of the site associated with its industrial history is considered to be **Moderate**.

Eastern Part The lower part of the site (Zone F) is principally undeveloped land with the exception of former boat houses. The land in the eastern part of the site (Zone G) comprises limited historical use including historical gravel pits and allotment gardens, and a small disused highway depot. Based on the known history of the site, it is considered that the potential for significant site wide contamination to be present in Zones F and G is **Very Low** with the exception of the former depot and the infilled gravel pits in Zone G where the potential is assessed as **Moderate**.

Zones

For ease of reference each of the zones were allocated with their potential source of contamination (PSC) as summarised below:

Zone A – South eastern part of this zone was occupied by former railway land (PSC A), the northern part by former tanks (PSC B);

Zone B – Within former railway land (PSC A), north western part is within an area of former tanks (PSC B), Tesco filling station adjacent to northern boundary (PSC C);

Zone C – Within former railway land (PSC A), all except western end within historical landfill (PSC D);

Zone D – Within area of former railway land (PSC A), all except eastern end within historical landfill (PSC D);

Zone E – Potential sources of contamination were not identified;

Zone F – Potential sources of contamination were not identified; and

Zone G – Western half of this zone is within a historical gravel pit (PSC E), disused Highways compound at the eastern end (PSC F), fly-tipping (PSC G).

Compensation Area West of Kennetmouth – information that the material in the mounds is sourced from the Tesco Superstore and is potentially affected by contamination (PSG I).

5.3.2 Off site

The Site is bordered to the south by a railway land including a large embankment. Historically the land to the south of the railway land was used for industry principally by the Huntley & Palmers Biscuit Factory, Gasworks, and agriculture (seed trial ground). The gasworks site has subsequently been remediated and the land is redeveloped for commercial and residential use.

The land to the north of the western part of the site was used as railway sidings, fuel tanks, and a factory. Subsequently, this part of the site was redeveloped as part of the Tesco Superstore. The land to the north of the eastern part of the site is principally undeveloped land with a public house and boathouse.

The land to the east of the site was used as a factory and works, these were demolished and remediated with the Thames Valley Business Park constructed.

Overall the potential for significant off-site contamination to be present on the land surrounding the site is considered to be **Moderate** for the railway land and former industrial areas in the vicinity of the site, and **Very Low** for the undeveloped land.

Potential Sources of Contamination (PSC) identified on the site or within the vicinity of the site are described in Table 5.1. The table include details of the contaminants that may arise as a result of the current and historical activities that have taken place at the site.

A Geoenvironmental Constraints Plan is presented as **Figure 4**.

Table 5.1 - Potential Sources of Contamination (PSC)

PSC	Potential for Contamination	Potential Contaminants of Concern
PSC A - Railway land	Moderate potential for wide contamination in Zones A, B C D	Typically metals, organic contaminants in particular diesel and PAHs, biocides and ash.
PSC B - Former storage tanks	Moderate potential for localised contamination Zones A, B	Fuels and oils.
PSC C – Filling station	Moderate potential for	Petrol, diesel and oils

PSC	Potential for Contamination	Potential Contaminants of Concern
(off Site)	wide contamination in Zone B	
PSC D – Historical landfill site	Moderate potential for wide contamination in Zones C and D.	Dependent on composition of fill materials, but possibly metals, asbestos, ash, Polycyclic Aromatic Hydrocarbons (PAHs) and solvents. Soil gas given the possibility of degradable material being present.
PSC E - Historical gravel pits	Moderate potential for localised contamination in Zone G.	Typically metals, asbestos, ash, and PAHs
PSC F – Disused highway depot	Low potential for wide contamination in Zone G	Potential presence of metals, asbestos, PAHs, fuels, oils and solvents.
PSC G – fly tipping	Low potential for localised contamination in zone G	Potential presence of ash, metals, and asbestos.
PSC H –Former Allotments (off site)	Low potential for site wide contamination	Potential presence of ash, metals, and asbestos.
PSC I – Mounds (Compensation area West of Kennetmouth)	Moderate potential for site wide contamination	Potential presence of metals, asbestos, PAHs, fuels, oils and solvents.

5.4 Pathways

Potential environmental hazards need a pathway connecting the source (if present) to potential receptors in order to be able to impact upon the receptors. These pathways are capable of conveying the contaminants. Pathways may be anthropogenic (artificial) or natural.

Anthropogenic pathways are artificial routes capable of conveying contaminants and include such routes as surface water drains, high permeability backfill materials, poorly consolidated Made Ground, foundations, and persons disturbing contamination sources in such a way as to liberate contaminants.

In the case of persons working with contaminated ground (e.g. to lay foundations or install services) direct contact with the source becomes possible, and pathways such as dermal contact, inhalation or ingestion require consideration.

The site is expected to be underlain by Alluvium. Downward and lateral migration of contaminants within the Alluvium is likely to be somewhat limited owing to the presence of a mantle of relatively low permeability cohesive Alluvium in the near surface soils. However, it is possible that the installation of piled foundations could form a potential downward pathway for groundwater migration.

Potential pollutant linkages have been identified using the information on potential sources (contaminant types), receptors and exposure pathways. The Risk Estimation table presented in **Appendix 9** details all pollutant linkages that are considered to be plausible.

5.5 Receptor Identification

The proposed development is for a road and a bridge transport link with pedestrian use.

The adjacent River Thames and the River Kennet are considered to be highly sensitive controlled water receptors. Similarly, the Chalk and River Terrace Deposits Aquifers are considered to be sensitive receptors.

Details of the potential receptors considered, their sensitivities (see Table 2 in the PBA Methodology) and whether or not the receptor is plausible are summarised in the following table.

Table 5.2 - Potential Receptors

Receptor Type	Potential Receptor? (Y/N) / Sensitivity Value	Comment
Human Health Current	Y / 5	Open space
Human Health Future	Y / 5	Pedestrians
Neighbouring Human Health	Y / 5	Commercial/light industrial properties
Construction Workers	Y / 4	Full development with excavations
Surface Waters	Y / 5	The River Kennet and the River Thames
Groundwater	Y / 3	Superficial Deposits (Shallow) - Secondary Aquifer
	Y / 5	Chalk Aquifer (Deep) - Principal Aquifer
Property (Buildings/Materials)	Y / 2	Proposed river bridge crossing
Property (Animals / Crop)	N	Crops/produce or domestic animals/livestock are not present on or immediately adjacent to the site.
Ecological Systems	Y/2	A Local Wildlife Site known as "The Coal, Kennetmouth and Kings Meadow East".

Note: The Sensitivity Value is based on Table 2 of the PBA Methodology given in Appendix 2.

5.6 Risk Estimation

When there is a pollutant linkage (and therefore some measure of risk) it is necessary to determine whether the risk matters and therefore whether further action is required. PBA provide an estimation of the level of risk but do not comment on whether or not it is an unacceptable risk because the significance or acceptability of a risk depends on the individual stakeholder. Risk estimation involves predicting the likely consequence (what degree of harm might result) and the probability that the consequences will arise (how likely the outcome is).

Based on the information available, the estimated risks have been designated with further comments in the sections below. A risk estimation was carried out for Zones A, B, C, D, and G that at worst were identified to have **Moderate** potential for widespread contamination to be present within the zones.

Potential contamination sources have not been identified on Zones E and F. Without a source of contamination there are no Pollutant Linkages requiring risk assessment.

The outcomes of the risk assessments are presented in **Tables 1** in **Appendix 9** giving an assessment of consequence and probability for the proposed use as a transport link.

A summary of the risk estimation for the site is presented in **Table 5.3** below.

Table 5.3 – Risk Estimation

Receptor	Risk Estimation
Human Health (Current Users)	Low
Human Health (Future Users)	Low
Neighbouring Human Health	Low
Construction Workers	Moderate
Groundwater	Superficial Deposits (Shallow Aquifer) Low

Receptor	Risk Estimation
Chalk (Deep Aquifer)	Moderate
Surface Water	Moderate
Property (Buildings/Structures)	Low
Ecological Systems	Very Low

The risk to site users is relatively low due to the low sensitivity of the proposed end use, and the presence of hardstanding that will break the pollution linkage between the site soils and future users.

The risk to construction workers relates to the risk of ingestion, inhalation or skin contact of contaminated materials on the Site and inhalation of any potentially hazardous ground gases. Considering the expected variable and locally potentially significant concentrations of potential contaminants within the soils present on the Site, the potential risk to site workers is expected to be **Moderate**.

The provision of appropriate protective clothing and equipment to be worn by site workers together with the adoption of good standards of hygiene to prevent prolonged skin contact, inhalation and ingestion of soils during construction will be required to mitigate the risk to site workers. In addition, the methods of working should be selected to limit disturbance to the existing near-surface soils present on the Site.

Given the adoption of appropriate measures, the risks associated with the potential for skin contact, inhalation and ingestion of the near-surface soils to construction workers involved in earthworks or groundworks is expected to be **Low**.

5.7 Risk Evaluation

The Tier 1 risk assessment has identified a number of possible pollutant linkages. Whilst the collection of site specific data from an intrusive investigation is required to ascertain whether or not the PSCs are present, it is considered that given the site setting and the proposed development there are technical and financially viable solutions to manage the risks.

Given the site setting it is likely that basic mitigation measures including, health and safety for construction workers, and additional mitigation measures may need to be incorporated into the proposed development in the western part of the site.

The installation of piled foundations may create a pathway through the Alluvium for migration of potential contaminants from the Made Ground to the Aquifer at depth. It is recommended that in order to minimise the potential for groundwater contamination any piles installed as part of the proposed scheme will be designed and installed in accordance with the Environment Agency guidance for piling in potentially contaminated sites (EA, 2001 and 2002).

The current proposals for the Flood Compensation West of Kennetmouth is to remove the mound and dispose of the soils that are potentially affected by contamination in a suitable licensed facility after testing. Infiltration is not proposed in this area and it is understood that the compensation area will be lined to prevent the migration of surface water into the ground and the aquifer.

It is considered that these actions and potential mitigation measures are typical for similar brownfield redevelopments and should not be considered particularly onerous or unexpected.

The need to establish the nature of the ground conditions, the extent of contamination (if present) and identify potential remediation and/or mitigation measures associated with impacted soil, groundwater and surface water will need to be assessed through intrusive ground investigation, monitoring and Tier 2 risk assessments.

Given the level of risk and the type of relatively low sensitivity proposed end use it is considered that a ground investigation and Tier 2 contamination risk assessment for the whole site is not required to support the planning application for the whole site, and that these matters can be dealt with post consent during the detailed design investigations.

However, it is recommended that a preliminary geoenvironmental ground investigation is carried out in Zone D. This is an area of embankment construction and piled foundations for structures, where the risk assessment has identified as moderate geoenvironmental risk associated with the historical landfill and railway land. The investigation should target in particular the potential impacts from the proposed scheme on the highly sensitive Controlled Waters in the adjacent Rives Thames and Kennet, and the aquifer beneath the site.

A requirement to carry out a site wide geoenvironmental intrusive investigation can be satisfactorily dealt with by incorporation as a condition in any granted Planning Consent.

On this basis, it is considered unlikely that the local planning authority will designate the site as Contaminated Land under Part 2a of the Environmental Protection Act 1990.

6 Geotechnical Considerations

6.1 Introduction

This section of the report presents details of the geotechnical conditions and constraints to the development of the site based on the known history of the site and the available information on ground conditions. It should be noted that the assessment of the constraints presented in this report is based on the information available to date and the expected works required to construct the development as currently proposed.

The constraints may need to be reassessed should the form of the proposed development be changed and when the results of future ground investigation works scheduled become available. Ground investigation will be required at a later stage to confirm the ground conditions on site and provide appropriate parameters for design.

6.2 Approach Embankments

It is currently proposed to construct approach embankments up to 120 m long and rising to about 5.0 m high leading to the bridge and viaduct abutments.

The design considerations for the proposed approach embankments will be the slope of the embankment sides, the bearing capacity and settlement of the founding soils, drainage requirements and the type and method of construction.

6.2.1 Method of Construction

Conventional earthworks may be suitable for the construction of the approach embankments provided that stable side slope gradients for the imported materials to be used can be accommodated in the space available for the embankment footprints. If steeper embankment side slopes are required then the embankment could be constructed using reinforced soil techniques, or constructed within steep or vertical retaining structures.

The ground conditions below the proposed embankments are expected to comprise a surface layer of Made Ground overlying Alluvium (clay) and River Terrace Deposits. A granular drainage blanket is likely to be needed below the base of the embankment to control the build up of pore water pressures, possibly in combination with a geogrid to mitigate any potential adverse settlement of the embankment owing to the variability and potential for locally soft and compressible materials to be present in the Made Ground and the Alluvium.

6.2.2 Settlement

Construction of the proposed embankments will result in a net increase in loading on the foundation soils resulting in potentially significant total and differential settlements.

Whereas detailed settlement analysis will need to be carried out during design, it is expected that some of the settlement will occur during or immediately after construction with most of the remaining settlement taking place within about 12 months. Locally greater and/or longer term settlement may be experienced associated with the biodegradation of any organic matter or secondary settlement of any peat present.

It is expected that a transition slab will be required to accommodate the relative settlement between the embankment and the proposed bridge abutment. Other settlement mitigation measures can also be considered for the embankments such as preloading or surcharge loading to allow settlement to take place prior to the construction of the road and the use of geogrid re-enforcement.

Foundation treatment such as ground improvement using vibro-displacement stone or concrete columns may be considered in order to control or restrict settlement, however they

may not be suitable on the western part of the site if contamination is present because of the possibility that the method will create downward contamination pathways. Similarly, the installation of vertical wick drains or band drains in the foundation soils to accelerate consolidation settlement may not be feasible for the same reason.

6.2.3 Drainage

Embankment drainage will be required to limit long term absorption of water, which otherwise would tend to increase the pore pressure in the fill and reduce the factor of safety against slope failure, perhaps ultimately resulting in failure of the slope.

The Specification for Highway Works (HA, 2009) requires the installation of drainage channels to collect run off from the carriageway, the vegetating of side slopes to limit water absorption from precipitation and run off on these slopes, and the inclusion of a coarse granular starter layer at the base of the embankment to limit water absorption by capillary action from the founding soils. In addition, consideration should also be given to providing a drainage channel along the base of the side slopes.

Disposal of surface water using shallow infiltration (soakaways) is not proposed as part of the scheme.

6.3 Foundations to Structures

The current proposals intend to construct a western approach road and embankment in the western part of the site leading to an abutment and a bridge with a main span of about 59 m long crossing over the River Kennet. From the main span eastwards, the road will be supported by a viaduct about 180 m long spanning over 8 piers decreasing in height to ground level.

It is anticipated that the proposed bridge and viaduct structures will be supported on pile foundations extending into the Chalk providing load carrying capacity from shaft adhesion and base resistance. For the ground conditions at the site, bored and cast-in-place piles formed using continuous flight auger (cfa) techniques should be appropriate although the presence of any existing buried structures in the Made Ground or flint bands in the Upper Chalk may form obstructions to piling works. If the use of conventional rotary auger techniques is required, it is likely that temporary casing will be needed to the base of the River Terrace Deposits to support the pile bore.

Allowance should be made for the potential concrete loss in piling operations owing to the potential for sub-horizontal solution fissures in the Chalk.

The actual pile capacity will need to be determined at detailed design stage using the findings of a site specific ground investigation.

6.4 Earthworks

The natural River Terrace Deposits lying beneath the Site are likely to be suitable for use as founding strata for road pavements. Any Made Ground, clay alluvium and the materials placed as part of the former landfill and within the historical gravel pits are unlikely to have been placed to an engineering specification and will require testing, treatment such as rolling and/or compaction, before road construction commences.

In any event, given the current variations in ground levels at the site it is assumed that some cut and fill earthworks will be required to create a suitable sub-grade for road construction. Final earthworks design will require information from a ground investigation and geotechnical assessment.

The potential for reuse of more recently deposited soils in the historical gravel pit will also need to be investigated as part of detailed design. The thickness and composition of fill material in various parts of the site will need to be verified and will affect the final design of pavements and any structure foundations.

6.5 Pavement Design

Based upon the ground conditions encountered on the Site, it is expected that pavements supported on undisturbed natural ground on a suitable depth of sub-base will, in general, prove adequate provided the exposed formation is compacted by a heavy smooth wheeled roller and any soft or degradable materials removed and replaced with compacted granular fill. A conservative CBR value of 2% may be adopted for preliminary design.

6.6 Concrete Mix Design

In accordance with BRE (2005) the Alluvium, River Terrace Deposits and Chalk do not have naturally high sulphate concentrations or acidic conditions and special precautions in the mix design of buried concrete are unlikely to be needed unless sulphate is present as an anthropogenic contaminant owing to the historical use of the site.

The concentrations of sulphate and the pH for the soils and any groundwater will be tested as part of the proposed ground investigation to determine the concrete mix design appropriate for the Site.

6.7 Future Ground Investigation

A supplementary ground investigation will be required as part of the detailed design stage to support the design of the proposed scheme and associated works. The geotechnical assessment will be required to provide suitable information to assess the ground conditions and provide geotechnical parameters for the geotechnical and structural design of the various elements of the proposed scheme including the proposed roads, embankment approach, bridge and viaduct foundations, re-enforced soil, retaining structures, earthworks and other geotechnical elements of the proposed scheme.

For special structures such as a bridge or viaduct the minimum requirements for a number of exploratory holes in accordance with the guidance given in Eurocode 7 (BS EN 1997-1 and BS EN 1997-2) is two exploratory holes for each pier. Where available, historical ground investigation records can be used, however, additional exploratory holes will be required to meet the minimum guidance.

The exact scope of ground investigation will be confirmed at detailed design stage. However, it is expected that the scope of ground investigation will comprise the following:

- Deep boreholes to assist with the design of the piled foundations for the proposed bridge and viaduct structures.
- Shallow boreholes to assist with the design of the approach embankments and for contamination investigation purposes.
- The excavation of trial pits to examine the near surface ground conditions including the historical landfill, and the historical gravel pits for geotechnical and contamination purposes.
- The installation of groundwater monitoring well and the monitoring of groundwater levels.
- Sampling and chemical testing of soil, groundwater, and surface water samples.
- Geotechnical analyses of selected soil samples to determine appropriate geotechnical parameters for the design of the geotechnical elements of the proposed scheme.

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This report has been prepared within an agreed timeframe and to an agreed budget that will necessarily apply some constraints on its content and usage. The remarks below are presented to assist the reader in understanding the context of this report and any general limitations or constraints. If there are any specific limitations and constraints, they are described in the report text.

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The conclusions and recommendations made in this report and the opinions expressed are based on the information reviewed and/or the ground conditions encountered in exploratory holes and the results of any field or laboratory testing undertaken. There may be ground conditions at the site that have not been disclosed by the information reviewed or by the investigative work undertaken. Such undisclosed conditions cannot be taken into account in any analysis and reporting.

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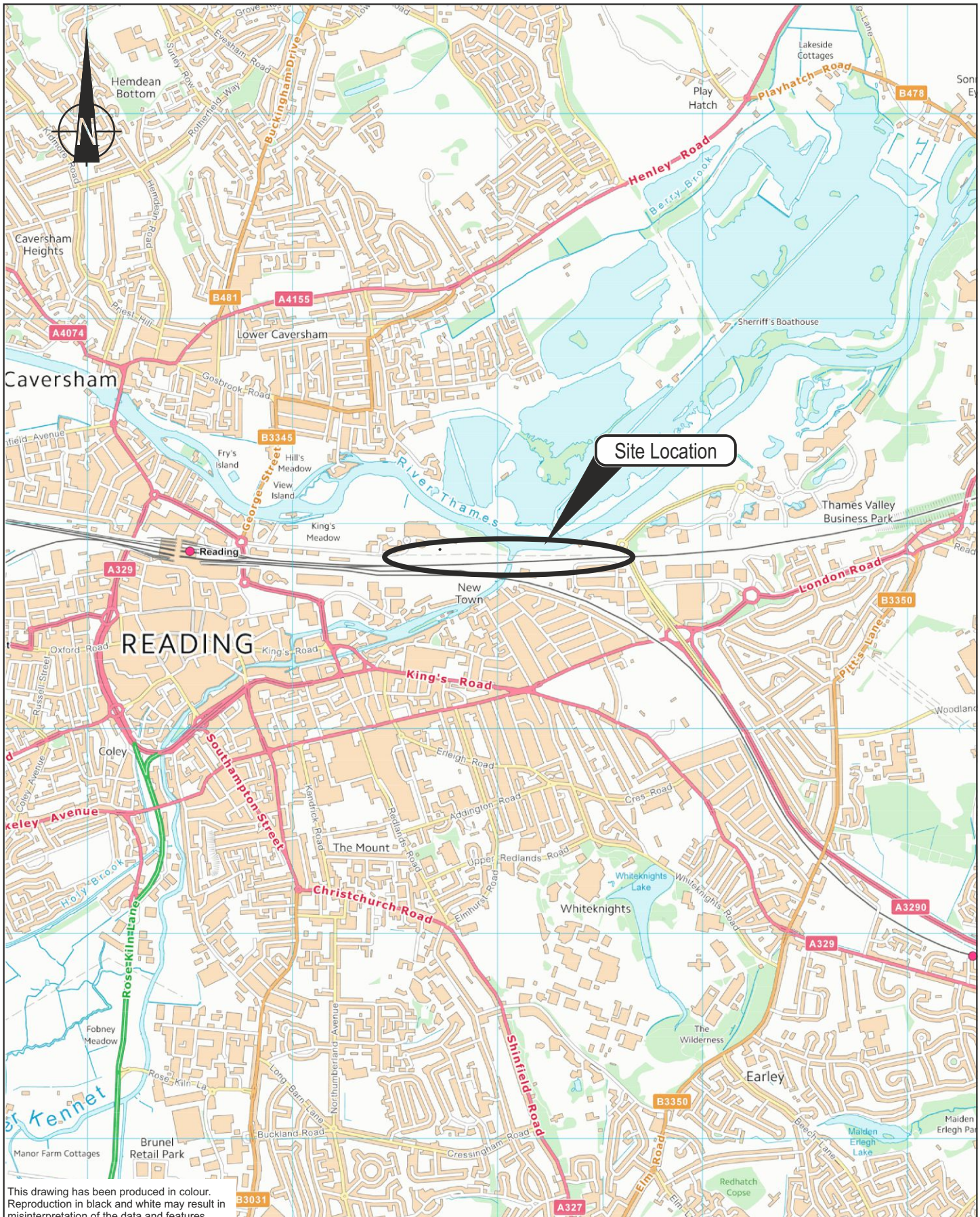
The interpretation carried out in this report is based on scientific and engineering appraisal carried out by suitably experienced and qualified technical consultants based on the scope of our engagement. We have not taken into account the perceptions of, for example, banks, insurers, other funders, lay people, etc, unless the report has been prepared specifically for that purpose. Advice from other specialists may be required such as the legal, planning and architecture professions, whether specifically recommended in our report or not.

Public or legal consultations or enquiries, or consultation with any Regulatory Bodies (such as the Environment Agency, Natural England or Local Authority) have taken place only as part of this work where specifically stated.

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FIGURES



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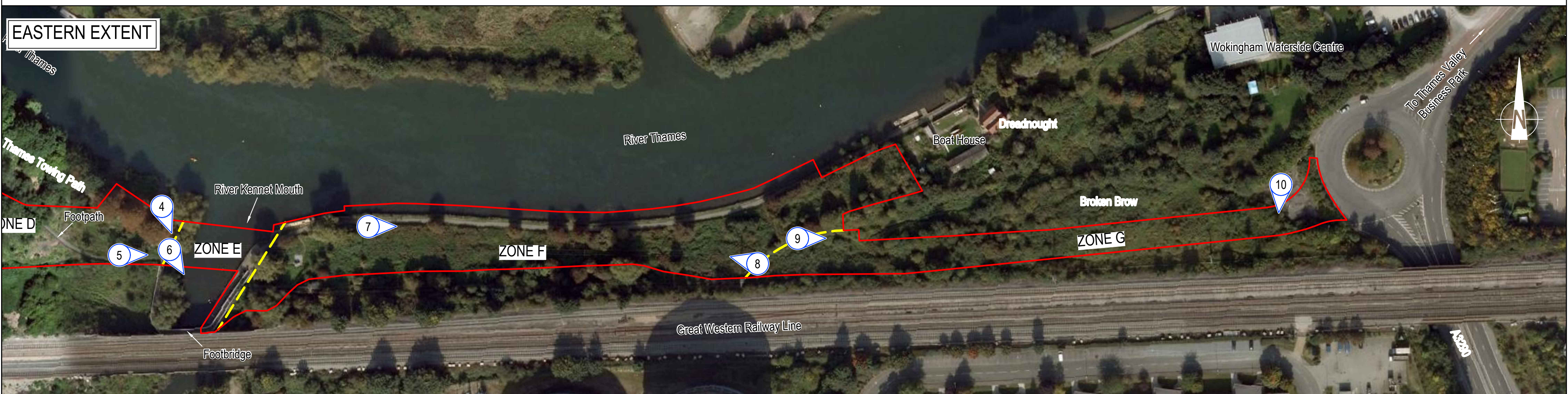
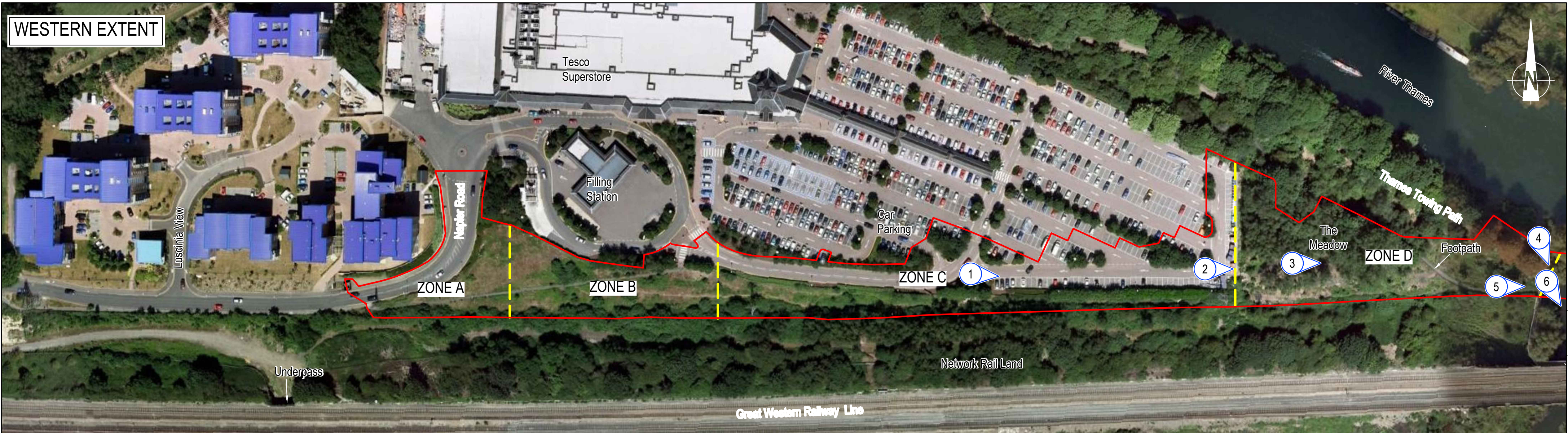
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SITE LOCATION PLAN

Date	13.07.2016
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FIGURE 1	



- Key**
- Approximate Site Boundary
 - 1 Photograph Plate Number

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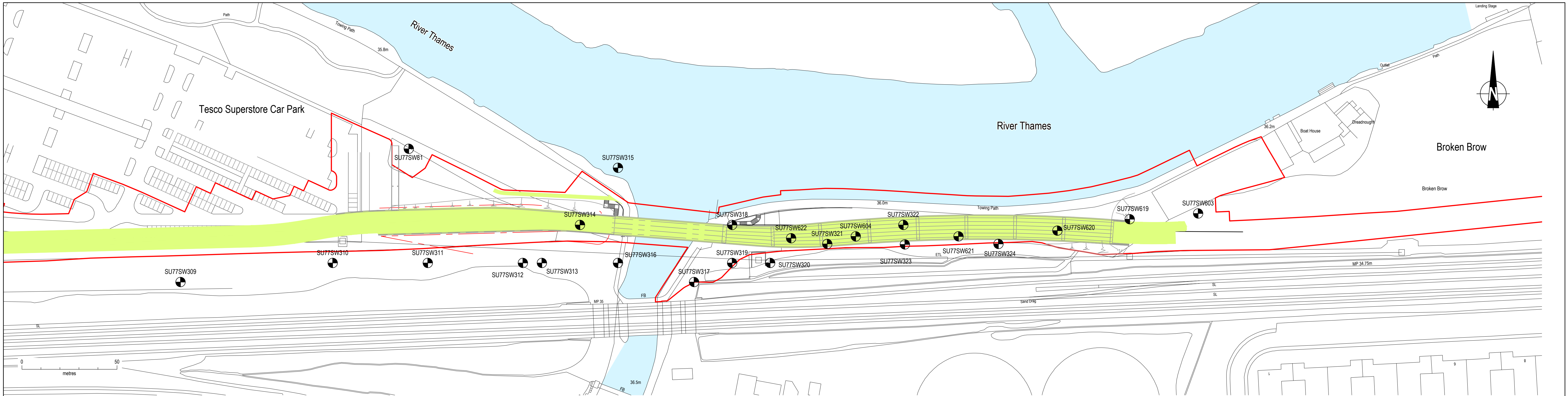
SITE LAYOUT PLAN

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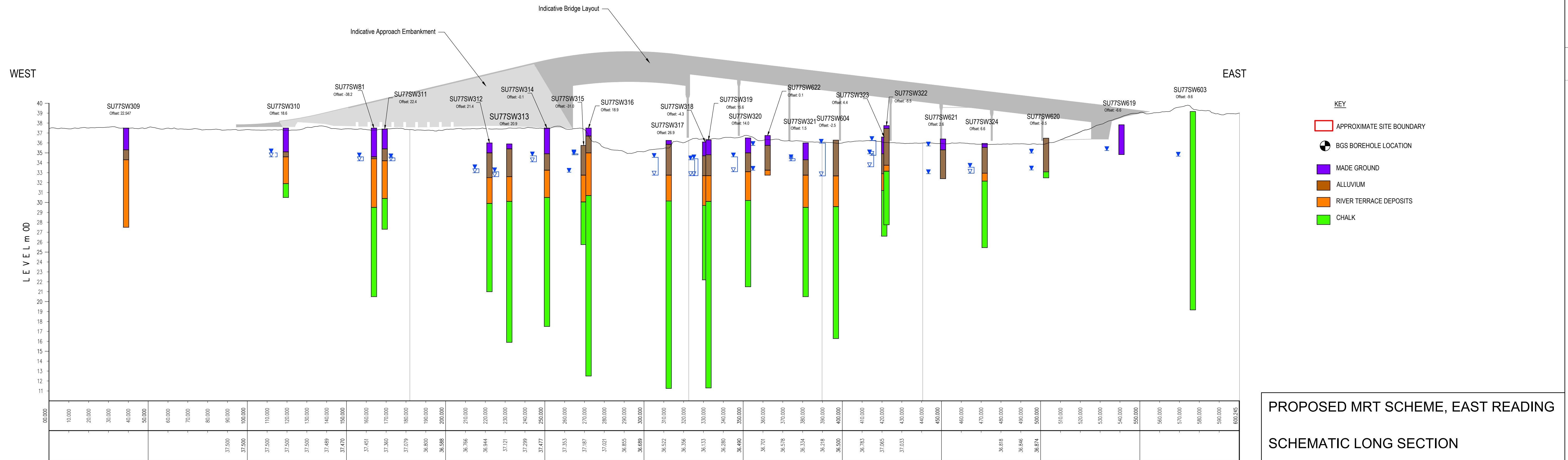
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PLAN VIEW
Scale 1:1000



SCHEMATIC LONG SECTION
Horizontal Scale 1:1000 - Vertical Scale 1:200

Note:
Offset is measured in metres from centre line as shown in the plan view.
Positive values denote north of the centreline. Negative values denotes south of the centreline.

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SCHEMATIC LONG SECTION

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