Oxpens River Bridge, Oxford

Phase 1 Ground Condition Assessment

Project reference: OXPEN-STN-GEN-ALL-RP-G-0601 P01

On behalf of **Oxford City Council**

OXFORD CITY COUNCIL

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Summary

This report presents a Phase 1 Ground Condition Assessment for the proposed redevelopment of the Oxpens River Bridge, Oxford. This report has been prepared to support the planning application for the redevelopment of the Site in a planning context and aims to address the requirements of the National Planning Policy Framework (NPPF).

Site Location and Description The Site is situated about 0.8 km south-west of Oxford City Centre. The land to the north of the River Thames comprises principally Oxpens Meadow, a public park, .The land to the south of the river comprises principally park land and river bank. The River Thames bisects the Site flowing to the south-east. The Great Western Railway and a railway bridge are to the west of the Site.

Site History Historically, the northern part of the Site was mostly recreational space . The southern part of the Site was vacant until the 1900 when the St Ebbe's Gas Works expanded into the Site. The land was raised by demolition materials sourced from the former gas works to the north of the River Thames. The portion of the gas works in the southern part of the Site comprised part of a gas holder. Further areas of the gas works including rail sidings, coal storage areas, wagon tipplers, coal elevators, a retort house, purifiers, benzole plant, a large oil tank, a compressor house, lagoons and other gas holders were present to the south of the site boundary. By mid 1960s the gasworks had ceased operation and the former gasworks structures were demolished and some of the sub-surface structures may have been left in place and the land become part of Grandpont Nature Park. A historical landfill is recorded to the south of the Site.

Ground Conditions The natural ground conditions are recorded to comprise Alluvium underlain by the Northmoor Sand and Gravel Member and the Oxford Clay Formation at depth. Made Ground is also present principally associated with the former gas works to the south of the river. The Northmoor Sand and Gravel Member are designated as Secondary A Aquifer. The natural groundwater flow is anticipated to be towards the River Thames.

GROUND STABILITY HAZARDS

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 Negligible/Very Low. The exception relates to a Low risk associated with the potential for swell or shrink of the near surface clay soils, Moderate potential for running sands in the Northmoor Sand and Gravel Member, and a Moderate potential for compressible soils in the Alluvium. Foundations will need to be designed to accommodate the movement or be taken to a depth where the likelihood of damaging movement from shrinking or swelling of clay soils is low and settlement effects arising from the alluvium can be ameliorated. The design of foundations will be required to limit the settlement of structures including any earth structures to an acceptable level. In addition, allowance should be made for controlling groundwater inflows in excavations below the groundwater table. Further, the potential for significant thickness of Made Ground and the presence of obstructions in the ground associated with the former gas works subsurface structures will need to be taken into consideration for the design and construction of the proposed scheme.

GEOENVIRONMENTAL RISK ASSESSMENT

A number of potential sources of contamination have been identified for both on-site and off-site sources, associated with historical and current land uses. Overall, the potential for contamination to be present is assessed to be **Low** for the northern part of the Site and **Very High** for wide spread significant contamination to be present in the southern part of the Site associated principally with the former gas works.

Based on the information available, the estimated geoenvironmental risks have been assigned as **Moderate** and **High** for groundwater in the southern part of the Site at worst. 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 ground gas will need to be assessed through intrusive ground investigation. It is considered that a ground investigation will be required to support the planning application for redevelopment of the Site. A geoenvironmental ground investigation and Tier 2 assessment will be required in relation to the geoenvironmental risks associated principally with the former gas works and risk to site users, Controlled Waters for both groundwater and the River Thames and the Environment with regards to the proposed scheme.

The local planning authority confirmed that the Site is not designated as Contaminated Land under Part 2a of the Environmental Protection Act 1990.

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

1.1.1 Stantec UK Limited (Stantec) has been commissioned by Oxford City Council (the Client) to undertake a Phase 1 Ground Condition Assessment to support the planning application for the proposed Oxpens River Bridge, Oxford (the Site).

1.1.2 This report has been prepared to support the planning application for the redevelopment of the site in a planning context and aims to address the requirements of the National Planning Policy Framework (NPPF) (MHCLG, 2023).

1.1.3 This report presents a Phase 1 Ground Condition Assessment comprising a desk study, Tier 1 (preliminary) qualitative contamination risk assessment, and a preliminary ground stability appraisal.

1.1.4 Guidance on the use of this report is presented in in a note after the text of this report.

1.2 Objectives and Scope of Works

1.2.1 The NPPF (MHCLG, 2021) stipulates that planning policies and decisions should ensure that a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation)"; and that "after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and adequate site investigation information, prepared by a competent person, is available to inform these assessments.

1.2.2 The objective of this report is to review readily available information in the public domain to identify and assess the likely ground conditions at the Site and in the immediate surrounding area. It also aims to identify potential geoenvironmental and land stability hazards that may require management as well as any potential constraints to the proposed development.

1.3 Methodology

Assessment of Ground Conditions – Contamination

1.3.1 UK legislation on the contamination of land from historical activities is principally contained in Part 2A of the Environmental Protection Act, 1990 (which was inserted into the Act by Section 57 of the Environment Act 1995).

1.3.2 The Regulations and Statutory Guidance that accompanied the Act, including the Contaminated Land (England) Regulations 2006, have been revised with the issue of the Contaminated Land (England) (Amendment) Regulations 2012 (SI 2012/263) and the Contaminated Land Statutory Guidance for England 2012.

1.3.3 Under the NPPF (2023), the broad approach, concepts and principles behind land contamination management advocated by the Part 2A regime are applied to the determination of planning applications. The Land Contamination: Risk Management (LC:RM) (EA, 2023) guidance which is based on the now superseded Model Procedures for the Management of Contaminated Land (CLR11) (EA, 2004) provides references to established technical and procedural practice.

1.3.4 LC:RM presents a three-stage process to the management of contaminated land:

- Stage 1 = risk assessment
- Stage 2 = options appraisal and
- Stage 3 = remediation

1.3.5 The Stage 1 risk assessment is undertaken in a phased manner with the three tiers being:

- Tier 1 – "Preliminary Risk Assessment" – a qualitative assessment forming part of a Phase 1 report,
- Tier 2 – "Generic Risk Assessment" - a quantitative assessment using published criteria to screen site specific ground condition data forming part of a Phase 2 report and
- Tier 3 – "Detailed Risk Assessment" – a quantitative assessment involving the generation of site-specific assessment criteria (SSAC).

1.3.6 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.

1.3.7 Each tier of risk assessment comprises the following four stages:

- Hazard Identification – identifying potential contaminant sources on and off Site.
- Hazard Assessment – assessing the potential for unacceptable risks by identifying what pathways and receptors could be present, and what pollutant linkages could result (forming the Conceptual Site Model (CSM)).
- Risk Estimation – estimating the magnitude and probability of the possible consequences (what degree of harm might result to a defined receptor and how likely); and
- Risk Evaluation – evaluating whether the risk needs to be, and can be, managed.

1.3.8 The Stantec methodology for ground condition assessment (contamination) is presented in **Appendix A**.

Assessment of Ground Conditions – Instability

1.3.9 Planning Authorities are required (NPPF, 2023, paragraphs 183 and 184) to consider if land instability poses a potentially unacceptable risk to development. In paragraph 178, the requirement to take account of potential hazards arising from natural hazards (such as natural cavities) or former activities such as mining is outlined.

1.3.10 The preliminary ground stability assessment methodology adopted by Stantec follows the guidance on preliminary land stability assessment given in the Planning Practice Guidance for Land Stability published by the Department for Levelling Up, Housing and Communities (DLHC, 2019).

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

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

1.4 Sources of Information

1.4.1 The following primary sources of information were used in the compilation of this report:

- A walkover survey by a Stantec representative to observe the existing conditions on the Site with selected photographs of the Site are presented in **Appendix B**.
- Historical OS maps are presented in **Appendix C** and an EnviroCheck Report provided by Landmark Information Group (LIG, 2023) is presented in **Appendix D**.
- Review of the Natural Cavity and Artificial non-coal (underground) mining cavity databases managed and enhanced by Stantec.
- Review of borehole records held by the British Geological Society (BGS) accessed via their website, http://www.bgs.ac.uk/data/boreholescans/home.html.
- Review of map records held by the British Geological Society (BGS) accessed via their website http://mapapps.bgs.ac.uk/geologyofbritain/home.html
- Review of the MAGIC (Multi-Agency Geographic Information for the Countryside) website, http://www.magic.gov.uk. The MAGIC website provides authoritative geographic information about the natural environment from across government. The information covers rural, urban, coastal and marine environments across Great Britain. It is presented in an interactive map which can be explored using various mapping tools.
- A search of the Stantec project database to identify ground condition reports within 0.5 km of the site.
- Review of risk map records of Regional Unexploded Bomb Risk held by Zetica UXO and located at https://zeticauxo.com/downloads-and-resources/risk-maps.
- A review of historical and current aerial photography available on the public domain.
- A request for information was issued to Oxford City Council, Environment Agency, and National Grid. To date a response was received from Oxford City Council and National Grid and these are included in the report.

2 Land Use Information

2.1 Introduction

2.1.1 This section presents the location, description, and historical and current land uses on and immediately adjacent to the Site.

2.2 Site Location and Description

2.2.1 The Site is situated about 0.8 km south-west of Oxford City Centre. The Site comprises land to the south and north of the River Thames with the river itself bisecting the Site flowing in general direction from the north-west to the south-east. The Site is approximately centred at National Grid Reference SP 507 056. A Site Location Plan is presented as **Figure 1**.

2.2.2 The Site is irregular in shape and has overall dimensions of about 320 by 540 m in plan area. The Great Western Railway and a railway bridge orientated north-west to south-east are situated immediately adjacent to the western boundary of the Site.

2.2.3 The Site can be divided to two parcels of land as following:

- The **Northern Part** of the Site is situated to the north of the River Thames and to the east of the Oxford Ice Risk. This part of the Site is occupied by park land as part of Oxpens Meadows.
- The **Southern Part** of the Site is situated to the south of the River Thames and East of the Great Western Railway. This part of the Site comprises principally park land as part of Grandpont Nature Park.

2.2.4 A Site Layout Plan, showing the extent of the site is presented as **Figure 2**.

2.3 Topography

2.3.1 The ground level along the northern bank of the River Thames is about 55.5 m OD rising slightly to the north to about 56.0 m OD in the vacant land and between about 56.0 and 57.0 m OD in the land to the south of the Ice Rink and the park land.

2.3.2 The ground level along the southern bank of the River Thames is about 55.5 m OD rising to about 59.0 m OD within Grandpont Nature Park to the south.

2.4 Site History

2.4.1 This section presents a summary of the historical land uses on the site and in the immediate surrounding area as identified from historical Ordnance Survey (OS) mapping records and aerial images provided by Landmark (LIG, 2023), copies of which are presented in **Appendix C** and **D**, respectively. Additional information was obtained from other sources available in the public domain and from the response received from Oxford City Council.

2.4.2 Further information with regards to the former gas works is presented in **Section 2.5** below.

2.4.3 Historically the Site was a situated in the flood plain of the River Thames (Isis) situated about 0.8 km to the south-west of Oxford City Centre. By 1850 the Oxford and Rugby Railway (now named Great Western Railway) was constructed with the railway and the rail bridge recorded at their current locations.

2.4.4 The first OS map editions available dated 1876 and 1878 shows that the Site was situated in the flood plain of the River Thames surrounded principally by agricultural land with the

2.4.4 The first OS map editions available dated 1876 and 1878 shows that the Site was situated in the flood plain of the River Thames surrounded principally by agricultural land with the River Thames, Castle Mill Stream and the Great Western Railway and bridge at their current locations. A small watercourse named St Ebbe's Bathing Place and further apparent channel to the north is shown to connect the River Thames and Castle Mill Stream in the northern area of the Site. The land to the east of Castle Mill Stream named St Ebbe's is shown to be occupied principally by terraced housing. St Ebbe's Gas Works operated by Oxford Gaslight and Coke Company is recorded about 0.2 km to the north-east of the Site.

2.4.5 By 1900 Ebbe's Gas Works was expanded to the south of the River Thames including into parts of the Site. A rail siding was constructed off the Great Western Railway to provide rail access to the gas works including a new rail bridge named Isis Bridge constructed over the River Thames. Two gas holders were constructed as part of the 'South Works' to the south of the River Thames and south of the Site.

2.4.6 The OS map edition dated 1939 shows the northern part of the Site to comprise St Ebbe's Bathing Place and a Recreation Ground. South Works has expanded significantly with additional rail sidings, buildings and infrastructure associated with the transportation and processing of coal and the production of coal gas. A third gas holder has been constructed within the southern part of the Site immediately south of the River Thames. Sports Grounds are also shown to the south of the Site. A gravel pit is recorded about 80 m to the south-east of the Site.

2.4.7 By the mid-1950s the land to the south of the River Thames is shown to be raised. The South Works are shown to have expanded further with additional structures including a small tank (an oil tank). The former watercourse named St Ebbe's Bathing Place has been infilled in the northern part of the Site and this area is labelled as a Recreation Ground.

2.4.8 By late 1960s the gas works were closed, decommissioned and the gas holders and the associated structures were demolished. Subsequently, by the 1980s most of the southern part of the Site became part of Grandpont Nature Park. A school and two and three storey blocks of flats were constructed to the east of the southern part of the Site. The former St Ebbe's Gas Works and the terraced housing to the north of the River Thames were replaced with housing.

2.4.9 By the mid-1980s the Oxford Ice Rink was constructed off site to the north-west of the northern part of the Site.

2.4.10 No significant changes are shown on the latest map dated 2021 on the Site or its immediate surroundings.

2.5 St Ebbe's Gas Works

2.5.1 The information presented below is based on information available on the public domain, and information provided by National Grid Archives and Oxford City Council database as detailed further in **Section 2.8**.

2.5.2 According to the available information St Ebbe's Gas Works was established in 1818. The gas works were initially situated on the northern bank of the River Thames about 0.2 km to the east of the Site. Over time the gas works to the north of the river expanded significantly to keep up with the rising demand for gas in Oxford.

2.5.3 By 1882, the land to the south of the River Thames was purchased by the gas works company for the purpose of building new gas holders. In 1886/7 a rail sidings were constructed with a bridge constructed over the River Thames to serve the gas works both to the south and north of the River Thames for the delivery of coal required for the production of coal gas and the collection of by-products.

2.5.4 Initially the land to the south of the River Thames was used for the construction of gas holders. However, over time structures required for the delivery and processing of coal and the production of coal gas were constructed to the south of the River Thames including within the Site itself. It is understood that the land was raised as part of the gas works with materials sourced from the demolition of the some of the gas works to the north of the river.

2.5.5 A plan of St Ebbe's Gas Works available in the public domain dated 1948 show that at its peak the gasworks to the south of the River Thames included rail sidings, coal storage areas, wagon tipplers and coal elevators, a retort house, purifiers, benzole plant, a large oil tank, a compressor house, and gas holders. In addition, aerial photographs available in the public domain show lagoons associated with the gas works situated between Gas Holders No. 3 and 4. Gas Holder No. 4 was located within the southern part of the Site.

2.5.6 According to available information by 1964 the gas works were decommissioned and subsequently by 1968 the gas holders and the associated structures were demolished. According to information provided by Oxford City Council when the gas works were demolished part of the below ground structures were left in the ground and were capped with clay about 0.45 m thick. It is understood that some of the gross contamination was removed at the time, however, it is highly possible that some of the gross contamination and/or affected soils were left insitu.

2.6 Current Land Use

2.6.1 The current land use information is based on a walkover survey undertaken by a representative from Stantec on 29th September 2021. Selected photographs taken during the walkover are presented in **Appendix B** and their location is shown on **Figure 2**.

2.6.2 Oxpen Meadow, a public park with grass cover and mature trees along the western site boundary, is present in the northern area of the Site. The northern area also encompasses a small landscape area to the north of Oxford Ice Rink. Oxford Ice Rink lies outside the site boundary to the north-west. A public footpath is present along the northern bank of the River Thames leading from Oxpens Meadowto a crossing under the rail bridge present to the west of the site boundary.

2.6.3 The southern part of the Site comprises principally park land as part of the Grandpont Nature Park with grass cover, semi mature trees and several paved and unpaved footpaths. Footpaths cross this portion of the Site connecting to the land to the east and south of the Site. The Thames Path is present along the southern bank of the River Thames and crosses under the rail bridge to the west.

2.6.4 The Great Western Railway bridge over the River Thames comprises a twin steel bridge supported on brick piers at each end of the bridge. The western bridge section has two intermediate brick piers supports whilst the eastern bridge section has two intermediate steel column supports. The bases of the bridge girders are about 2 m above the footpath level.

2.7 Industrial Setting

2.7.1 Information on the industrial setting of the Site is presented in the Envirocheck Report (LIG, 2023) and reproduced in **Appendix D**. The results of the database search are summarised on the following table and discussed in the following sections:

Data Type	Number On-Site (1)	Number within 250m of Site (1)
Waste Regulation		
Landfill Sites	0 (2)	0 (0)

Data Type	Number On-Site (1)	Number within 250m of Site (1)
Licensed Waste Management Facilities	0 (0)	0 (0)
Statutory Permits/Authorisations		
Pollution Prevention and Control (2)	0 (0)	0 (1)
Registered Radioactive Substances	0 (0)	0 (0)
Planning Hazardous Substance Consents	0 (0)	0 (0)
COMAH Sites (3) and NIHHS Sites (4)	0 (0)	0 (0)
Potential Contaminative Uses		
Fuel Stations	0 (0)	0 (0)
Contemporary Trade Directory Entries	0 (0)	0 (0)
Discharge Consents	0 (0)	1 (5)
Pollution Records		
Contaminated Land Register Entries and Notices	0	0
Pollution Incidents to Controlled Waters	2	24

Note:

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

2.7.2 **Landfills** The area south of the Site is shown to be situated on a historical landfill. The license holder of the landfill is recorded to be Oxford City Council and Oxfordshire County Council (WRC Ref: 3100/0171). The landfill is recorded to have receive inert and Special Waste with the last waste recorded to have been deposited on 31st December 1997. Information provided by Oxford City Council indicates that the Site received waste from the former gas works including liquids and sludges and Special waste and was closed in 1977. The landfill was capped by clay and is currently used for recreation and sports fields and a car park. The historical landfill has been taken forward as a potential source of contamination and is discussed further in **Section 5**.

2.7.3 **Pollution Incidents to Controlled Waters** There are 2 records of minor incidents (Category 3) at the Site dated 1990 and 1993 with no further information given. In addition, there are 24 records of pollution incidents to Controlled Waters within 250 m of the Site with the majority of the incidents recorded as minor incidents (Category 3) between 1989 and 1999. There were two incidents recorded as Significant Incidents (Category 2) one recorded in 1989 about 80 m to the north of the Site and the second was recorded in 1989 about 170 m to the north of the Site. Based on the type of incidents recorded and the time passed since the incidents occurred it is considered that the historical incidents do not represent a particular risk to the Site or the proposed development.

2.7.4 **Discharge Consents** There are 2 records of sewage discharge from Thames Water pumping station and 3 records or surface water discharge from Pembroke College all of which are

revoked or surrendered. A record of an active discharge consent from Pembroke College is recorded about 80 m south-east (downstream) of the site. Based on the type of activities, their location and that the majority are no longer active these are not considered to represent a particular risk to the Site or the proposed development.

2.8 Regulatory Responses

2.8.1 A request for information was issued to the Local Planning Authority, the Environment Agency and the National Grid with regards to geoenvironmental information that they may hold in relation to the site.

2.8.2 To date information was received from Oxford City Council and National Grid. A summary of the information received is presented in the Sections below whilst a copy of the responses received is presented in **Appendix E**.

Local Planning Authority

2.8.3 The Land Quality Officer (Mr. Paul Scott) at Oxford City Council have provided valuable information with regards to the history of the site and geoenvironmental information about the Site and the former gas works.

2.8.4 **Contaminated Land Strategy / Part 2A of the EPA 1990** The Grandpont Nature Park which occupies part of the former gas works, has been identified for inspection under the Council's Land Quality Strategy as a Category 3 site, which is considered by the Council to be suitable for its present use. According to the Council contaminants are probably or certainly present in the ground but these are unlikely to have an unacceptable risk on key receptors. '*Assessment action **is unlikely** to be needed whilst the site remains in its present use or otherwise remains undisturbed*.'

2.8.5 The Council states that should re-development of the identified Category 3 site occur, then an intrusive site investigation is likely to be required as part of any planning permission.

2.8.6 **Summary of Previous Land Uses** According to the Council records Grandpont Nature Park was occupied by the gas works from the 1920's until the 1980's. The information indicates that the gas works were built in 1927 and covered an area of 20.6 acres of land. The gas works were active between 1927 and 1964 when it was decommissioned. Prior to gas works being built on this site, gas works were present on the north side of the River Thames at Friars Wharf. When part of the gas works to the north of the river were demolished the materials from that site were used to raise the land as part of the Gas Works to the south of the river.

2.8.7 There is limited information in the Council's records with regards to the remediation of the former gas works at the Grandpont Nature Park or the railway sidings land. It is understood that some remediation was undertaken across the site during the decommissioning and demolition of the former gas works, principally involving the removal of grossly contaminated soils and infrastructure and capping with clay sourced from the Oxford Sewer scheme in the 1970's and early 1980's. Records dated 1979 for the former gas indicates that the former gas works site was levelled and clay capped to a depth of 0.45m (18 inch) placed at the surface.

2.8.8 **Landfill Sites** A historical landfill known as Grandpont landfill is recorded south of the Site. The historical landfill occupies an area of 60,730 m^2 and accepted demolition waste from the former gas works, liquids and sludges and Special waste and was closed in 1977. The landfill was capped by clay and is currently used for recreation and sports fields. The southern part of the Grandpont Landfill known as Tuckwells Meadow Landfill was filled at a later date and did not accept gas works waste. This landfill is currently used as an adventure playground named South Oxfordshire Adventure Playground. Recent testing by the Council of the playground site in 2020 did not identify any significant contamination risks to site users or any significant landfill gas risks.

National Grid

2.8.9 A drawing provided by National Grid archives dated 1960 show Gas Holders No. 3 and 4 with associated pipework used for the collection and distribution of coal gas. The former rail sidings, structures and infrastructure associated with coal processing and coal gas production are not recorded in the drawing. It is likely that these were demolished by that time.

2.9 Proposed Development

2.9.1 The proposed footbridge is situated between Grandpont Nature Park, south of the river, and the proposed Oxpens development site, north of the river. The bridge is to be designed as a dry route in times of flood to provide a continuous pedestrian route that would remain dry during a flood event.

2.9.2 The footbridge will require construction access from the south via Grandpont and via the floodplain in the north.

2.9.3 The proposed bridge and access ramps will be prefabricated off-site and installed on site. It is expected that the structure and the access ramps will be supported on pile foundations.

2.9.4 The footbridge will provide a greater capacity link from the city centre, station and proposed Oxpens development through to Grandpont and Osney Mead facilitating future redevelopment.

2.9.5 It is understood that it is proposed to reduce a portion of the site to the north of the river to 55.3m AOD for flood compensation works.

3 Environmental Settings

3.1 Introduction

3.1.1 Information on the environmental settings is presented in this section and the data is used to inform the stability assessment in **Section 4** and the geoenvironmental risk assessment in **Section 5**.

3.2 Geology

Geological Map

3.2.1 The 1:50,000 scale geological sheet (BGS, 1982) indicates that the Site is underlain by Superficial Deposits of Alluvium with the Solid Geology of the Oxford Clay Formation recorded at depth. The Northmoor Sand and Gravel Member (formerly denoted 1st Flood Plain Terrace Deposits) is recorded in the vicinity of the Site and is likely to be present between the Oxford Clay Formation and the Alluvium.

3.2.2 Made Ground is denoted to the south of the Site and along the rail line to the west. It is expected that the Made Ground is associated with land rising at the former gas works and the railway embankment. In addition, it is expected that Made Ground is locally present elsewhere associated with current and other historical developments of the Site.

Historical Ground Investigations

BGS Records

3.2.3 The British Geological Survey archives contain records of eleven boreholes sunk in 1969 to the south and north of the River Thames at and in the immediate vicinity of the Site as part of a ground investigation for the proposed Oxford Relief Road Scheme D47. The boreholes were sunk to between 13.7 and 20.1 m depth.

3.2.4 Copies of the borehole records have been obtained from the archives and are reproduced in **Appendix F.** The locations of the boreholes are shown on the Site Layout Plan presented as **Figure 2**.

2014 Idom Merebrook

3.2.5 In 2014 a ground investigation was carried out to the north of the River Thames, and west of the site boundary, by Idom Merebrook Limited in relation to a proposed residential development on the land off Oxpens Road (IM, 2014).

3.2.6 The ground investigation comprised five window sample boreholes to 5.0 m depth and eight trial pits to a depth of 3.0 m depth.

3.2.7 A copy of the relevant exploratory hole records issued by Idom (2014) are reproduced in **Appendix F**. The location of the exploratory holes are shown on the Site Layout Plan presented as **Figure 2**.

2021 Listers Geo

3.2.8 In 2021 a ground investigation was carried out to the north of the River Thames including the northern part of the Site by Listers Geo on behalf of Oxford West End Development Limited in relation to the redevelopment of the land for residential uses (LG, 2021).

3.2.9 The ground investigation comprised six boreholes sunk by cable percussion techniques to 25.0 m depth, five trial pits to between 2.2 and 3.5 m depth and eleven window sample boreholes to between 1.0 and 4.0 m depth. A total of two exploratory holes (TP04 and BH06) were sunk within the Site boundary.

3.2.10 A copy of the relevant exploratory hole records is reproduced in **Appendix F**. The location of the exploratory holes are shown on the Site Layout Plan presented as **Figure 2**.

Ground Conditions

3.2.11 A summary of the ground conditions based on the historical ground investigations is summarised in the table below.

Summary of Ground Conditions

Strata [1]	Approximate Base (m bgl)	Typical Description
Made Ground	0.5 to 1.1	Variable - Firm dark brown silty sandy CLAY with gravel OR GRAVEL with low cobble content. Gravel of flint and fragments of brick, concrete, glass and other man made materials. Locally with coal, ash and clinker.
	Locally 2.6 to 3.5 in the vicinity of the former gas holders and former infilled channel	Fill – ash, brick, soil, clay and gravel.
Alluvium	1.0 to 3.4	Very soft and soft organic silty CLAY locally with gravel.
Northmoor Sand and Gravel Member	4.4 to 7.5	Medium dense yellow and brown SAND and GRAVEL with clay. Locally recorded as ‘blowing sands’.
Oxford Clay Formation	>25.0	Stiff becoming hard bluish grey calcareous shaly CLAY with selenite iron pyrites and shell debris.

Groundwater

3.2.12 Groundwater was locally recorded during drilling and trial pitting between 0.9 and 5.3 m depth.

3.3 Hydrogeology

Aquifer Classification

3.3.1 The Environment Agency classifies the Alluvium as a Secondary B Aquifer whilst the Northmoor Sand and Gravel Member is classified as a Secondary A Aquifer. Secondary A aquifers typically comprise layers with moderate permeability that can support local water supplies and may form an important source of base flow to rivers. Secondary B Aquifers typically have low to moderate permeability that may store and yield limited amounts of groundwater.

3.3.2 The Oxford Clay Formation is classified as an unproductive stratum. These deposits have low permeability that have negligible significance for water supply or river base flow.

3.3.3 The EnviroCheck Report (LIG, 2023) indicates that the surface soils have a high leaching potential. Soils of high leaching potential will readily transmit pollutants easily from the surface to the aquifer at depth.

3.3.4 The Site is not situated within a Source Protection Zones (SPZ) set out by the Environment Agency for the protection of groundwater abstractions.

Groundwater Flow

3.3.5 Based on the information available it is expected that the groundwater level in the Superficial Deposits is typically between about 1.0 to 3.0 m below ground level (bgl) in the lower parts of the Site corresponding to a reduced level of about 55 to 56 m OD.

3.3.6 It is expected that in general the groundwater in the Alluvium and the Northmoor Sand and Gravel Member flows towards and is in hydraulic continuity with the River Thames. However, the presence of a continuous sheet pile wall along the southern bank is likely to provide a degree of segregation between the aquifer in the Superficial Deposits and the River Thames.

3.4 Surface Water

3.4.1 The River Thames is classified by the Environment Agency as a Primary River. The section of the river between Evenlode to Thame is monitored by the Environment Agency and is classified as having a Moderate ecological status between 2013 and 2019, and a Good chemical status between 2013 and 2015 or Fail between 2016 and 2019 for priority hazardous substances recorded including tributyltin, mercury, perfluorooctane sulphonate (PFOS), and polybrominated diphenyl ethers (PBDE).

3.5 Ecological Systems

3.5.1 The EnviroCheck Report (LIG, 2023) indicate that there are no statutory designated areas of environmental sensitivity within 2 km of the Site with the exception of an area of Adopted Green Belt. An ancient woodland is recorded about 0.7 km to the east of the Site.

3.5.2 Grandpont Nature Park is situated in the southern part of the Site and Oxpens Meadow is situated in the northern part of the Site.

3.5.3 The Site 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.

3.5.4 The Upper Thames Tributaries was designated by Natural England as an Environmentally Sensitive Area, however this designation is now ‘decommissioned’. It is considered that the River Thames itself is a sensitive ecological receptor.

3.5.5 It should be noted the statement above regarding ecological systems does not purport to be an ecological risk assessment.

4 Potential Ground Stability Constraints

4.1 Introduction

4.1.1 In accordance with the requirements of the National Planning Policy Framework (DLHC, 2023), 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.

4.1.2 The potential for land instability at the site has been considered, in relation to;

- Naturally occurring geological hazards
- Artificial Cavities
- Natural Cavities
- Slope Stability
- Potentially adverse foundation conditions

4.1.3 Consideration is given below to the risk of the potential stability constraints arising from existing ground conditions at the site, as identified in this data review. The geological constraints to the development are those relating to the natural ground conditions and any geological hazards on the site.

4.2 Natural and Mining Cavities

4.2.1 The National Natural and Mining (non-coal) Cavities Databases, maintained and updated by Stantec, have been searched for relevant natural and mining cavity records.

4.2.2 A search of the Stantec Non-Coal Mining Cavities Database indicates that there are no recorded natural or man-made cavities within 2 km of the Site centre. Based on the ground conditions, geomorphology and the known history of the Site the potential for natural cavities or man-made cavities to be present at the Site is considered to be **Very Low**.

4.3 Surface Quarrying

4.3.1 There is a record of a historical gravel pit in the vicinity of the Site situated about 80 m to the south-east. However, there are no records of former or current surface quarrying at the Site itself. Furthermore, there is no visually apparent surface evidence of historical quarrying activities at the Site. As such, based on the information available the potential for former (now infilled) surface quarries to be present at the Site is considered to be **Low**.

4.3.2 It should be noted that significant thicknesses of Made Ground are likely to be present on site associated with the former gas works in particular in and in the vicinity of the former gas holder.

4.4 Naturally Occurring Geological Hazards

4.4.1 An assessment of potential geological hazards that may give rise to instability or adverse construction conditions as supplied by the BGS from their National Geoscience Information Service (NGIS) are presented in the EnviroCheck Report reproduced in **Appendix D**. 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.

4.4.2 The information contained in the 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 at the site is summarised in the table below.

Summary of Geological Hazards

Hazard	BGS-NGIS Assessed Hazard Potential On-site	Stantec Assessment and commentary
Potential for Shrink and Swell Clay Ground Stability Hazard	No Hazard / Very Low	Disagree – The Alluvium may contain high proportions of clay which can be susceptible to shrink and swell for soils that are the near surface as a result of change in moisture conditions. Based on review of the ground investigation information available it is expected that the thickness of the Alluvium is likely to be limited therefore the impact from shrink and swell is expected to be minor. Overall, we consider that the risk for shrink and swell is **Low**.
Potential for Running Sands Ground Stability Hazards	Very Low / Low	Disagree – The Northmoor Sand and Gravel Member is recorded to be affected by 'blowing sands' and may contain materials susceptible to running sands for excavations under the water table. As such the risk associated with running sand for excavations below the water table is considered to be **Moderate**.
Potential for Compressible Soils Ground Stability Hazards	Moderate	Agree – The Alluvium is likely to be very soft and compressible soils.
Potential for Collapsible Ground Stability Hazards	Very Low	Agree – natural soils that are prone to collapse are not expected to be present.
Coal Mining Affected Areas	No Hazard	Agree - The Site is situated in area where coal or coal mining activities are not present.
Potential for Landslide Ground Stability Hazards	Very Low	Agree - The current ground levels are relatively flat and significant re-profiling is not proposed.

4.5 Potential Adverse Foundation Conditions

4.5.1 The information available indicates that the natural ground conditions comprise Alluvium underlain by Northmoor Sand and Gravel Member with the Oxford Clay Formation at depth. In addition, significant thicknesses of Made Ground are likely to be present associated with the former gas works and the infilled channel. A ground investigation will be required to confirm the full nature and extent of the strata at the Site and to inform the design of foundations and other geotechnical elements as part of the proposed scheme.

4.5.2 The ground stability assessment has identified that in general the potential for adverse foundation conditions is **Very Low/Negligible** for coal and non coal mining, collapsible deposits and landslides.

4.5.3 The potential for shrinkable soils hazard to be present is considered to be **Low**. 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 very low.

4.5.4 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. The potential for significant settlement will need to be taken into consideration for the design and construction of the proposed foundations for the proposed bridge structure. At this stage based on the information available it is expected that the bridge will be supported using piled foundations constructed through the Alluvium and the Northmoor Sand and Gravel Member into the Oxford Clay Formation.

4.5.5 The potential for running sands that may develop in excavations below the groundwater table in the Northmoor Sand and Gravel Member has been assessed to be **Moderate**. Allowance should be made for controlling groundwater inflows in excavations below the groundwater table extended into the Northmoor Sand and Gravel Member.

4.5.6 Based on the information available it is expected that some of the former structures as part of the former gas works remain in the ground. The presence of obstructions such as the remains of former gas holders, slabs, tanks, foundations etc. should be expected for sub-surface works within the former gas works. In addition, the potential presence of significant thickness of Made Ground associated with the former gas works and the infilled channel will need to be taken into consideration with regards to the design of any foundations and other infrastructure at the Site.

4.6 Unexploded Ordnance (UXO)

4.6.1 The unexploded ordnance (UXO) hazard and risk mitigation map, prepared by Zetica Ltd (2021), indicates that the risk for UXOs to be present on the Site is assessed as **Low**. It should be noted that this report does not purport to be a UXO Risk Assessment.

5 Tier 1 Preliminary Risk Assessment

5.1 Introduction

5.1.1 The methodology developed and adopted by Stantec for the assessment of ground conditions is presented in **Appendix A**. In accordance with guidance presented in LC:RM (EA, 2021) we adopt a staged approach to risk assessment and this report presents a Tier 1 assessment or first stage.

5.1.2 The underlying principle to ground condition assessment is the identification of pollutant linkages to evaluate whether the presence of a source of contamination could potentially lead to harmful consequences.

5.2 Conceptual Site Model

5.2.1 The Tier 1 Preliminary Risk Assessment includes the development of a preliminary 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.

5.2.2 For a pollutant linkage to be identified, a connection between all three elements (source-pathway-receptor) is required.

Potential Sources of Contamination and Contaminants of Concern

On Site

5.2.3 **Northern Part** The majority of the northern part of the site was undeveloped land and included the St Ebbe's Bathing Place which was subsequently infilled.. Overall, the potential for significant contamination to be present associated with the historical and current land uses of the site and historical ground investigations available is considered to be **Low** (Classification score of 2 out of 5 in Table 1, **Appendix A**) .

5.2.4 **Southern Part** By 1900 the southern part of the Site became part of St Ebbe's Gas Works. Gas works often have a legacy of persistent contamination associated with gas and coke manufacturing, by-products, waste products and ancillary processes.

Potential Contaminants Arising from Gas Works Sites

5.2.5 In general, former gas works sites have a significant environmental legacy. Potential sources of contamination arise from the locations at which certain chemical processes were carried out and the locations on the site where waste by-products were stored and disposed. A summary of common contaminants arising from gas works are listed below. This information has been obtained from the CL:AIRE publication Gasworks Profiles (CL:AIRE, 2014), the former Department of Environment publication Industry Profile: Gas works, coke works and other coal carbonisation plants (DoE, 1995) and Notes on the redevelopment of gasworks sites (ICRCL, 1986).

- **Coal tars** – a by-product of coal carbonisation comprising a complex mixture of organic compounds including polycyclic aromatic hydrocarbons (PAHs), phenolic compounds, BTEX (benzene, toluene, ethyl-benzene, xylene) compounds, aromatic and aliphatic hydrocarbons, oxygen, nitrogen and sulphur compounds and inorganic components (e.g. ammonium and cyanide). Coal tars are often found in the ground around buildings, condensers, scrubbers/washers, tar tanks, interconnecting pipework and at the base of tar tanks and gas holders.

- **Ammoniacal liquours** – a waste from the gas cleaning process containing ammonium, sulphate, phenol, ferrocyanide and thiocyanate. Ammonical liquors may be found in the ground around scrubbers/washers, tar tanks, interconnecting pipework and also in the base of tar tanks and gas holders.

- **Blue billy, spent oxide, foul lime** – wastes from the gas purification process containing sulphur, cyanide and sulphur compounds. These wastes may be found in the ground around purifiers and in general Made Ground where ground levels have been raised.

- **Ash/coal dust** – these waste materials can contain heavy metals and PAHs, although at variable concentrations. These wastes may be found around coal stores, retort houses and in general Made Ground.

- **Coke** – Solid remaining after gasification process and would contain concentrations of arsenic and lead in the ash.

- **Volatiles** – Petrol range hydrocarbons associated with the former benzole plant. These hydrocarbons can migrate to groundwater and float as free product on the surface of the groundwater.

Potential Sources of Contamination

5.2.6 **Gas holders** - The base of gas holders have been identified as potential sources of coal tars and ammoniacal liquors. The gas holder bases were normally emptied during site clearance and backfilled (ICRCL, 1986), although any leakage from these gas holder bases during operation or decommissioning would have released these contaminants into the surrounding environment.

5.2.7 **Process plant** - The majority of the gas work structures were located outside of the site boundary, however, parts of the former structures that housed these processes which could have led to local contamination of the surrounding ground such as retort houses, benzole plant and purifiers were situated within the Site.

5.2.8 **General Made Ground** - The land raising used materials from the former gas works to the north of the river. In addition, subsequent clearance of the gas works and redevelopment of the site may have led to the spread of contaminants away from specific locations and into different areas of the site within Made Ground.

General Commentary

5.2.9 By 1900 the southern part of the Site became part of Ebbe's Gas Works. The former gas works in the Site comprised mainly a gas holder with rail sidings, coal storage areas, wagon tipplers and coal elevators, a retort house, a large oil tank, a compressor house, purifiers, benzole plant, other gas holders and lagoons present immediately to the south. The former gas works were demolished in the 1960s with the above ground structures removed. According to the available information some of the gross contamination was removed as part of the decommissioning, however, it should be expected that some of the contamination and affected soils and possible groundwater were left in the ground. Overall, the potential for significant contamination to be present associated with the historical gas works in the southern part of the Site is considered to be **High** (Classification score of 4 out of 5 in Table 1, **Appendix A**).

Off Site

5.2.10 The potential for off site contamination to be present, based on the past and present uses of the neighbouring land and historical ground investigations is considered to be at worst **Moderate** for rail land and **High** for the southern part associated with the former gas works and historical landfill.

5.2.11 The table below presents a summary of the main potential sources of contamination and the associated contaminants.

Potential Sources of Contamination (PSC) and Contaminants of Potential Concern (COPC)

Location of Source	PSC Reference	Description	COPC
Northern Part			
On and Off site	1	Former recreation ground and infilled channel of St Ebbe's Bathing Place	**Low** potential for site wide elevated concentrations of contaminants typically comprise metals, Polyaromatic Hydrocarbons (PAHs), ash, pesticides, herbicides and asbestos.
Southern Part			
On and Off site	2	Former gas works mainly associated with the gas holders and general Made Ground	**High** potential for contaminants to be present in the southern part of the Site, these include mainly: Former gas holders with associated coal tars. In addition, metals, cyanide, sulphates, phenols, various hydrocarbons (LNAPL/DNAPL), ammonia, asbestos and ground gas.
On and Off site	3	Historical landfill	**High** potential for metals, Hydrocarbons (PAHs, TPH), solvents and asbestos landfill gas and leachate.

Potential Receptors

5.2.12 The proposed development comprises a number of footpaths at grade, a new footbridge with associated approach embankments and ramps. It should be noted that the scheme will include relatively very little changes across the majority of the Site which will be used for access during the construction of the scheme. The actual work will be restricted principally to the area around the proposed footbridge and associated footpaths.

5.2.13 The adjacent River Thames with associated flora and fauna are considered to be highly sensitive controlled water receptors. Similarly, the Northmoor Sand and Gravel Member and to some degree the Alluvium Aquifers are considered to be sensitive receptors.

5.2.14 The receptors considered as part of this land contamination assessment are summarised in the table below and based on the information reviewed either eliminated from further consideration or allocated a sensitivity score in accordance with the Stantec Methodology. The sensitivity score informs the consequence element of the risk estimation process, definitions of which can be found in Table 2 of **Appendix A**.

Potential Receptors and Sensitivity Score

Receptor Type	Comment	Sensitivity Score
Human Health – Current	Leisure and pedestrians	4
Human Health – Future	Leisure and pedestrians	4
Human Health - Neighbors	Leisure, pedestrians and neighboring residents	5
Human Health – Construction / Maintenance Workers	Construction workers and future maintenance workers	4
Groundwater	Secondary aquifers	2
Surface Water	The River Thames with Moderate Ecological Status and Good/Fail Chemical Status	3
Property (Buildings) / Heritage	Possible heritage within the Site	1
Property - Animal or Crop Effect	Agricultural fields in the vicinity of the Site	2
Ecological Systems	Green Belt and local park land	2

Potential Pathways

5.2.15 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.

5.2.16 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.

5.2.17 It should be note that different pathways are relevant for different types of contaminants. The organic contaminates on site are likely to include dense organic contaminates such as coal tars known as Dense Nonaqueous Phase Liquids (DNAPLs) that are relatively immobile or relatively lighter organic mobile fractions known as Light Non-Aqueous Phase Liquid (LNAPLs). Some of the lighter organic contaminants are likely to have volatilised from the liquid phase to vapour phase and probably lost to the atmosphere by now. However, the denser fractions are more persistent and may still remain in the ground and groundwater.

5.2.18 According to the available information the former gas works were capped with clay about 0.5 m thick. If present the cap is likely to form a pathway break between current site users and the majority of contaminants in the ground. In addition, the proposed structures do not comprise any enclosed spaces on site therefore soil gas and vapours migrating to the surface are likely to dissipate into open air. The proposed works will need to consider carefully the removal of the clay cap (if present) and the potential creation of pathways between any contamination in the ground and the potential risk to site workers, future site users and the environment.

5.2.19 The Site is expected to be underlain by Alluvium, however, locally the Alluvium may have been removed associated with foundations to former structures. Downward and lateral migration of contaminants is likely to be limited due to the presence of a mantle of relatively low permeability cohesive Alluvium in the near surface soils.

5.2.20 The natural groundwater flow direction in the Superficial Deposits is expected to be towards the River Thames. However, the continuous sheet pile wall along the southern bank of the River Thames is expected to provide a barrier to some degree to groundwater migration from the aquifer into the river. In any case groundwater should be considered as both a receptor and a pathway of contaminates migrating from Site to the River Thames.

5.3 Risk Estimation

5.3.1 When there is a pollutant linkage and therefore some measure of risk it is necessary to determine whether the risk is significant and therefore whether further action is required. 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).

5.3.2 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 the Northern Part of the Site with a separate risk estimation for the Southern Part of the Site.

5.3.3 The outcome of the risk assessment is presented in **Appendix G**. A summary of the worst-case risk estimation for the Site, based on localised potential hazards is presented in the table below.

Risk Estimation

Receptor	Northern Side Low potential for contamination to be present	Southern Side Very High potential for contamination to be present
Human Health - Current	Low	Moderate
Human Health – Future	Low	Moderate
Human Health - Neighbors	Moderate	Moderate
Human Health – Construction / Maintenance Workers	Moderate	High
Groundwater	Low	High
Surface Water	Low	Moderate
Property (Buildings) / Heritage	Very Low	Very Low
Property - Animal or Crop Effect	Very Low	Low
Ecological Systems	Very Low	Low

5.3.4 The **High** risk to construction and maintenance workers relates to the risk of ingestion, inhalation or skin contact of contaminated materials on the Site. The provision of appropriate protective clothing and equipment to be worn by site workers together with the selection of appropriate working methods and 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 and effectively reduce the risk estimation from High to **Low**.

5.3.5 Possible pollutant linkages are determined using professional judgement. If a linkage is considered possible, it is considered that this represents a potentially 'unacceptable risk' and therefore requires further consideration. This may be through remediation or mitigation or through further tiers of assessment.

5.3.6 The proposed scheme will include relatively very little changes across the majority of the Site which will be used for access during the construction of the scheme. The actual work will be restricted principally to the area around the proposed footbridge and associated footpaths. It is expected that the footbridge will be supported by piles.

5.3.7 Possible pollutant linkages have been identified and the risk to the identified receptors is considered to be at worst **Moderate** and **High** for groundwater in the southern part of the Site. For High risk it is considered that harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short-term and are likely over the longer-term.

5.4 Risk Evaluation and Recommendations

5.4.1 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.

5.4.2 Given the site setting it is likely that some mitigation measures including, health and safety for construction workers, and additional mitigation measures may need to be incorporated into the proposed development in particular in the southern part of the Site in particular with regards to the potential risk to both groundwater and the adjacent river. In addition, it is considered that these actions together with potential remediation may be required.

5.4.3 It should be noted that the majority of the proposed development will comprise of footpaths constructed at grade or above the existing ground level. It is expected that the proposed bridge will be supported on piled foundations, however, the proposed bridge is situated outside of the areas that are most likely to be severely impacted by the former gas works. Therefore, the actual changes of the current status quo is likely to remain largely unchanged.

5.4.4 The choice of piling technique will need to be considered carefully to minimise the risk to Controlled Waters. It is expected that a piling risk assessment will be required to demonstrate that the proposed piling works do not represent an unacceptable risk to the superficial aquifers and the adjacent river.

5.4.5 The need to establish the actual nature of the ground conditions, the extent of contamination 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.

5.4.6 It is recommended that a geoenvironmental ground investigation is carried out in particular in the southern part of the Site that is identified to have potentially a higher geoenvironmental risk associated with the historical gas works. 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 the aquifer beneath the Site and the protection of future site users and the environment.

5.4.7 The local planning authority confirmed that the Site is not designated as Contaminated Land under Part 2a of the Environmental Protection Act 1990.

5.5 Data Gaps and Uncertainty

5.5.1 It is considered that there is a reasonable level of confidence that the information presented in this report provides a good understanding of the likely ground conditions and enables identification of potential risks. However, further work is recommended to refine the Conceptual Site Model and reduce uncertainty.

Essential Guidance for Report Readers

1) 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.

2) The opinions and recommendations expressed in this report are based on statute, guidance, and best practice current at the time of its publication. Stantec UK Ltd (Stantec) does not accept any liability whatsoever for the consequences of any future legislative changes or the release of subsequent guidance documentation, etc. Such changes may render some of the opinions and advice in this report inappropriate or incorrect and the report should be returned to us and reassessed if required for re-use after one year from date of publication. Following delivery of the report, Stantec has no obligation to advise the Client or any other party of such changes or their repercussions.

3) Some of the conclusions in this report may be based on third party data. No guarantee can be given for the accuracy or completeness of any of the third-party data used.

4) Historical maps and aerial photographs provide a “snapshot” in time about conditions or activities at the site and cannot be relied upon as indicators of any events or activities that may have taken place at other times. It is possible for developments to have occurred between surveys that are not shown or for the map record to have been censored for military security.

5) The absence of cavity records in the Stantec natural and mining cavities (non-coal) databases is not considered as conclusive as to the absence of these features and we do not warranty that the data is complete or error free.

6) 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 considered in any analysis and reporting.

7) It should be noted that this report 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.

8) The identification of invasive and/or noxious plants such as Japanese Knotweed is outside the remit of our appointment.

9) This report has been written for the sole use of the Client stated at the front of the report in relation to a specific development or scheme. The conclusions and recommendations presented herein are only relevant to the scheme or the phase of project under consideration. This report shall not be relied upon or transferred to any other party without the expressed written authorisation of Stantec. Any such party relies upon the report at its own risk.

10) 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 considered 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.

11) 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

Site Grid Reference: SP 507 056

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OXFORD CITY COUNCIL

OXPENS RIVER BRIDGE, OXFORD

Title
SITE LOCATION PLAN

Prepared:	Checked:	Date:	Revision:	Figure
davco	AZ	2022.08.19	0	1

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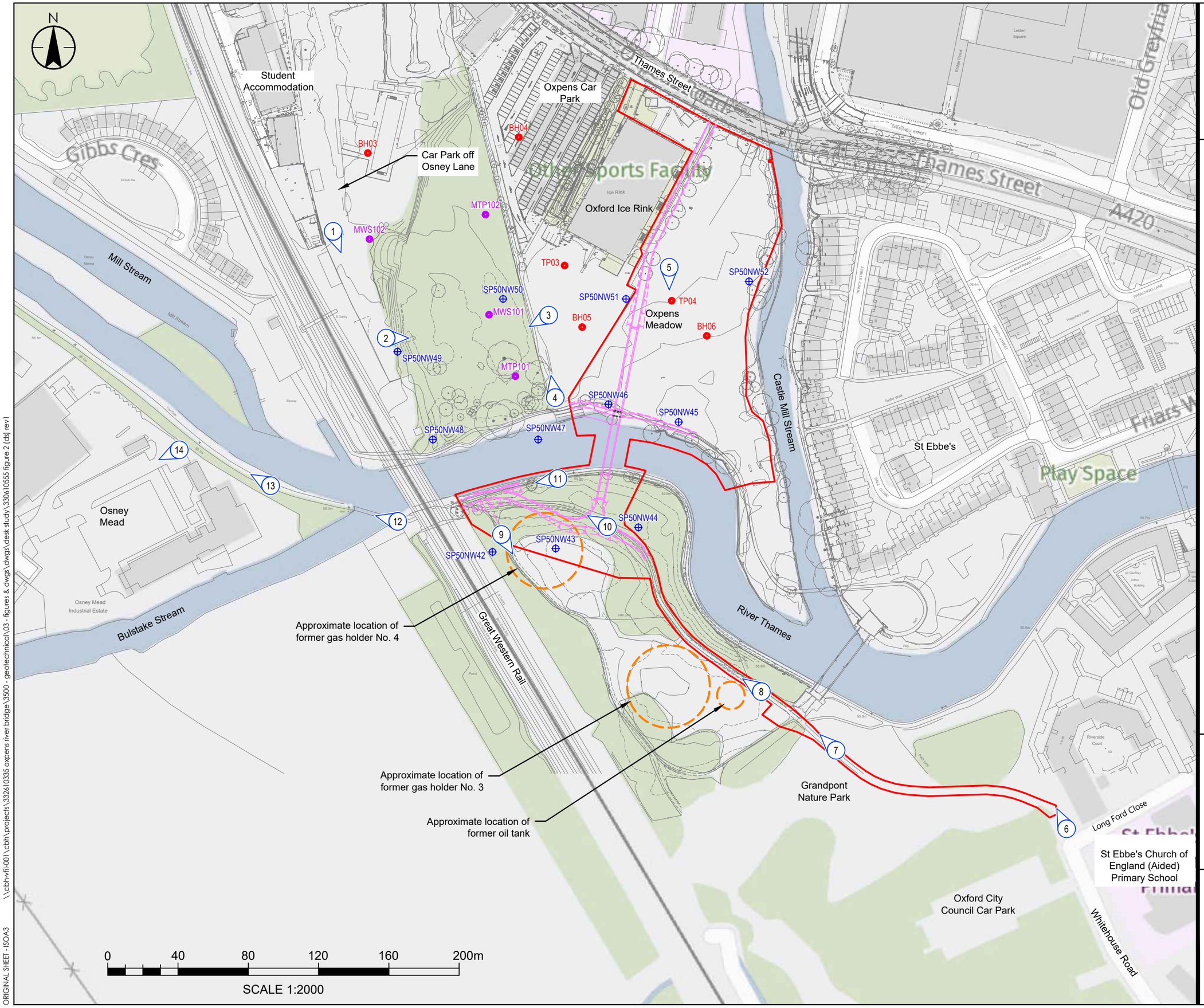

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Legend

- Approximate Site Boundary
- Photograph Position
- Proposed Layout

Historical Ground Investigations

- Idom Merebrook (2014)
- Listers (2021)
- BGS Boreholes

Client/Project:
OXFORD CITY COUNCIL

OXPENS RIVER BRIDGE, OXFORD

Prepared:	Checked:	Date:
davco	AZ	2023.10.11

Title
SITE LAYOUT PLAN

Revision:	Figure
1	2

Appendix A Stantec Methodology for the Assessment of Land Contamination (England)

Stantec Guide: Methodology for Assessment of Land Contamination (England)

1 INTRODUCTION

This document defines the approach adopted by Stantec in relation to the assessment of land contamination in England. The aim is for the approach to (i) be systematic and objective, (ii) provide for the assessment of uncertainty and (iii) provide a rational, consistent, transparent framework.

When preparing our methodology, we have made reference to various technical guidance documents and legislation referenced in Section 7 of which the principal documents are (i) Contaminated Land Statutory Guidance (Defra 2012), (ii) online guidance Land Contamination: Risk Management (LC:RM) accessed from GOV.UK which is expected to replace Contaminated Land Research (CLR) Report 11: Model Procedures for the Management of Contamination (EA 2004). It should be noted that LCRM is currently due to be revised following consultation and CLR 11 is archived, (iii) Contaminated land risk assessment: A guide to good practice (C552) (CIRIA 2001) (iv) National Planning Policy Framework (NPPF, 2019) (v) BS 10175 Investigation of potentially contaminated sites - Code of Practice (BSI 2017) and (vi) The series of British Standards on Soil Quality BS 18400.

2 DEALING WITH LAND CONTAMINATION

Government policy on land contamination aims to prevent new contaminated land from being created and promotes a risk-based approach to addressing historical contamination. For historical contamination, regulatory intervention is held in reserve for land that meets the legal definition and cannot be dealt with through any other means, including through planning. Land is only considered to be "*contaminated land*" in the legal sense if it poses an unacceptable risk.

UK legislation on contaminated land is principally contained in Part 2A of the Environmental Protection Act, 1990 (which was inserted into the 1990 Act by section 57 of the Environment Act 1995). Part 2A was introduced in England on 1 April 2000 and provides a risk-based approach to the identification and remediation of land where contamination poses an unacceptable risk to human health or the environment.

The Model Procedures for the Management of Land Contamination (CLR 11), were developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. The process involves identifying, making decisions on, and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK. The approach, concepts and principles for land contamination management promoted by LC:RM (and its predecessor CLR 11) are applied to the determination of planning applications. The guidance given in LC:RM follows the same principles.

Other legislative regimes may also provide a means of dealing with land contamination issues, such as the regimes for waste, water, environmental permitting, and environmental damage. Further, the law of statutory nuisance may result in contaminants being unacceptable to third parties whilst not attracting action under Part 2A or other environmental legislation.

2.1 Part 2A

The Regulations and Statutory Guidance that accompanied the Act, including the Contaminated Land (England) Regulations 2006, has been revised with the issue of The Contaminated Land (England) (Amendment) Regulations 2012 (SI 2012/263) and the Contaminated Land Statutory Guidance for England 2012.

Part 2A defines contaminated land as "*land which appears to the Local Authority in whose area it is situated to be in such a condition that, by reason of substances in, on or under the land that significant harm is being caused, or there is a significant possibility that such significant harm (SPOSH) could be caused, or significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution (SPOSP) being caused*".

Harm is defined as "*harm to the health of living organisms or other interference with the ecological systems of which they form part, and in the case of man, includes harm to his property*".

Part 2A provides a means of dealing with unacceptable risks posed by land contamination to human health and the environment, and under the guidance enforcing authorities should seek to find and deal with such land. It states that "*under Part 2A the starting point should be that land is not contaminated land unless there is reason to consider otherwise. Only land where unacceptable risks are clearly identified, after a risk assessment has been undertaken in accordance with the Guidance, should be considered as meeting the Part 2A definition of contaminated land"*. Further, the guidance makes it clear that *"regulatory decisions should be based on what is reasonably likely, not what is hypothetically possible".*

The overarching objectives of the Government's policy on contaminated land and the Part 2A regime are:

"(a) To identify and remove unacceptable risks to human health and the environment.

(a) To seek to ensure that contaminated land is made suitable for its current use.

(b) To ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of

sustainable development".

The enforcing authority may need to decide whether and how to act in situations where decisions are not straight forward, and where there is uncertainty. "*In so doing, the authority should use its judgement to strike a reasonable balance between: (a) dealing with risks raised by contaminants in land and the benefits of remediating land to remove or reduce those risks; and (b) the potential impacts of regulatory intervention including financial costs to whoever will pay for remediation, health and environmental impacts of taking action, property blight, and burdens on affected people".*

The authority is required to "*take a precautionary approach to the risks raised by contamination, whilst avoiding a disproportionate approach given the circumstances of each case".* The aim is "*that the regime produces net benefits, taking account of local circumstances*".

The guidance recognises that *"normal levels of contaminants in soils should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise".* Normal levels are quoted as:

"a) *natural presence of contaminants'* such as from underlying geology *'that have not been shown to pose an unacceptable risk to health and the environment*

b) *…low level diffuse pollution, and common human activity…"*

Similarly the guidance states that significant pollution or significant possibility of significant pollution of controlled waters is required for land to be considered contaminated and the "*fact that substances are merely entering water"* or "*where discharge from land is not discernible at a location immediately downstream"* does not constitute contaminated land.

To help achieve a more targeted approach to identifying and managing contaminated land in relation to the risk (or possibility) of harm to human health, the revised Statutory Guidance presented a new four category system for considering land under Part 2A, ranging from Category 4, where there is no risk that land poses a significant possibility of significant harm (SPOSH), or the level of risk is low, to Category 1, where the risk that land poses a significant possibility of significant harm (SPOSH) is unacceptably high.

For land that cannot be readily placed into Categories 1 or 4 further assessment is required. If there is sufficient concern that the risks could cause significant harm or have the significant possibility of significant harm the land is to be placed into Category 2. If the concern is not met land is considered Category 3.

The technical guidance clearly states that the currently published Soil Guidance Values (SGV's) and Generic Assessment Criteria (GAC's) represent *"cautious estimates of level of contaminants in soils"* which should be considered *"no risk to health or, at most, a minimal risk"*. These values do not represent the boundary between categories 3 and 4 and "*should be considered to be comfortably within Category 4".*

At the end of 2013 technical guidance in support of Defra's revised Statutory Guidance (SG) was published and then revised in 2014 (CL: AIRE 2014) which provided:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and

- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

For controlled waters, the revised Statutory Guidance states that the following types of pollution should be considered to constitute significant pollution of controlled waters:

"(a) Pollution equivalent to "environmental damage" to surface water or groundwater as defined by The Environmental Damage (Prevention and Remediation) Regulations 2009, but which cannot be dealt with under those Regulations.

(b) Inputs resulting in deterioration of the quality of water abstracted, or intended to be used in the future, for human consumption such that additional treatment would be required to enable that use.

(c) A breach of a statutory surface water Environment Quality Standard, either directly or via a groundwater pathway.

(d) Input of a substance into groundwater resulting in a significant and sustained upward trend in concentration of contaminants (as defined in Article 2(3) of the Groundwater Daughter Directive (2006/118/EC)".

The guidance also states that, in some circumstances, significant concentrations at a compliance point (in groundwater or surface water) may constitute pollution of controlled waters.

As with SPOSH for human health, the revised Statutory Guidance presents a four-category system for Significant Pollution of controlled waters. Category 1 covers land where there is a strong and compelling case for SPOSP, for example where significant pollution would almost certainly occur if no action was taken to avoid it. Category 4 covers land where there is no risk or the risk is low, for

example, where the land contamination is having no discernible impact on groundwater or surface water quality. Category 2 is for land where the risks posed to controlled waters are not high enough to consider the land as Category 1 but nonetheless are of sufficient concern to constitute SPOSP, Category 3 is for land where the risks posed to controlled waters are higher than low but not of sufficient concern to constitute SPOSP.

2.2 Planning

The Local Planning Authority (LPA) is responsible for the control of development, and in doing so it has a duty to take account of all material considerations, including contamination.

The principal planning objective is to ensure that any unacceptable risks to human health, buildings and other property and the natural and historical environment from the contaminated condition of the land are identified so that appropriate action can be considered and taken to address those risks.

The National Planning Policy Framework (NPPF, 2019), includes the following.

Paragraph 118 states that planning policies and decisions should "*(c) give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land*."

Paragraph 179 states "*Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner*".

Paragraph 170 states "*planning policies and decisions should contribute to and enhance the natural and local environment by:*

(e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; *and*

(f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."

Paragraph 178 describes the policy considerations the Government expects LPA's to have in regard to land affected by contamination when preparing policies for development plans and in taking decisions on applications.

Paragraph 178 states "*planning policies and decisions should ensure that:*

(a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);

(b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and

c) adequate site investigation information, prepared by a competent person, is available to inform these assessments."

Paragraph 183 states "*The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities.*"

The Glossary in Annex 2 provides the following:

***Brownfield land registers**: Registers of previously developed land that local planning authorities consider to be appropriate for residential development, having regard to criteria in the Town and Country Planning (Brownfield Land Registers) Regulations 2017. Local planning authorities will be able to trigger a grant of permission in principle for residential development on suitable sites in their registers where they follow the required procedures.*

***Competent person (to prepare site investigation information)**: A person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation.*

***Previously developed land**: Land which is or was occupied by a permanent structure, including the curtilage of the developed land (although it should not be assumed that the whole of the curtilage should be developed) and any associated fixed surface infrastructure. This excludes: land that is or was last occupied by agricultural or forestry buildings; land that has been developed for minerals extraction or waste disposal by landfill, where provision for restoration has been made through development management procedures; land in built-up areas such as residential gardens, parks, recreation grounds and allotments; and land that was previously developed but where the*

remains of the permanent structure or fixed surface structure have blended into the landscape.

***Site investigation information**: Includes a risk assessment of land potentially affected by contamination, or ground stability and slope stability reports, as appropriate. All investigations of land potentially affected by contamination should be carried out in accordance with established procedures (such as BS10175 Investigation of Potentially Contaminated Sites – Code of Practice).*

Stantec adopt the principle that a Preliminary Investigation (Desk Study and Site Reconnaissance) and Preliminary Risk Assessment (see below) is the minimum assessment requirement to support a planning application.

The level at which contamination is deemed to be unacceptable, or, gives rise to adverse effects under a planning context has not been identified but is envisaged to be more precautionary than the level required to determine land as contaminated under Part 2A.

2.3 Building Control

The building control department of the local authority or private sector approved inspectors are responsible for the operation and enforcement of the Building Regulations (DCLG 2010) to protect the health, safety and welfare of people in and around buildings. Approved Document C requires the protection of buildings and associated land from the effects of contamination, to be applied (non-exclusively) in all changes of use from commercial or industrial premises, to residential property.

3 APPROACH

As with CLR11 the guidance given in LC:RM presents three stages of risk management: -

(a) Stage 1 - Risk Assessment;

(b) Stage 2 - Options Appraisal; and

(c) Stage 3 - Remediation.

Each stage has three tiers. The three tiers of Stage 1 Risk Assessment are: -

- Tier 1 - Preliminary Risk Assessment (PRA) - first tier of RA that develops the outline conceptual model (CM) and establishes whether there are any potentially unacceptable risks.

- Tier 2 - Generic Quantitative Risk Assessment (GQRA) - carried out using generic assessment criteria and assumptions to estimate risk.

- Tier 3 - Detailed Quantitative Risk Assessment (DQRA) - carried out using detailed site-specific information to generate Site Specific Assessment Criteria (SSAC) as risk evaluation criteria.

For each tier of a Stage 1 - Risk Assessment you must:

1. Identify the hazard - establish contaminant sources.

2. Assess the hazard - use a source-pathway-receptor (S-P-R) pollutant linkage approach to find out if there is the potential for unacceptable risk.

3. Estimate the risk - predict what degree of harm or pollution might result and how likely it is to occur.

4. Evaluate the risk - decide whether a risk is unacceptable.

A Stantec Preliminary Investigation report normally comprises a desk study, walkover site reconnaissance and preliminary risk assessment (PRA). The project specific proposal defines the actual scope of work which might include review of ground investigation data in which case the report includes a GQRA.

Risk estimation involves identifying the magnitude of the potential consequence (taking into account both the potential severity of the hazard and the sensitivity of the receptor) and the magnitude of the likelihood i.e. the probability (taking into account the presence of the hazard and the receptor and the integrity of the pathway). This approach is promoted in current guidance such as R&D 66 (NHBC 2008).

For a PRA, Stantec's approach is that if a pollution linkage is identified then it represents a potentially unacceptable risk which either (1) remediation / direct risk management or (2) progression to further tiers of risk assessment (GQRA and GQRA) requiring additional data collection and enabling refinement of the CM using the site specific data.

4 IDENTIFICATION OF POLLUTANT LINKAGES AND DEVELOPMENT OF A CONCEPTUAL MODEL (CM)

For all Tiers of a Stage 1 Risk Assessment, 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. A pollutant linkage consists of the following three elements: -

- A source/hazard – a substance or situation which has the potential to cause harm or pollution;
- A pathway – a means by which the hazard moves along / generates exposure; and
- A receptor/target – an entity which is vulnerable to the potential adverse effects of the hazard.

The *Conceptual Model* identifies the types and locations of potential contaminant sources/hazards and potential receptors and potential migration/transportation pathway(s). The CM is refined through progression to further tiers of risk assessment (GQRA and GQRA) requiring additional data collection.

4.1 Hazard Identification

A hazard is a substance or situation that has the potential to cause harm. Hazards may be chemical, biological or physical.

In a PRA the potential for hazards to be present is determined from consideration of the previous or ongoing activities on or near to the site in accordance with the criteria presented in the **Table 1**.

Based on the land use information Contaminants of Potential Concern (COPC) are identified. The COPC direct the scope of the collection of site-specific data and the analytical testing selected for subsequent Tiers.

At Tier 2 the site-specific data is evaluated using appropriate published assessment criteria (refer to Stantec document entitled Rationale for the Selection of Evaluation Criteria for a Generic Quantitative Risk Assessment (GQRA)). In general, published criteria have been developed using highly conservative assumptions and therefore if the screening criterion is not exceeded (and if enough samples from appropriate locations have been analysed) then the COPC is eliminated as a potential Hazard. It should be noted that exceedance does not necessarily indicate that a site is contaminated and/or unsuitable for use only that the COPC is retained as a potential Hazard. Published criteria are generated using models based on numerous and complex assumptions. Whether or not these assumptions are appropriate or sufficiently protective requires confirmation on a project by project basis. Manipulation of the default assumptions would normally form part of a Tier 3 Detailed Quantitative Risk Assessment (DQRA).

When reviewing or assessing site specific data Stantec utilise published guidance on comparing contamination data with a critical concentration (CL:AIRE/CIEH 2008) which presents a structured process for employing statistical techniques for data assessment purposes.

4.2 Receptor and Pathway Identification

For all Tiers the potential receptors (for both on site and adjoining land) that will be considered are:

- Human Health – including current and future occupiers, construction and future maintenance workers, and neighbouring properties/third parties;
- Ecological Systems; [1]
- Controlled Waters [2] – Under section 78A(9) of Part 2A the term "pollution of controlled waters" means the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter. The term "controlled waters" in relation to England has the same meaning as in Part 3 of the Water Resources Act 1991, except that "ground waters" does not include waters contained in underground strata but above the saturation zone.
- Property - Animal or Crop (including timber; produce grown domestically, or on allotments, for consumption; livestock; other owned or domesticated animals; wild animals which are the subject of shooting or fishing rights); and
- Property - Buildings (any structure or erection, and any part of a building including any part below ground level, but does not include plant or machinery comprised in a building, or buried services such as sewers, water pipes or electricity cables including archaeological sites and ancient monuments).

If a receptor is taken forward for further assessment it will be classified in terms of its sensitivity, the criteria for which are presented in **Table 2**. Table 2 has been generated using descriptions of environmental receptor importance/value given in various guidance documents including R&D 66 (NHBC 2008), EA 2017 and Transport Analysis Guidance (based on DETR 2000). Human health and buildings classifications have been generated by Stantec using the attribute description for each class. Surface water sensitivity is classified using the Water Framework Directive (WFD) status for the River Basin obtained from: https://environment.data.gov.uk/catchment-planning/

[1] International or nationally designated sites (as defined in the statutory guidance (Defra Circular 04/12)) "*in the local area*" will be identified as potential ecological receptors. A search radius of 1, 2 or 5km will be utilised depending on the site-specific circumstances (see also pathway identification). The Environment Agency has published an ecological risk assessment framework (EA 2008) which promotes (as opposed to statutorily enforces) consideration of additional receptors to include locally protected sites and protected or notable species. These additional potential receptors will only be considered if a Phase 1 habitat survey, undertaken in accordance with guidance (JNCC 1993), is commissioned and the data provided to Stantec. It should be noted that without such a survey a Land Contamination risk assessment may conclude that the identification of potential ecological receptors is inconclusive (refer to Stantec Specification for a Preliminary Investigation (Desk Study and Site Reconnaissance).

[2] The definition of "pollution of controlled water" was amended by the introduction of Section 86 of the Water Act 2003. For the purposes of Part 2A groundwater does not include waters above the saturated zone and our assessment does not therefore address perched water other than where development causes a pathway to develop.

The exposure pathway and modes of transport that will be considered are presented in **Table 3**.

4.3 Note regarding Ecological Systems

The Environment Agency (EA) has developed an ecological risk assessment framework which aims to provide a structured approach for assessing the risks to ecology from chemical contaminants in soils (EA 2008). In circumstances where contaminants in water represent a potential risk to aquatic ecosystems then risk assessors will need to consider this separately.

The framework consists of a three-tiered process: -

- Tier 1 is a screening step where the site soils chemical data is compared to a soil screening value (SSV)
- Tier 2 uses various tools (including surveys and biological testing) to gather evidence for any harm to the ecological receptors
- Tier 3 seeks to attribute the harm to the chemical contamination

Tier 1 is preceded by a desk study to collate information about the site and the nature of the contamination to assess whether pollutant linkages are feasible. The framework presents ten steps for ecological desk studies and development of a conceptual model as follows.

1. Establish Regulatory Context
2. Collate and Assess Documentary Information
3. Summarise Documentary Information
4. Identify Contaminants of Potential Concern
5. Identify Likely Fate Transport of Contaminants
6. Identify Potential Receptors of Concern
7. Identify Potential Pathways of Concern
8. Create a Conceptual Model
9. Identify Assessment and Measurement Endpoints
10. Identify Gaps and Uncertainties

The information in a standard PRA report covers Steps 1 to 4 inclusive. Step 5 considers fate and transport of contaminants and it should be noted that our standard report adopts a simplified approach considering only transport mechanisms. A simplified approach has also been adopted in respect of Steps 6 and 7 receptors (a detailed review of the ecological attributes has not been undertaken) and pathways (a food chain assessment has not been undertaken). Step 9 is outside the scope of our standard PRA report.

It should be noted that the PRA report will present an assessment for ecological systems (where identified as a receptor for a land contamination assessment) considering the viability of the mode of transport given the site-specific circumstances and not specific pathways. The PRA may conclude that the risk to potential ecological receptors is inconclusive.

4.4 Note regarding controlled waters

Controlled waters are rivers, estuaries, coastal waters, lakes and groundwaters, but not perched waters.

The EU Water Framework Directive (WFD) 2000/60/EC provides for the protection of sub-surface, surface, coastal and territorial waters through a framework of river basin management. The EU Updated Water Framework Standards Directive 2014/101/EU amended the EU WFD to update the international standards therein; it entered into force on 20 November 2014 with the requirements for its provisions to be transposed in Member State law by 20 May 2016. Other EU Directives in the European water management framework include:

- the EU Priority Substances Directive 2013/39/EU;
- EU Groundwater Pollutants Threshold Values Directive 2014/80/EU amending the EU Groundwater Directive 2006/118/EC; and
- EU Biological Monitoring Directive 2014/101/EU.

The Ground Water Daughter Directive (GWDD) was enacted by the Groundwater Regulations (2009), which were subsumed by the Environmental Permitting Regulations (2010) which provide essential clarification including on the four objectives specifically for groundwater quality in the WFD: -

Achieve ‘Good’ groundwater chemical status by 2015, commonly referred to as ‘status objective’;
Achieve Drinking Water Protected Area Objectives;
Implement measures to reverse any significant and sustained upward trend in groundwater quality, referred to as ‘trend objective’; and

Prevent or limit the inputs of pollutants into groundwater, commonly referred to as ‘prevent or limit’ objectives

The Water Act 2003 (Commencement No.11) Order 2012 amends the test for 'contaminated land' which relates to water pollution so that pollution of controlled waters must now be "significant" to meet the definition of contaminated land.

The Water Framework Directive (WFD) requires the preparation, implementation and review of River Basin Management Plans (RBMP) on a six-year cycle. River basins are made up of lakes, rivers, groundwaters, estuaries and coastal waters, together with the land they drain. River Basin Districts (RBD) and the WFD Waterbodies that they comprise are important spatial management units, regularly used in catchment management studies. River Basin Management Plans (RBMP) have been developed for the 11 River Basin Districts in England and Wales.

These were released by Defra in 2009 (Defra 2009) and updated in 2015.

These RBMP's establish the current status of waters within the catchments of the respective Districts and the current status of adjoining waters identified. As part of a Tier 2 risk assessment water quality data is screened against the WFD assessment criteria. Comparison with the RBMP's current status of waters for the catchment under consideration would form part of a Tier 3 assessment.

5 RISK ESTIMATION

Risk estimation classifies what degree of harm might result to a receptor (defined as consequence) and how likely it is that such harm might arise (probability).
At Tier 1 the consequence classification is generated by multiplying the hazard classification score and the receptor sensitivity score. This approach follows that presented in the republished R&D 66 (NHBC 2008).

The criteria for classifying probability are set out in **Table 4** and have been taken directly from Table 6.4 CIRIA C552 (CIRIA 2001). Probability considers the integrity of the exposure pathway.

The consequence classifications detailed in **Table 5** have been adapted from Table 6.3 presented in C552 and R&D 66 (Annex 4 Table A4.3).

The Tier 1 risk classification is estimated for each pollutant linkage using the matrix given in **Table 6** which is taken directly from C552 (Table 6.5).

Subsequent Tiers refine the CM through retention or elimination of potential hazards and pollutant linkages.

6 RISK EVALUATION

Evaluation criteria are the parameters used to judge whether harm or pollution needs further assessment or is unacceptable. The evaluation criteria used will depend on:

- the reasons for doing the RA and the regulatory context such as Part 2A or planning;
- the CM and pollutant linkages present;
- any criteria set by regulators;
- any advisory requirements such as from Public Health England;
- the degree of confidence and precaution required;
- the level of confidence required to judge whether a risk is unacceptable;
- how you've used or developed more detailed assessment criteria in the later tiers of RA;
- the availability of robust scientific data;
- how much is known - for example, about the pathway mechanism and how the contaminants affect receptors; and
- any practical reasons such as being able to measure or predict against the criteria.

In order to put the Tier 1 risk classification into context the likely actions are described in **Table 7** which is taken directly from Table 6.6 of C552 (CIRIA 2001).

REFERENCES

BSI 2017 BS 10175:2011+A2:2017 Investigation of potentially contaminated sites - Code of Practice

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

CIRIA 2001: Contaminated land risk assessment – a guide to good practice C552.

CIRIA 2008: Assessing risks posed by hazardous ground gases to buildings C655

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and Tweed, Southeast, Thames, Western Wales) December 2009

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JNCC 1993 Handbook for Phase 1 Habitat Survey – A Technical for Environmental Audit prepared by the Joint Nature Conservancy Council (JNCC)

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Stantec Methodology for Assessment of Land Contamination (England)

Table 1: Criteria for Classifying Hazards / Potential for Generating Contamination

Classification/Score	Potential for generating contamination/gas based on land use
Very Low 1	Land Use: Residential, retail or office use, agriculture Contamination: Limited. Gas generation potential: Soils with low organic content
Low 2	Land Use: Recent small scale industrial and light industry Contamination: locally slightly elevated concentrations. Gas generation potential: Soils with high organic content (limited thickness)
Moderate 3	Land Use: Railway yards, collieries, scrap yards, engineering works. Contamination: Possible widespread slightly elevated concentrations and locally elevated concentrations. Gas generation potential: Dock silt and substantial thickness of organic alluvium/peat
High 4	Land Use: Heavy industry, non-hazardous landfills. Contamination: Possible widespread elevated concentrations. Gas generation potential: Shallow mine workings Pre 1960s landfill
Very High 5	Land Use: Hazardous waste landfills, gas works, chemical works, Contamination: Likely widespread elevated concentrations. Gas generation potential: Landfill post 1960

"Greenfield" is land which has not been developed and there has been no use of agrochemicals

Table 2: Criteria for Classifying Receptor Sensitivity/Value

Classification	Definition
Very Low 1	Receptor of limited importance • Groundwater: Unproductive strata (Strata with negligible significance for water supply or river baseflow) (previously Non-aquifer), Secondary B (water-bearing parts of non-aquifers), Secondary undifferentiated (previously minor or non-aquifer, but information insufficient to classify as secondary A or B) • Surface water: WFD Surface Water status Bad • Ecology: No local designation • Buildings: Replaceable • Human health: Unoccupied/limited access
Low 2	Receptor of local or county importance with potential for replacement • Groundwater: Secondary A aquifer • Surface water: WFD Surface Water status Poor • Ecology: local habitat resources • Buildings: Local value • Human health: Minimum score 4 where human health identified as potential receptor
Moderate 3	Receptor of local or county importance with potential for replacement • Groundwater: Principal aquifer • Surface water: WFD Surface Water status Moderate • Ecology: County wildlife sites, Areas of Outstanding Natural Beauty (AONB) • Buildings: Area of Historic Character • Human health: Minimum score 4 where human health identified as potential receptor
High 4	Receptor of county or regional importance with limited potential for replacement • Groundwater: Source Protection Zone 2 or 3 • Surface water: WFD Surface Water status Good • Ecology: SSSI, National or Marine Nature Reserve (NNR or MNR) • Buildings: Conservation Area • Human health: Minimum score 4 where human health identified as potential receptor
Very High 5	Receptor of national or international importance • Groundwater: Source Protection Zone (SPZ) 1 • Surface water: WFD Surface Water status High • Ecology: Special Areas of Conservation (SAC and candidates), Special Protection Areas (SPA and potentials) or wetlands of international importance (RAMSAR) • Buildings: World Heritage site • Human health: Residential, open spaces and uses where children are present

Table 3: Exposure Pathway and Modes of Transport

Receptor	Pathway	Mode of transport
Human health	Ingestion	Fruit or vegetable leaf or roots
		Contaminated water
		Soil/dust indoors
		Soil/dust outdoors
	Inhalation	Particles (dust / soil) – outdoor
		Particles (dust / soil) - indoor
		Vapours – outdoor - migration via natural or anthropogenic pathways
		Vapours - indoor - migration via natural or anthropogenic pathways
	Dermal absorption	Direct contact with soil
		Direct contact with waters (swimming / showering)
		Irradiation
Groundwater	Leaching	Gravity / permeation
	Migration	Natural – groundwater as pathway Anthropogenic (e.g. boreholes, culverts, pipelines etc.)
Surface Water	Direct	Runoff or discharges from pipes
	Indirect	Recharge from groundwater
	Indirect	Deposition of windblown dust
Buildings	Direct contact	Sulphate attack on concrete, hydrocarbon corrosion of plastics
	Gas ingress	Migration via natural or anthropogenic paths
Ecological systems	See Notes	Runoff/discharge to surface water body
	See Notes	Windblown dust
	See Notes	Groundwater migration
	See Notes	At point of contaminant source
Animal and crop	Direct	Windblown or flood deposited particles / dust / sediments
	Indirect	Plants via root up take or irrigation. Animals through watering
	Inhalation	By livestock / fish - gas / vapour / particulates / dust
	Ingestion	Consumption of vegetation / water / soil by animals

Table 4: Classification of Probability

Classification	Definition
High likelihood	There is a pollution linkage and an event either appears very likely in the short-term and almost inevitable over the long-term, or there is already evidence at the receptor of harm / pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter-term.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long-term.

Table 5: Classification of Consequence (score = magnitude of hazard and sensitivity of receptor)

Classification / Score	Examples
Severe **17-25** **(3 out of 25 outcomes)**	Human health effect - exposure likely to result in "significant harm" as defined in the Defra (2012) Part 2A Statutory Guidance [1]. Controlled water effect - short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Equivalent to EA Category 1 incident (persistent and/or extensive effects on water quality leading to closure of potable abstraction point or loss of amenity, agriculture or commercial value. Major fish kill. Ecological effect - short-term exposure likely to result in a substantial adverse effect. Catastrophic damage to crops, buildings or property
Medium **10-16** **(7 out of 25 outcomes)**	Human health effect - exposure could result in "significant harm" [1]. Controlled water effect - equivalent to EA Category 2 incident requiring notification of abstractor Ecological effect - short-term exposure may result in a substantial adverse effect. Damage to crops, buildings or property
Mild **5-9** **(7 out of 25 outcomes)**	Human health effect - exposure may result in "significant harm" [1]. Controlled water effect - equivalent to EA Category 3 incident (short lived and/or minimal effects on water quality). Ecological effect - unlikely to result in a substantial adverse effect. Minor damage to crops, buildings or property. Damage to building rendering it unsafe to occupy (for example foundation damage resulting in instability).
Minor **1-4** **(8 out of 25 outcomes)**	No measurable effect on humans. Protective equipment is not required during site works. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects to crops, buildings or property. The loss of plants in a landscaping scheme. Discolouration of concrete.

[1] Significant harm includes death, disease, serious injury, genetic mutation, birth defects or impairment of reproductive function. The local authority may also consider other health effects to constitute significant harm such as physical injury; gastrointestinal disturbances; respiratory tract effects; cardio-vascular effects; central nervous system effects; skin ailments; effects on organs such as the liver or kidneys; or a wide range of other health impacts. Whether or not these would constitute significant harm would depend on the seriousness of harm including impact on health, quality of life and scale of impact.

Table 6: Classification of Risk (Combination of Consequence Table 5 and Probability Table 4)

	Consequence			
Probability	***Severe***	***Medium***	***Mild***	***Minor***
High likelihood	Very high	High	Moderate	Low
Likely	High	Moderate	Moderate/	Low
Low likelihood	Moderate	Moderate	Low	Very low
Unlikely	Low	Low	Very low	Very low

Table 7: Description of Risks and Likely Action Required

Risk Classification	Description
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation is likely to be required in the short term.
High risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short-term and are likely over the longer-term.
Moderate risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer-term.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very low risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Appendix B Site Reconnaissance Photographs

Photograph 1 – Car park off Osney Lane with Great Western Rail in the background

Photograph 2 – View of the vacant parcel of land with Oxford Ice Rink in the background

Stantec	Client: **Oxford City Council**	**Oxpens Footbridge, Osney, Oxford**	Date: 07/01/2022 Scale: - Drawn: az Checked: - Appendix: **B**

Caversham Bridge House, Waterman Pl, Reading, RG1 8DN
Tel 0118 950 0761

Photograph 3 – Vacant parcel of land

Photograph 4 – Parcel of land to the south of the Ice Rink

Stantec	Client: **Oxford City Council**	**Oxpens Footbridge, Osney, Oxford**	Date: 07/01/2022 Scale: - Drawn: az Checked: - Appendix: **B**

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Photograph 5 – View of Oxpens Meadow

Photograph 6 – Entrance to Grandpont Nature Park off Whitehouse Road

Stantec	Client: **Oxford City Council**	**Oxpens Footbridge, Osney, Oxford**	Date: 07/01/2022 Scale: - Drawn: az Checked: - Appendix: **B**

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Tel 0118 950 0761

Photograph 7 – View of Grandpont Nature Park

Photograph 8 – View of Grandpont Nature Park at the location of former gas holder No. 3 to the left

Stantec	Client: **Oxford City Council**	**Oxpens Footbridge, Osney, Oxford**	Date 07/01/2022 Scale - Drawn az Checked - Appendix **B**

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Tel 0118 950 0761

Photograph 9 – View of Grandpont Nature Park at the location of former Gas holder No. 4

Photograph 10 – View of Grandpont Nature Park

Stantec	Client: **Oxford City Council**	**Oxpens Footbridge, Osney, Oxford**	Date: 07/01/2022 Scale: - Drawn: az Checked: - Appendix: **B**
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Photograph 11 – View of Thames Path and the River Thames with the Rail Bridge in the background

Photograph 12 – Footbridge over the Bulstake Stream

Stantec	Client: **Oxford City Council**	**Oxpens Footbridge, Osney, Oxford**	Date: 07/01/2022 Scale: - Drawn: az Checked: - Appendix: **B**

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Photograph 13 – Thames Path, River Thames and path leading to Osney Mead

Photograph 14 – View of Osney Mead

Stantec	Client: **Oxford City Council**	**Oxpens Footbridge, Osney, Oxford**	Date: 07/01/2022 Scale: - Drawn: az Checked: - Appendix: **B**
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Appendix C Historical OS Maps

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

Gravel Pit
Sand Pit
Other Pits
Quarry
Shingle
Orchard
Osiers
Reeds
Marsh
Mixed Wood
Deciduous
Brushwood
Fir
Furze
Rough Pasture
Arrow denotes flow of water
Trigonometrical Station
Site of Antiquities
Bench Mark
Pump, Guide Post, Signal Post
Well, Spring, Boundary Post
·285 Surface Level
Sketched Contour
Instrumental Contour
Main Roads
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
Sunken Road
Raised Road
Road over Railway
Railway over River
Railway over Road
Level Crossing
Road over River or Canal
Road over Stream
Road over Stream
County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy. County Borough Boundary (England)
Co. Burgh Bdy. County Burgh Boundary (Scotland)
R.D. Bdy. Rural District Boundary
Civil Parish Boundary

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Dunes
Boulders
Coniferous Trees
Non-Coniferous Trees
Orchard
Scrub
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Pylon
Electricity Transmission Line
Sloping Masonry
Pole
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge
Geographical County
Administrative County, County Borough or County of City
Municipal Borough, Urban or Rural District, Burgh or District Council
Borough, Burgh or County Constituency
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

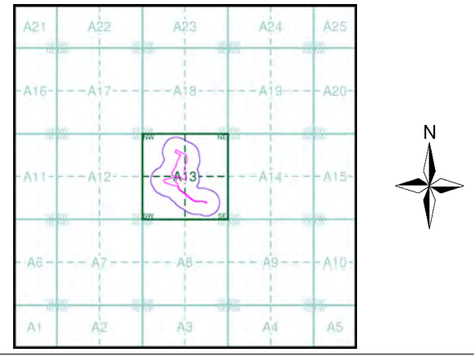
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Mud
Sand
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community boundary
District, Unitary, Metropolitan, London Borough boundary
Constituency boundary
Area of wooded vegetation
Non-coniferous trees
Non-coniferous trees (scattered)
Coniferous trees
Coniferous trees (scattered)
Positioned tree
Orchard
Coppice or Osiers
Rough Grassland
Heath
Scrub
Marsh, Salt Marsh or Reeds
Water feature
Flow arrows
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m Bench mark (where shown)
Triangulation station
Point feature (e.g. Guide Post or Mile Stone)
Pylon, flare stack or lighting tower
Site of (antiquity)
Glasshouse
General Building
Important Building

Stantec

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Berkshire	1:10,560	1886	2
Oxfordshire	1:10,560	1887	3
Oxfordshire	1:10,560	1900	4
Berkshire	1:10,560	1914	5
Oxfordshire	1:10,560	1922	6
Berkshire	1:10,560	1922	7
Berkshire	1:10,560	1938	8
Oxfordshire	1:10,560	1938	9
Historical Aerial Photography	1:10,560	1947	10
Ordnance Survey Plan	1:10,000	1960 - 1961	11
Ordnance Survey Plan	1:10,000	1967 - 1968	12
Ordnance Survey Plan	1:10,000	1972 - 1977	13
Ordnance Survey Plan	1:10,000	1981 - 1982	14
Ordnance Survey Plan	1:10,000	1994	15
10K Raster Mapping	1:10,000	1999	16
10K Raster Mapping	1:10,000	2006	17
VectorMap Local	1:10,000	2023	18

Historical Map - Slice A



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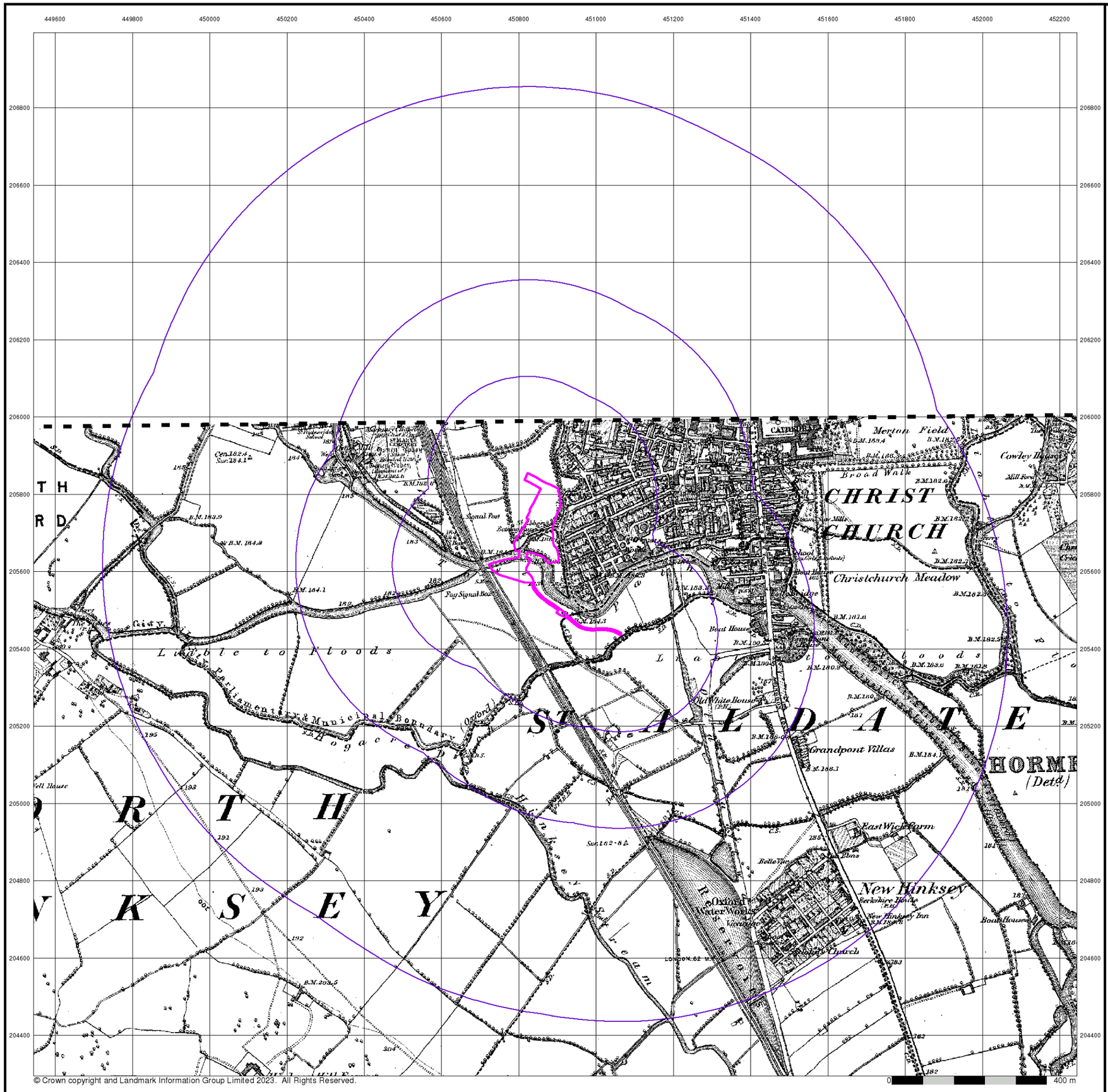


Stantec

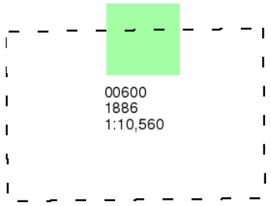
Berkshire

Published 1886

Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



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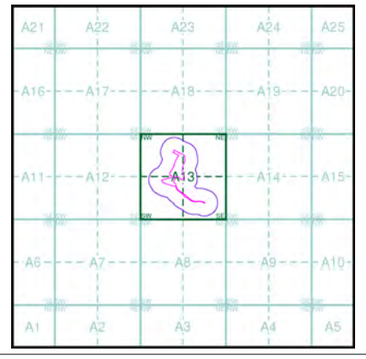

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Oxfordshire

Published 1887

Source map scale - 1:10,560

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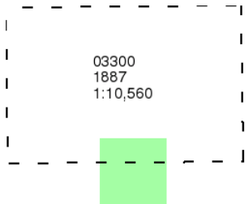

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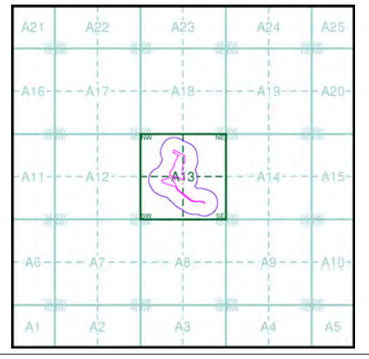

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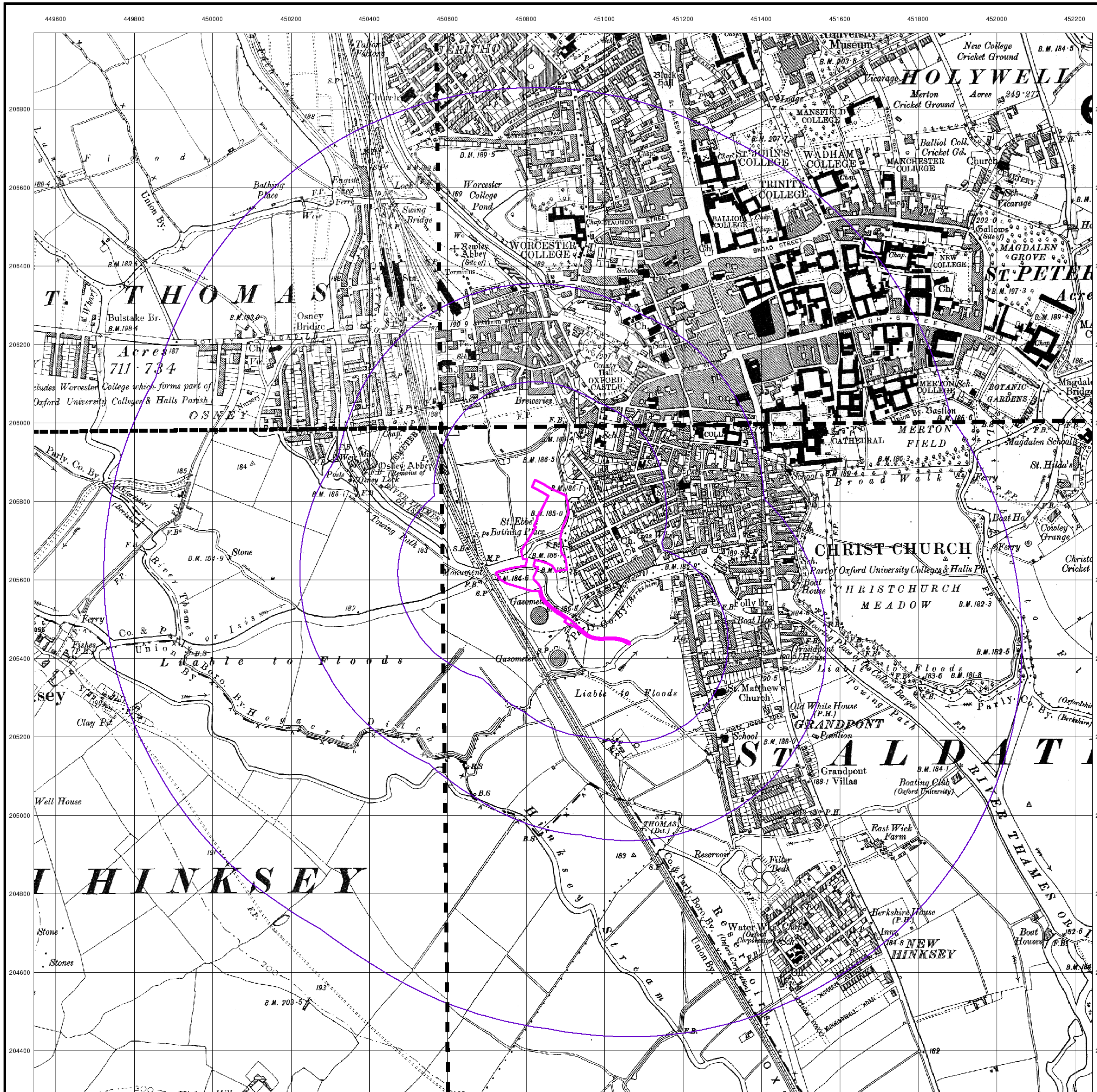

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Oxfordshire

Published 1900

Source map scale - 1:10,560

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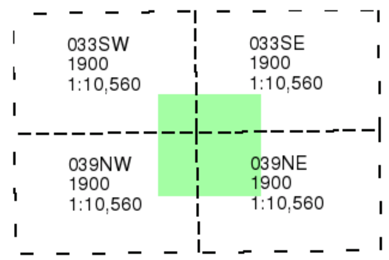

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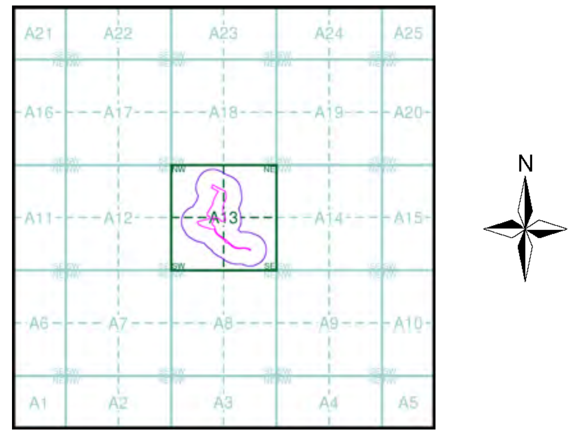

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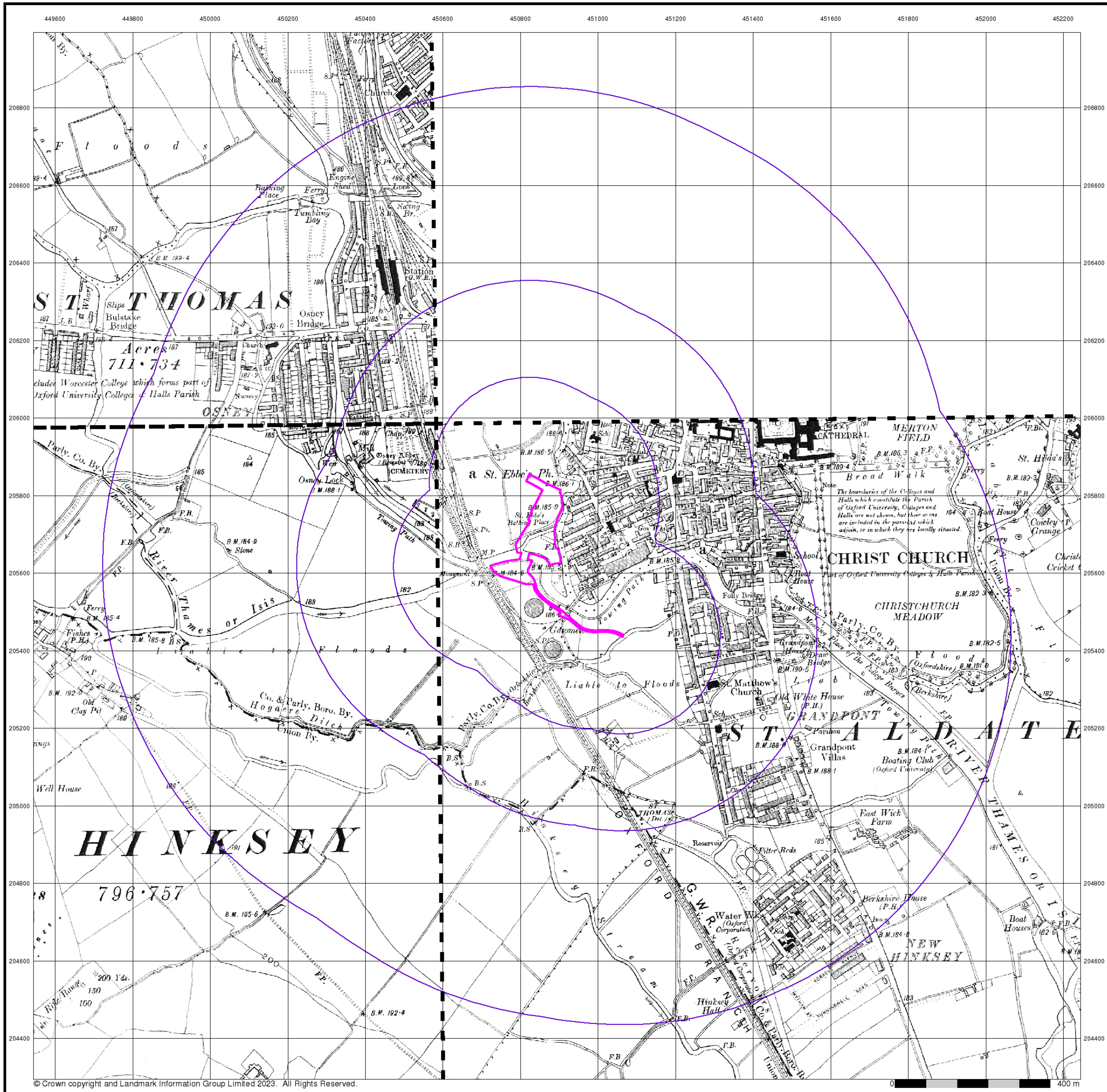

Berkshire

Published 1914

Source map scale - 1:10,560

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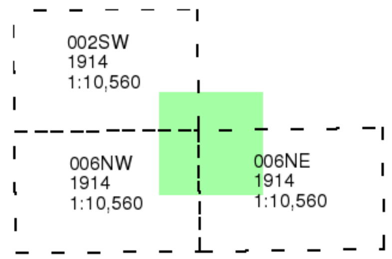
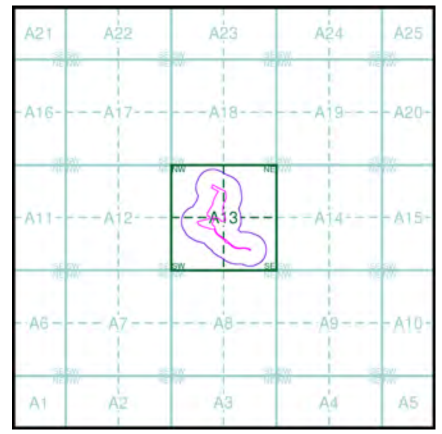


Historical Map - Slice A



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Oxfordshire

Published 1922

Source map scale - 1:10,560

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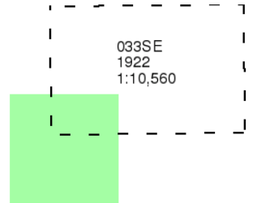
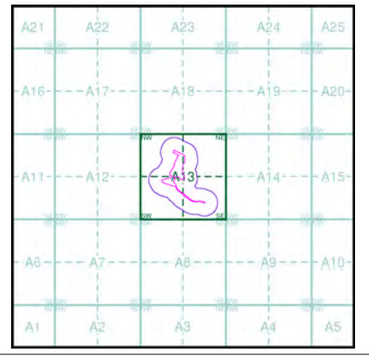


Historical Map - Slice A



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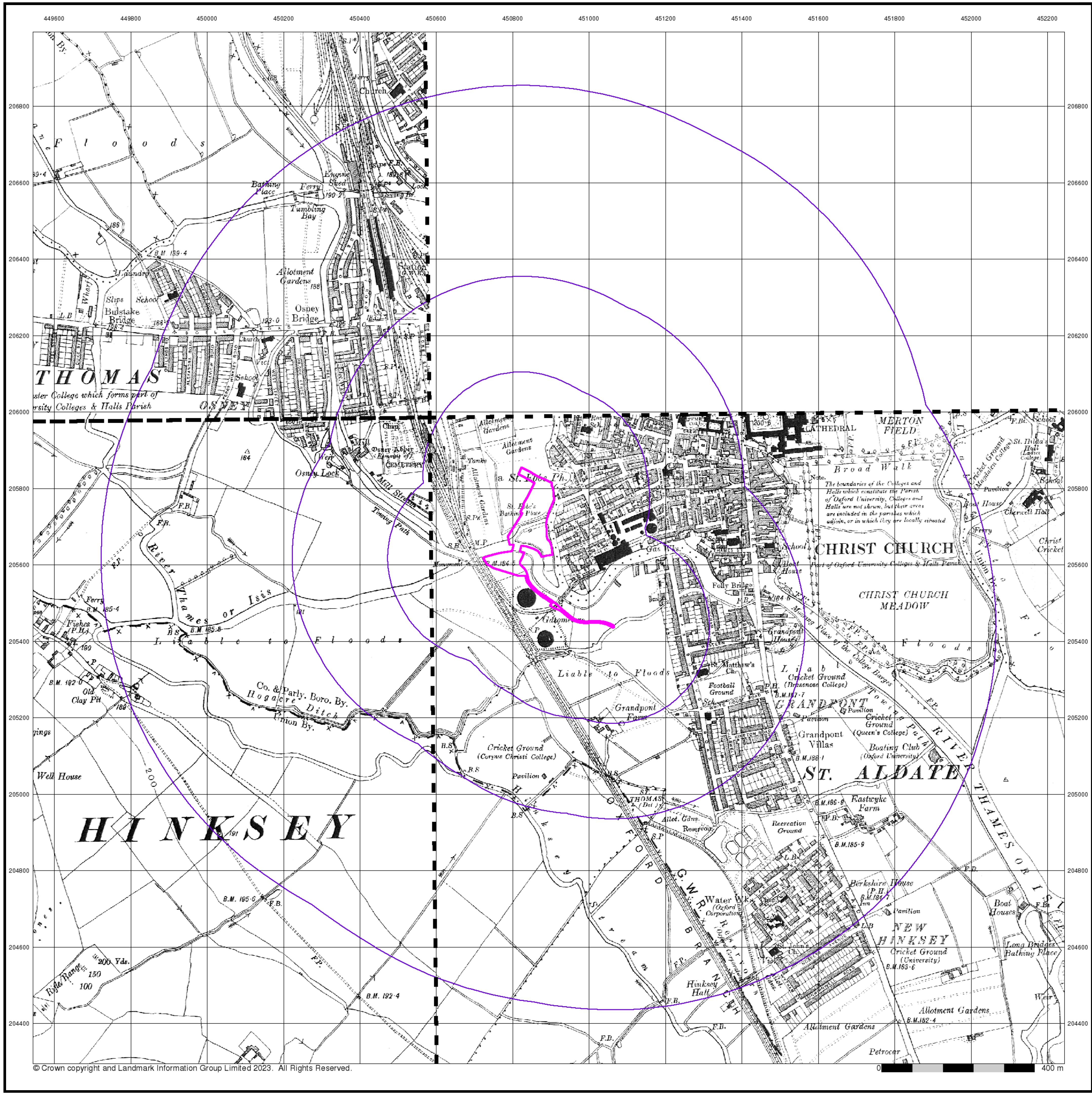

Stantec

Berkshire

Published 1922

Source map scale - 1:10,560

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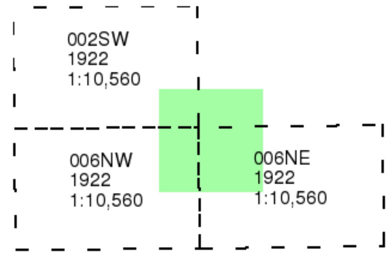

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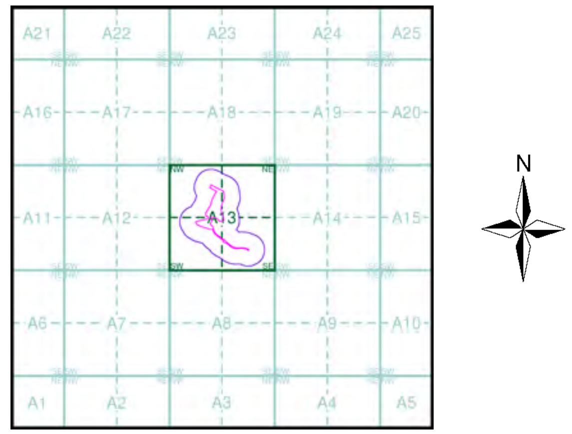

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