Doveside: Geo-Environmental Appraisal

Draft Report

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The Garganey Trust

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Barnsley

South Yorkshire

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Contract

This report describes work commissioned by Jeff Lunn, on behalf of the Garganey Trust, by an email dated 21-1-15. The Garganey Trust's representative for the contract was Jeff Lunn. Alex Jones, and Alice Davis of JBA Consulting carried out this work.

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Purpose

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Contents

List of Figures

List of Tables

1 Introduction

1.1 Project Background

JBA Consulting were appointed by the Garganey Trust in December 2016 to prepare a Geo-Environmental Appraisal to support a wetland creation Scheme at Doveside, Darfield, South Yorkshire. This report presents the site description, conceptual model, and preliminary environmental assessment of the site.

1.2 Aim and Scope of Study

The overall aim of the project is to produce a habitat creation plan for the site which can be submitted to planning. The aim of this report is to determine the presence and extent of any potential environmental (contamination related) risks associated with the development. The study includes:

- Desk-based study,
- Site walkover survey, including shallow soil auger survey,
- Topographical survey,
- Bathymetry survey of on-site ponds,
- Preliminary environmental assessment,
- Preliminary mitigation measures.

1.3 Data Sources

The data used in the desk study were obtained from the following sources:

- Topography and general mapping:
  - OS Open Data, Terrain 50 DTM
  - LiDAR DTM
  - Aerial photography (Google Earth and Bing Maps)
- Climate:
  - Flood Estimation Handbook (FEH) and CD-ROM (CEH, 2009)
- Geology and Soils:
  - BGS 1:50,000 Geology Map, Solid and Drift Edition, Sheet 87 Barnsley (2008)
  - BGS digital geology mapping
  - BGS online borehole database (BGS website)
  - BGS online Lexicon (BGS website)
  - 1:250,000 soils mapping (Soil Survey of England and Wales, 1983)
- Hydrogeology:
  - Aquifer classification (Environment Agency website)
  - Groundwater vulnerability (Environment Agency website)
  - Source Protection Zones (Environment Agency website)
  - Licensed abstractions (Environment Agency website)
  - Groundwater quality (Environment Agency website; ESI, 2006)
  - Major (Principal) Aquifer properties manual (Allen *et al.,* 1997)
  - Minor Aquifer properties manual (Jones *et al*., 2000)
- Other information relating to the site:
  - Landmark Envirocheck Report for the site

2 Site Description

2.1 Introduction

This chapter describes the geology, hydrology, hydrogeology and history of the site, and is based on a desk-based review (including a review of a Landmark Envirocheck Report for the site - see Appendix B) and observations made during two site walkover surveys.

2.2 Topography, Climate and Land Use

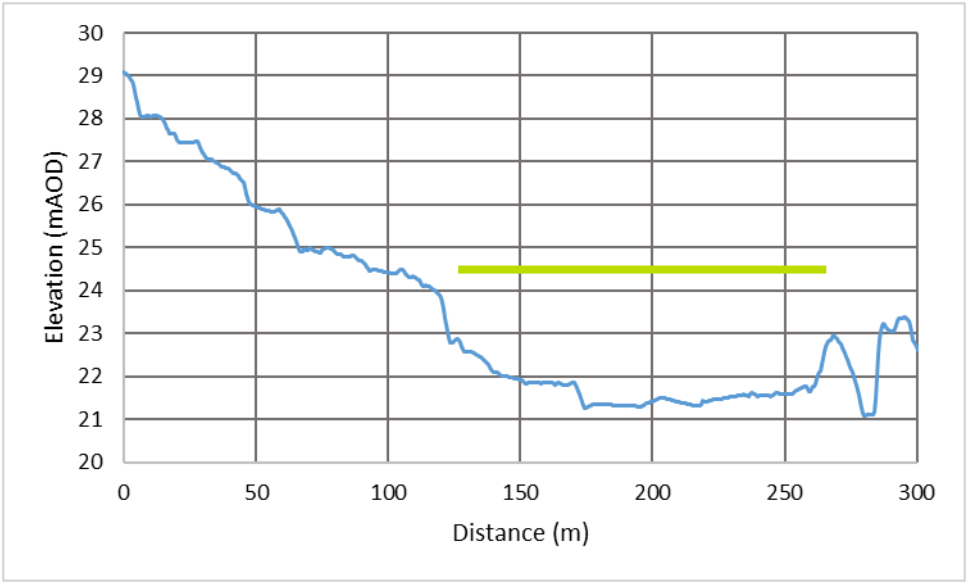
The site is located on the left bank of the River Dove, a tributary of the River Dearne to the south of Darfield, Barnsley (NGR 441226 403904) (Map 1).

2.2.1 Topography

The site lies on the left bank of the River Dove, a tributary of the River Dearne. The confluence of the two rivers lies approximately 580m downstream of the site, and the Dearne is the dominant water course in the area.

On-site ground elevations range from approximately 23.7 - 21.2 mAOD (see Map 2). Generally, the highest ground is in the north of the site, falling to the River Dove in the south. The Dove is however embanked in the vicinity of the site and this embankment following the southern boundary of the site reaches elevations of around 23.2 mAOD. There are two ponds on-site and an area of reed bed which historically may have also been a pond. There is an additional low lying area in the east of the site where water is also known to pond on the surface.

Figure 2-1 Site elevation cross section from north to south (green line indicates site)



The elevation profile of the site from north to south shows the higher ground to the north around the residential area of Darfield. The site itself is generally flat and low lying and the embanked River Dove and be seen in the south of the site.

2.2.2 Climate

The Flood Estimation Handbook (FEH) CD-ROM includes long-term average rainfall data for catchments in the UK. For the catchment of the River Dove encompassing the site, the Standard Annual Average Rainfall (SAAR)

2.2.3 Land Use

The site currently comprises areas of grassland, woodland, two ponds and an area of reedbed. Existing land uses immediately adjacent to the site comprise:

- North

- Residential properties of Darfield lie immediately to the north of the site.

- East
  - A historical landfill site lies immediately to the east of this site. The landfill site is raised above surrounding ground levels and has been landscaped and is covered by areas of grassland and woodland.
- South
  - The River Dove constitutes the southern boundary of the site. Beyond the river lies arable farmland to the west and Broomhill Flash nature reserve to the east.
- West
  - To the west of the site lie more grass fields and residential properties of Darfield.

2.3 Site Regulatory and Environmental Data

Information regarding potential hazards associated with environmental regulatory controls is summarised in Table 2-1. This information was obtained from the Landmark Envirocheck Report which is included as Appendix B.

Table 2-1 Regulatory data

Data Source	Details	Potential for impact on site?
Explosive sites	None within 1km.	No
Contaminated land register entries	None within 1km.	No
Landfill sites	Four located within 1km of the site. End of Ings road lies immediately east of the site, and there is no record of the type of waste deposited here. Land North of Valley Road Landfill lies 522m to the west, deposited waste includes inert and commercial. Station Road Industrial Estate Landfill lies 585m to the west, deposited waste included inert waste. Parkhill Quarry landfill lies to 565m to the south, deposited waste included inert, industrial, commercial, household, special, and liquid sludge.	Yes - Landfill sites represent potential sources of contamination which can reach the site via drainage.
Other waste management sites	Wombwell Wwtw biological treatment 417m to the southwest. Metal recycling site 716m to the west. Scrapyard 290m to the northeast.	Unlikely - Identified waste management sites are located a reasonable distance from the site with no obvious connection to site.
IPC authorisations and IPPC permits	Three IPPCs located 646m to the east of the site associated with Darfield Wwtw.	No - Darfield Wwtw is located on the far side of the River Dearne which will act as a hydraulic barrier.
Hazardous substances	None within 1km.	No
Fuel stations	None within 1km.	No
Contemporary trade directory entries	One vehicle bodywork repair centre located 81m to the northwest of the site. 15 CTDEs located between 251 and 500m from the site, and 36 located between 501 and 100m.	No - The majority are no longer active, and none relate to any potentially highly contaminative land uses.
LAPPC	One located 842m to the southwest of the site relating to the permitted burning of waste oil at A&A Motors.	No - A&A Motors is located a significant distance from the site and separated from it by a number of

		watercourses.
Discharge consents	None on site but 96 located between 28 and 1000m from the site, including sewage discharges at three locations to the River Dove upstream of the site.	Yes - There is potential for sewage discharges released to the River Dove upstream to reach the site
Recorded pollution incidents to controlled waters	None on site but 51 located between 78 and 1000m from the site. All incidents were either Category 3 (minor Incident) or Category 2 (Significant Incident). The most recent pollution incident occurred in 1998.	No - Most recent pollution event took place over 16 years ago.
Radon	The site is in an intermediate probability radon area.	No - There will be no buildings constructed as part of the development of the site and as such radon does not pose a hazard.
Notes IPC = Integrated Pollution Control; IPPC = Integrated Pollution Prevention & Control; LAPPC = Local Authority Pollution Prevention and Controls		

2.4 Historical Land Use

The site history has been determined from a review of OS historical maps (Appendix B).

2.4.1 On-site history

The earliest map dated 1854-1855 shows the entirety of the site to comprise a network of fields, with occasional trees on some of the field boundaries.

On the map dated 1962 an embankment exists along the course of the river in the south of the site. An electricity network also passes through the south of the site west to east.

On the map dated 1989 the electricity cables are no longer present.

On the map dated 2000 three ponds and associated drains can be seen on site.

2.4.2 Off-site history

On the earliest map, dated 1854-1855, the River Dove is shown to run alongside the site following its present-day course. The area surrounding the site is shown to be dominated by fields. The railway line runs north to south to the east of the site on the far side of the River Dearne.

On the map dated 1894, Darfield Main Colliery can be seen lying just over 500m to the west of the site.

On the map dated 1905, a sewage works lies 250m to the southwest of the site on the far side of Bulling Dike. A second sewage works lies 1,250m to the east of the site, on the far side of the River Dearne. A colliery is mapped 750m to the west of the site to the west of the residential properties of Low Valley.

On the map dated 1931, Ings Road Stadium lies 50m to the southwest of the site to the south of the River Dove. The residential area of Darfield has extended southwards towards the site; with schools mapped to the northeast of the site. A new larger sewage works has been built farther south than the pre-existing works, 300m to the south of the site.

On the map dated 1938, Park Hill Brick Works can be seen 750m to the south of the site.

On the map dated 1962, Ings Road Stadium is no longer present. A new series of embankment are present in an around the site, embanking the River Dove on both banks. Embankments to the north bank of the River Dove may be associated with the End of Ings Road Landfill site. Darfield continues to expand further south towards the site, and electricity pylons and cable run broadly north to south to the west of the site.

On the map dated 1966-1967, the areas of Darfield and Low Valley seem to be significantly more developed.

On the map dated 1971, a refuse tip is indicated in the field immediately to the east of the site.

On the map dated 1982, the field to the northeast of the site which was previously a refuse tip is shown to be a playing field.

On the map dated 1989, Park Hill, 750m to the south, is marked as being a disused tip. A factory and some works are also indicated between 500m and 1000m to the southwest of the site. The railway line is now disused.

On the map dated 1991, a pumping station is shown approximately 100m due west of the site.

On the map dated 2000, the houses associated with Doveside Drive located immediately to the north of the site have been developed. A new and larger sewage works has been built 250m to the southwest replacing the historical works.

2.4.3 Historical summary

A summary of potentially contaminative land uses based on our review of historic OS mapping data is provided in Table 2-2.

Table 2-2 Potentially contaminative land uses identified from the historical map review

Industry / Source	Location	Date	Potential for impact on site
Embankment	In the south of the site	1962 - present	Yes - Embankment is of unknown composition and may contain contaminative materials. Limited site augering identified that the embankments consisted predominately of colliery waste, with other material mixed in.
Railway line	850m east	Pre1954 - 1989	No - Railway was located on the far side of the River Dearne
Darfield Main Colliery	500m west	1894 - pre2000	Yes - There is potential for contaminants to migrate to the site via groundwater movement.
Sewage works	250m southwest	1905 - pre 1931	Unlikely - Sewage works has been absent for over 80 years
Sewage works	700m east	1905 - 2000	No - Located on the far side of the River Dearne
Sewage Works	400m south	1931 - 1989	Unlikely - Site was located on the far side of Bulling Dike.
Park Hill Brickworks and Landfill	700m south	1938 - 1989	Unlikely - Park Hill is located a reasonable distance from the site on the far side of Bulling Dike.
End of Ings Road Landfill and associated embankments	Immediately to the east	1962 - 1982	Yes - land adjoining the site was used for landfill of unknown materials and is highly likely to contain potentially contaminative material.
Factory & Works	500 - 100m southwest	1989 - present	No - Works are located on the far side of Bulling Dike.
Sewage Works	250m south	2000 - present	Yes - There is potential for contaminants to migrate towards the River Dove and reach the site.

2.5 Geology and Soils

Information on the soils and geology of the site and surrounding area has been derived from the Soil Survey of England and Wales (1983), 1:50,000 BGS geology mapping (Map 3 and Map 4), and the BGS online borehole archive. The geology beneath the site is summarised in Table 2-3.

Table 2-3 Site geology

Age	Group	Formation/Member	Description	Thickness
Recent		Made Ground	Granular Colliery spoil with other waste material included	Unknown Landfill lies 3m+ above adjoining natural ground level
Quaternary		Alluvium	Clay and silt	*~6-7.5 m
Carboniferous	Pennine Coal Measures Group	Pennine Middle Coal Measures Formation	Interbedded grey mudstone, siltstone, pale grey sandstone and commonly coal seams.	*up to 700m
Notes *BGS borehole logs available from BGS GeoIndex **BGS online Lexicon of named rock units				

2.5.1 Soils

The site is underlain by soils belonging to the Conway soil association which typically comprise deep stoneless fine silts and clayey soils variable affected by groundwater. These soils typically develop on flat land at risk of flooding (Soil Survey of England and Wales, 1983).

Shallow soil auger survey

A hand auger survey was conducted across the site (10 holes between 0.4-0.6m deep). It identified that the site was underlain by mottled gleyed silty clay. The exception to this was in the south-east corner of the site, where the OS mapping indicated that a pond had been present. This area was now a soft rush dominated waterlogged area. The upper 20cm of deposits were peaty clay deposited as the pond infilled. Beneath this the silty clay alluvium returned.

The survey also augered to 30cm into the raised banks. It identified that the material was primarily granular colliery spoil material but included evidence of other waste including broken glass. The arising from an animal set on the landfill immediately to the east was observed. It indicated that the landfill was made of a simple mix of granular colliery spoil and other waste material (glass and pottery). The observations of the made ground material were limited and may not be completely representative. However, it can be stated that the made ground is likely to be mainly colliery spoil which has been mixed with other material. The nature and contaminative potential of this other material is unknown.

2.5.2 Superficial (drift) Geology

The valleys of the Dearne and Dove are filled with alluvial deposits dominated by clay and silt, but will also contain sand and gravels. The majority of the site is underlain by such alluvial deposits, the exception of which is the northern edge of the site on the steeper ground which is mapped as being free from superficial deposits. There are no records of any boreholes being drilled on site, but logs available located to the south of the Dove approximately 500m upstream of the site suggest that alluvial deposits in this area may be between 6 and 7.5m thick.

The known area of landfill to the east of the site is mapped as made ground, though these made ground deposits are shown as extending within the site boundary and to the south of the site. The made ground mapped on site lies adjacent to the southern site boundary in the east of the site, extending up to 27m into the site. During the site walkover survey exposures within the landfill wall created by burrowing animals were seen to comprise colliery spoil, and there was also evidence of domestic waste including bottles. The embankment on-site also appears to be formed from colliery spoil. The embankments were created at a similar period to the landfill and may have been designed to form the edge of a landfill cell that was not completed.

2.5.3 Bedrock Geology

The site is underlain by the Carboniferous Pennine Middle Coal Measures Formation which consists of interbedded mudstone, siltstone and sandstone (Map 4). There are a number of units

within the PMCM that predominantly comprise sandstone, and though a number of these are mapped as outcropping in the vicinity of the site none immediately underlie the site.

The coal measures are heavily faulted in the area with the majority of faults trending northwest-southeast, one such fault lies ~150m to the north of the site. Broomhill fault runs perpendicular to these faults and lies approximately 1km to the east of the site.

2.6 Mining and Mineral Extraction

The site lies within a Coal Mining Reporting Area as defined by the Coal Authority, though the site is not shown as having been or likely to have been historically worked at for coal at the surface or at shallow depths. There is however one mine entry mapped in the site adjacent to the western boundary, and during the site visit an area of standing water and ochre staining was observed in this location.

There is much evidence of coal working in the wider vicinity, the nearest evidence of which lies about 70m to the north of the site in Darfield where there is a cluster of mapped mine entries and an area indicated as a probable area of shallow coal mine workings. Farther west is the site of Darfield Main Colliery where there are also a number of mapped mine entries. Approximately 500m to the west there are also a couple of marked mine entries, this is a location marked as being an 'old colliery' on historical mapping.

2.7 Surface Water Hydrology

The River Dove is a main river and constitutes the southern boundary of the site, along this reach the rivers course has been straightened. In the vicinity of the site the Dove is generally between 5 and 8m wide. The Dove is a tributary of the River Dearne, and the confluence of the two rivers lies 565m downstream of the site.

Three ponds are mapped on site though the southern pond has filled in with fen vegetation. The eastern and western ponds remain open. Three surface water discharge culverts enter the site along the northern boundary which serve the housing estate to the north. A small drain also enters the site from the west, it is a shallow drain which appears to have been poorly maintained. A network of small drains connects the sewer outfalls and the ponds. Water is discharged from the site, to the River Dove, through a culvert, which passes through the embankment, which separates the site from the river. The water level within the ponds and drains on site is controlled by a hump in the drain which leads to the outfall culvert.

2.7.1 Water Quality

The River Dove from source to River Dearne is described as a heavily modified water body and is currently regarded a shaving moderate ecological quality and good chemical quality and therefore moderate overall quality by the Environment Agency. The stretch of the River Dearne downstream of the site (the Dearne Darfield STW to River Don), and is currently regarded as having moderate ecological quality and good chemical quality and therefore overall moderate status.

2.7.2 Surface Water Abstractions

British Coal historically held a licence to abstract surface water for industrial purposes 854m to the west of the site. The RSPB hold a surface water abstraction licence to maintain lake and pond throughflow through the Old Moor Wetlands Reserve located 1,322m to the southeast of the site, historically this licence was held by Barnsley Metropolitan Borough Council.

2.8 Catchment Descriptors

The FEH gives the Standard Percentage Runoff (SPR) for the catchment of the River Dove which captures the site as 24.2%. The SPR is the percentage of rainfall responsible for the short-term increase in river flow during and/or following a rainfall even (Boorman *et al*., 1995). 24.2% is a low to moderate SPR which would suggest that the catchment as a whole may not be too flashy. The queried catchment includes the upper reaches of the Dove which are largely undeveloped. The SPR is generally higher in built up areas given the higher proportion of impermeable/relatively impermeable surfaces so 24.2% seems a reasonable valued for the queried catchment.

The Baseflow Index (BFI) for the catchment of the River Dove up to and including the site is about 0.54. This the proportion of total streamflow made up of baseflow (mostly groundwater input). This suggests that around half of the flow of the Dove and its tributaries is made up of baseflow.

2.9 Hydrogeology

The alluvium is regarded as a Secondary A aquifer by the Environment Agency. A Secondary A aquifer is described as "permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases supporting an important source of baseflow to rivers". The bedrock beneath the site, the PMCM, is also regarded as a Secondary A aquifer.

2.9.1 Groundwater Abstractions

There are no operation licenses for groundwater abstraction located within 2km of the site.

2.9.2 Groundwater Source Protection Zones

There are no groundwater Source Protection Zones (SPZs) located within 5km of the site.

2.9.3 Aquifer Vulnerability and Water Quality

The groundwater beneath the site is described as belonging to a secondary aquifer of high vulnerability by the Environment Agency. This is attributed to the fact that the overlying soils are of high leaching potential, and can readily transmit liquid discharges because they are either shallow, or susceptible to rapid by-pass flow directly to rock, gravel or groundwater.

2.9.4 Aquifer Properties

The alluvial deposits will contain some groundwater, with groundwater storage and transport likely to be contained within more permeable horizons where sands and gravels dominate.

The Coal Measures Group forms a complex multi-layered minor aquifer. Argillaceous strata predominate, acting as aquitards or aquicludes, isolating the sandstone horizons which effectively act as separate aquifers (Jones et al, 2000). Coal Measures sandstones generally possess very little primary porosity or intergranular permeability as they are generally very fine grained, well cemented, and hard and dense. Groundwater storage and movement within the Coal Measures occurs predominantly within and through fractures in the sandstones. The widespread removal of coal in the area has disrupted natural hydrogeological conditions through the creation of shafts, galleries, collapsed workings, and subsidence induced fractures.

2.9.5 Groundwater Flow

Local groundwater flow is likely to be towards the River Dove, with the general direction of regional flow being towards the River Dearne. Flow within the alluvial deposits will primarily be within more permeable layers where present, and the alluvium on site may be in hydraulic continuity with the River Dove. The observed nature of the alluvium on site indicates it is likely to be relatively impermeable. The made ground deposits of the embankment and landfill appear to be dominated by granular material so are likely to be relatively permeable. Groundwater from the landfill is likely to discharge to the surface at the base of the landfill at the eastern edge of the site. Any groundwater movement within the PMCM will likely be contained within fractures or more permeable sandstone horizons.

2.10 Designated Sites

The site lies within a nitrate vulnerable zone and is an area of adopted greenbelt. There are no nationally designated sites located within 2km of the site.

Wombwell Ings, a nature reserve owned by the RSPB lies immediately to the south of the site between the River Dove and Bulling Dike. To the south of this is the site of the proposed Wombwell wetland and Broomhill Flash. Old Moor nature reserve, also owned by the RSPB lies about 1.7 km downstream of the site on the right (south) bank of the River Dearne. Bolton Ings is another nature reserve recently acquired by the RSPB which lies on the left (north) bank of the River Dearne opposite Old Moor.

2.11 Summary of Site Sensitivity

The sensitivity of each of the identified receptors in the vicinity of the site to contamination is summarised in Table 2-4.

Table 2-4 Sensitivity of environmental receptors in the vicinity of the site

Receptor Type	Receptor	Sensitivity	Reasoning

Groundwater	Secondary A Aquifer (Alluvium)	Moderate	The alluvium may store and transmit reasonable volumes of groundwater. The superficial aquifer is reasonably vulnerable to contamination as the deposits are located near to the surface and are overlain by soils of high leaching potential.
Groundwater	Secondary A Aquifer (PMCM)	Moderate	The PMCM is a Secondary A aquifer which may store and transmit reasonable volumes of groundwater. Where overlain by alluvium, the alluvium will offer some protection to the underlying PMCM.
Surface Water	River Dove and River Dearne	Moderate	Both watercourses are currently regarded as having good chemical quality, moderate ecological status and overall moderate status.
Ecology	Old Moor Nature Reserve, Bolton Ings, Wombwell Ings, Broomhill Flash	Moderate	All nature reserves provide desirable habitats for a range of wildlife, though none of the sites are nationally designated.

3 Hydrogeological Conceptual Model

The Environment Agency defines a conceptual model as "a description of how a hydrogeological system is believed to behave" and its development as "an iterative or cyclical process of development and testing in which new observations are used to evaluate and improve the model." (Environment Agency, 2002, p.4.1-2).

A conceptual model summarises our understanding of the functioning of a groundwater system and is typically presented as a schematic summary diagram with accompanying maps and explanatory text as required.

3.1 Conceptual Model of Doveside Wetland

Figure 3-1 and Figure 3-2 illustrate cross-sections of the site, and coupled with the explanatory text below summarises the hydrogeological conceptual model proposed for the site at Doveside.

Figure 3-1 North to south topographical cross-section of the site

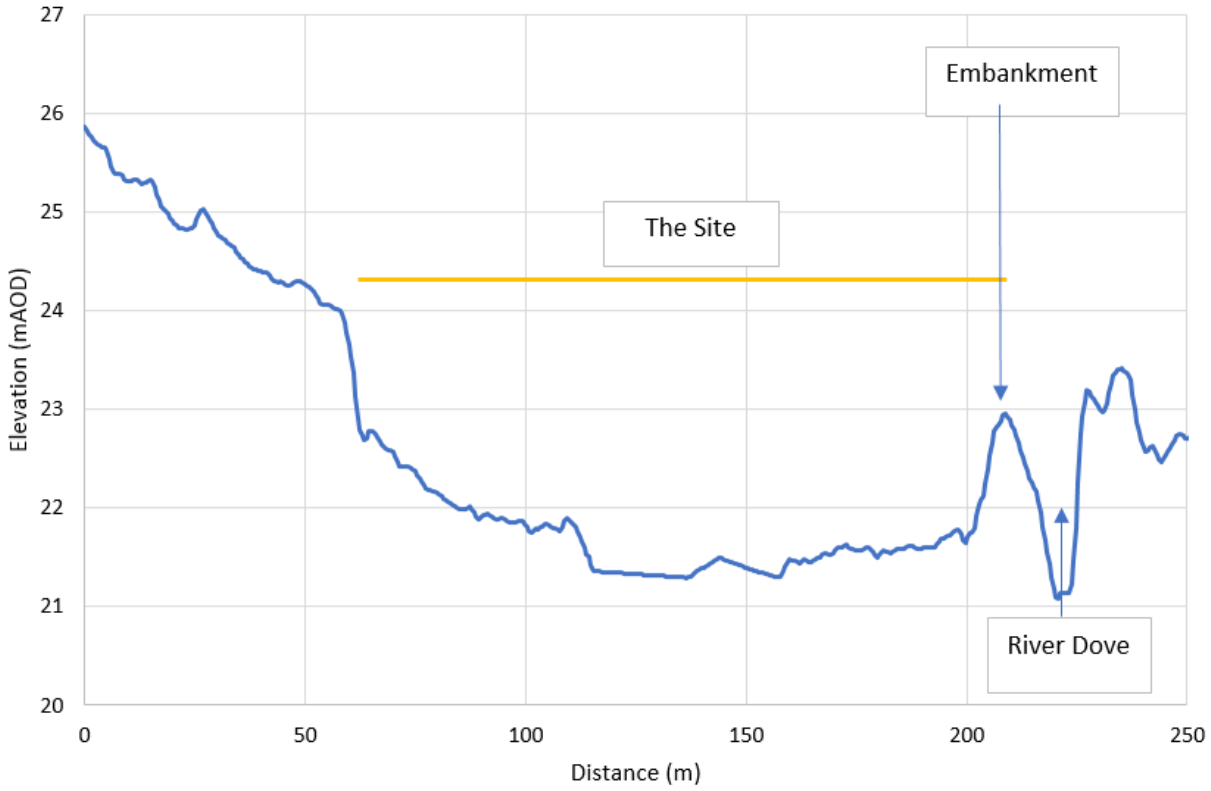
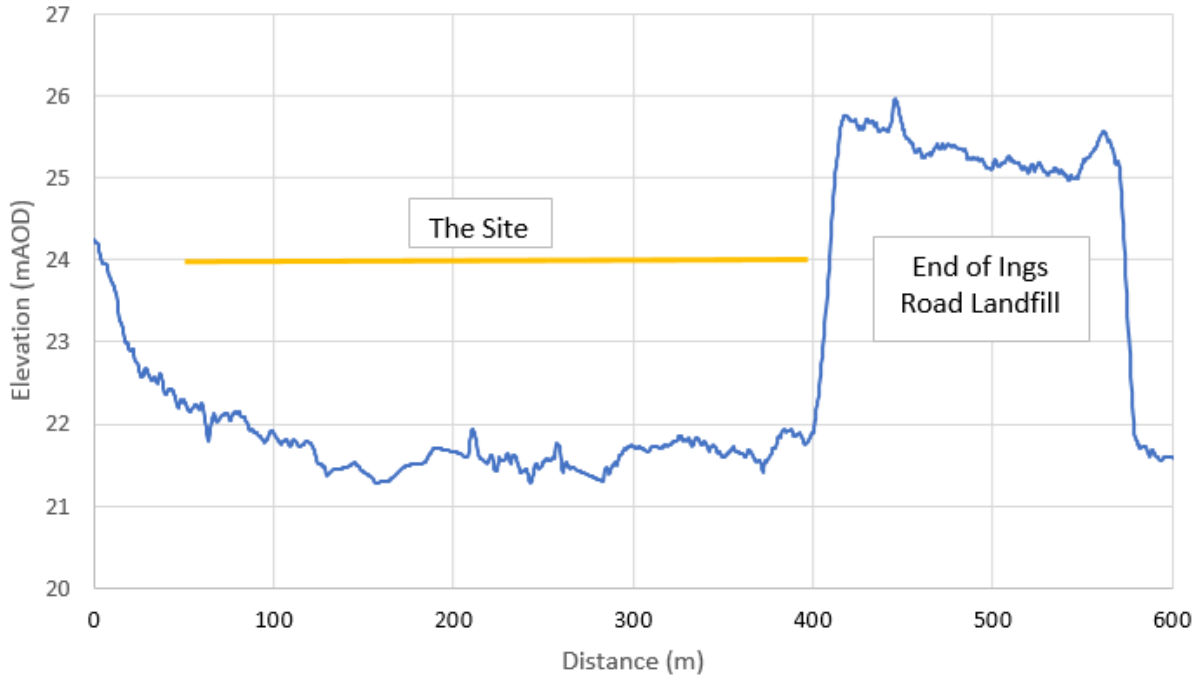


Figure 3-2 West to east topographical cross-section of the site



The main features of the conceptual model are as follows:

- The River Dove constitutes the southern boundary of the site, discharging to the River Dearne downstream of the site.
- There are three surface water discharge culverts which enter the site from its northern boundary, carrying drainage from the housing estate to the north.
- There are two open ponds and a naturally infilled pond on the site. The ponds are connected by a network of small drains. There is a culverted outfall from the on-site surface water network which discharges water to the river Dove passing through its embankment.
- The bedrock beneath the site belongs to the Pennine Middle Coal Measures Formation (PMCM) which predominantly comprises interbedded mudstone, siltstone, sandstone and commonly coal seams.
- It is proposed to develop a wetland on the site, improving the current ecological value of the site by creating reedbed and fen habitats to provide a haven for birds.
- The vast majority of the site is underlain by alluvium, the exception of which is the north of the site which is free from drift deposits.
- The ground rises towards the housing estate to the north of the site. There is a break in slope to the north of the site boundary which is likely to have been artificially created, this material may have been won from the on-site ponds.
- The superficial and bedrock deposits are all regarded as Secondary A aquifers by the Environment Agency:
    - Silt and clay alluvial deposits will typically be lower permeability with groundwater dominating in the more permeable horizons where present.
    - Groundwater within the PMCM will largely be contained within fractures and fissures.
- End of Ings Road Landfill lies immediately to the east of the site. The surface of the historical landfill site is raised significantly around the surrounding ground level and there are no records of the type of waste the site handled.

4 Preliminary Environmental Assessment

The methodology for the preliminary environmental assessment is given in Appendix C.

4.1 Identified Sources

The following sources of contamination have been identified from historic and current land uses of the site and surrounding area, their locations are indicated in Map 5:

- On site
  - Embankment in the south.
- Off site
  - Landfill sites within 1km of the site, in particular End of Ings Road Landfill which is located immediately to the east of the site;
  - Consented discharges to the River Dove upstream of the site;
  - Darfield Main Colliery and additional mine workings to the west and northwest of the site;
  - Sewage works to the south.

4.2 Pathways and Receptors

Potential receptors and possible pathways to reach these receptors are summarised below:

- Current and future site users [direct contact, inhalation, accidental ingestion];
- Groundwater (Secondary A aquifers) [migration via permeable strata];
- Surface water (River Dove and River Dearne) [overland flow, migration via drainage, baseflow];
- Ecology (Old Moor Nature Reserve, Bolton Ings, Wombwell Ings, Broomhill Flash) [Overland flow, transportation via surface water courses, migration via drainage, baseflow];

4.3 Qualitative Risk Assessment

A qualitative risk assessment has been undertaken for these potential source-pathway-receptor linkages based on DEFRA (DEFRA, 2011) and CIRIA guidance (CIRIA, 2001). This is based on consideration of both:

- The likelihood of an event (probability - takes into account both the presence of the hazard and the receptor, as well as the integrity of the pathway);
- The severity of the potential consequence (takes into account both the potential severity of the hazard and sensitivity of the receptor).

Further information of the risk assessment methodology is given in Appendix C. The preliminary qualitative risk assessment is given in Table 4-1.

Table 4-1 Preliminary Qualitative Risk Assessment

Source	Pollutant	Receptor	Pathway to Receptor	Associated Hazard [Potential Severity]	Likelihood of Occurrence	Risk
Embankment of unknown composition	Organic compounds Inorganic compounds Ammonia Metals Asbestos	Site users (current and future use)	Direct contact, inhalation, accidental ingestion	Health risk [Medium]	Likely The works will involve the creation of new culverts passing through the embankment. This may involve site workers being brought into contact with any contaminants present within the embankment.	**Moderate Risk**
		Groundwater	Migration via permeable strata	Pollution of groundwater [Medium]	Low Any earthworks have the potential to create or alter pathways from the surface/subsurface to deeper groundwater. Earthworks on site will involve shallow soil excavation and the creation of new culverts passing through the embankment which may mobilise contaminants though is unlikely to significantly alter the current scenario.	**Moderate / Low Risk**
		Surface water	Overland flow, migration via drainage, baseflow	Pollution of surface water [Medium]	Low There is potential for any contaminants exposed by earthworks on-site to be washed into the River Dove. The installation of new culverts through the embankment could introduce a new migration pathways between the embankment and the river.	**Moderate / Low Risk**
		Ecology	Overland flow, transportation via surface water courses, migration via drainage, baseflow	Pollution/ contamination of nature reserves [Medium]	Unlikely Any contaminants mobilised from the embankment could potentially migrate to nearby nature reserves via drainage from the site. However, contaminants would be subject to significant dilution and/or attenuation on their journey and contaminants are unlikely to be retained in concentrations detrimental to wildlife.	**Low Risk**
Landfill Sites - in particular End of Ings Road Landfill	Methane Carbon dioxide Organic compounds Inorganic compounds	Site users (current and future use)	Direct contact, migration of landfill gas, inhalation, accidental ingestion	Health risk [Medium]	Likely The works will involve the creation of a new drainage ditch adjacent to the End of Ings Road Landfill Site. This may involve site workers being brought into contact with contaminants though should reduce the exposure of future site users to contaminants in the future.	**Moderate Risk**

Source	Pollutant	Receptor	Pathway to Receptor	Associated Hazard [Potential Severity]	Likelihood of Occurrence	Risk
	Ammonia Metals Asbestos PCBs PAHs	Groundwater	Migration via permeable strata	Pollution of groundwater [Medium]	Low End of Ings Road Landfill was constructed prior to the introduction of landfill regulations and it is unlikely that it is lined or capped (waste can be seen in the side of the landfill on site). As a result, it is likely to be leaching contaminants to groundwater. However, the planned works will not worsen the current hydrogeological environment and as such will not increase any existing contamination risk. It is proposed to create a drain along the eastern boundary of the site to ensure groundwater levels are not raised within the adjacent landfill, as this could potentially mobilise contaminants.	**Moderate / Low Risk**
		Surface water	Overland flow, migration via drainage, baseflow	Pollution of surface water [Medium]	Low Drainage from End of Ings Road Landfill site currently enters the Doveside site from the east, flowing through the site of the proposed wetland, ultimately discharging to the Dove. It is proposed to create a new drain along the eastern edge of the site to capture drainage from the site, this will discharge directly to the Dove. The new system is not significantly different from the existing, though it may slightly reduce the potential for attenuation by eliminating flow through the pond system.	**Moderate / Low Risk**
		Ecology	Overland flow, transportation via surface water courses, migration via drainage, baseflow	Pollution/ contamination of nature reserves [Medium]	Unlikely Drainage from the End of Ings Road Landfill currently discharges to the Dove via the site. The works on site will slightly shorten this drainage network from the landfill to the Dove. However, though any contaminants which reach the Dove may reach nature reserves downstream they will still be subject to significant dilution and/or attenuation and are unlikely to be retained in concentrations detrimental to wildlife.	**Low Risk**

Source	Pollutant	Receptor	Pathway to Receptor	Associated Hazard [Potential Severity]	Likelihood of Occurrence	Risk
Consented discharges to the River Dove	Fuels/ hydrocarbons Metals Polycyclic aromatic hydrocarbons (PAHs) Organic compounds	Site users (current and future use)	Direct contact, inhalation, accidental ingestion	Health risk [Mild]	Unlikely The proposed works will create two points at which high flows within the Dove can spill into the site, meaning any contaminants within the river will be able to reach the site. However, as the system is designed to allow water onto the site during high flow periods only, any contaminants will be substantially diluted and are unlikely to be present in quantities that could be detrimental to human health.	**Very Low Risk**
		Groundwater	Migration via permeable strata	Pollution of groundwater [Medium]	Unlikely There is potential for contaminants to be transported to the site via drainage where they could potentially migrate to ground via the proposed wetland. However, the proposed works will not alter the existing threat to groundwater which is likely to be limited given the potential for dilution and attenuation of contaminants within the River Dove.	**Low Risk**
		Surface water	Overland flow, migration via drainage, baseflow	Pollution of surface water [Medium]	Unlikely The discharges presently discharge directly to the River Dove. The works on site will not alter the current mechanism.	**Low Risk**
		Ecology	Overland flow, transportation via surface water courses, migration via drainage, baseflow	Pollution/ contamination of nature reserves [Medium]	Unlikely There is potential for contaminants to reach the nature reserve via surface water courses. Though as the discharges are already being discharged directly to the Dove the works will not alter the existing flow pathway.	**Low Risk**
Darfield Main Colliery and additional mine workings	Organic compounds Inorganic compounds Metals and metal compounds	Site users (current and future use)	Direct contact, inhalation, accidental ingestion	Health risk [Mild]	Unlikely Contaminants associated with mining could be transported to the site via groundwater flow or drainage, though contaminants will be subject to dilution and attenuation on this journey. The end land use of the site as a wetland means site users will be visitors to the site and are therefore unlikely to suffer any long-term exposure to any contaminants mobilised to site.	**Very Low Risk**

Source	Pollutant	Receptor	Pathway to Receptor	Associated Hazard [Potential Severity]	Likelihood of Occurrence	Risk
		Groundwater	Migration via permeable strata	Pollution of groundwater [Medium]	Unlikely Contaminants from mine workings could migrate towards the site via groundwater, though they would be subject to attenuation within the aquifer and the proposed works on site will have no impact upon this existing contamination pathway.	**Low Risk**
		Surface water	Overland flow, migration via drainage, baseflow	Pollution of surface water [Medium]	Unlikely Contaminants from mine workings could migrate towards the River Dove via drainage or baseflow, though they would be subject to attenuation and dilution within the aquifer/watercourses, and the proposed works will have no impact upon these pre-existing pathways.	**Low Risk**
		Ecology	Overland flow, transportation via surface water courses, migration via drainage, baseflow	Pollution/ contamination of nature reserves [Medium]	Unlikely Contaminants from mine workings could migrate towards nature reserves via drainage or baseflow, though they would be subject to attenuation and dilution within the aquifer/watercourses, and the proposed works will have no impact upon these pre-existing pathways.	**Low Risk**
Sewage Works to the south	Metals, metalloids and their compounds Inorganic compounds Acids/alkalis Asbestos Organic compounds Micro-organisms (pathogens) Methane Carbon dioxide Hydrogen sulphide	Site users (current and future use)	Direct contact, inhalation, accidental ingestion	Health risk [Mild]	Unlikely Contaminants associated with the sewage works could migrate towards the Dove via baseflow meaning there is some limited potential for contaminants to reach the site at peak flows. If contaminants were to reach the site, they would do so in very low volumes that are highly unlikely to be detrimental to human health.	**Very Low Risk**
		Groundwater	Migration via permeable strata	Pollution of groundwater [Medium]	Unlikely Contaminants from the sewage works could migrate to groundwater but are unlikely to reach the site as groundwater will likely discharge to the River Dove. Any contaminants will be subject to attenuation and dilution within the aquifer/watercourse and the works on site will not impact this pre-existing pathway.	**Low Risk**

Source	Pollutant	Receptor	Pathway to Receptor	Associated Hazard [Potential Severity]	Likelihood of Occurrence	Risk
		Surface water	Overland flow, migration via drainage, baseflow	Pollution of surface water [Medium]	Unlikely Contaminants from the sewage works could migrate to the River Dove via drainage or baseflow, but contaminants will be subject to attenuation/dilution and the works on-site will not alter this pre-existing pathway.	**Low Risk**
		Ecology	Overland flow, transportation via surface water courses, migration via drainage, baseflow	Pollution/ contamination of nature reserves [Medium]	Unlikely Contaminants from the sewage works could migrate towards nature reserves via drainage or baseflow, though they would be subject to attenuation/dilution and the works on-site would not alter this pre-existing pathway.	**Low Risk**

5 Conclusions and Recommendations

5.1 Conclusions

The following conclusions can be drawn from the desk-based environmental risk assessment undertaken for the site under present site conditions:

- The risk to site users from both current and historic use of the site and surrounding area is assessed as being **Very Low to Moderate**. The moderate risk to site users relates to the embankment on-site and End of Ings Landfill to the east of the site. This exposure pathway relates principally to the construction workforce involved in the development of the site.
- The risk to groundwater from both current and historic use of the site and surrounding area is assessed as being **Low to Moderate/Low**. The moderate/low risk is associated with the embankment on site and End of Ings Landfill to the east.
- The risk to surface water from both current and historic use of the site and surrounding area is assessed as being **Low to Moderate/Low**. The moderate/low risk is associated with the embankment on site and End of Ings Landfill to the east.
- The risk to ecology from both current and historic use of the site and surrounding area is assessed as being **Low**.

5.2 Recommendations

The contamination risk associated with the site is generally found to be very low - low, but there is some moderate/low and moderate risk associated with End of Ings Road Landfill site to the east of the site and the embankment on site. The proposed works are unlikely to significantly change any contamination pathways long-term, though there are risks associated with the embankment and the landfill site during the construction period. The nature of the waste deposited within the landfill and embankment is not known but waste materials were observed in the side of the landfill bordering the site and within the embankment. If this material contains pollutants, they are likely to be migrating into the site.

In order to determine the degree to which the site is, if at all, contaminated it is recommended that a site investigation and appropriate chemical sampling be undertaken in the south and east of the site focusing on the two areas of the site highlighted as potentially having a contamination risk. The ground investigation should incorporate trial pitting along the eastern boundary of the site in the location of the proposed drain and bund. As well as either trial pitting or hand augering/digging (should trial pitting not be possible) within the embankment.

Appendices

A Maps

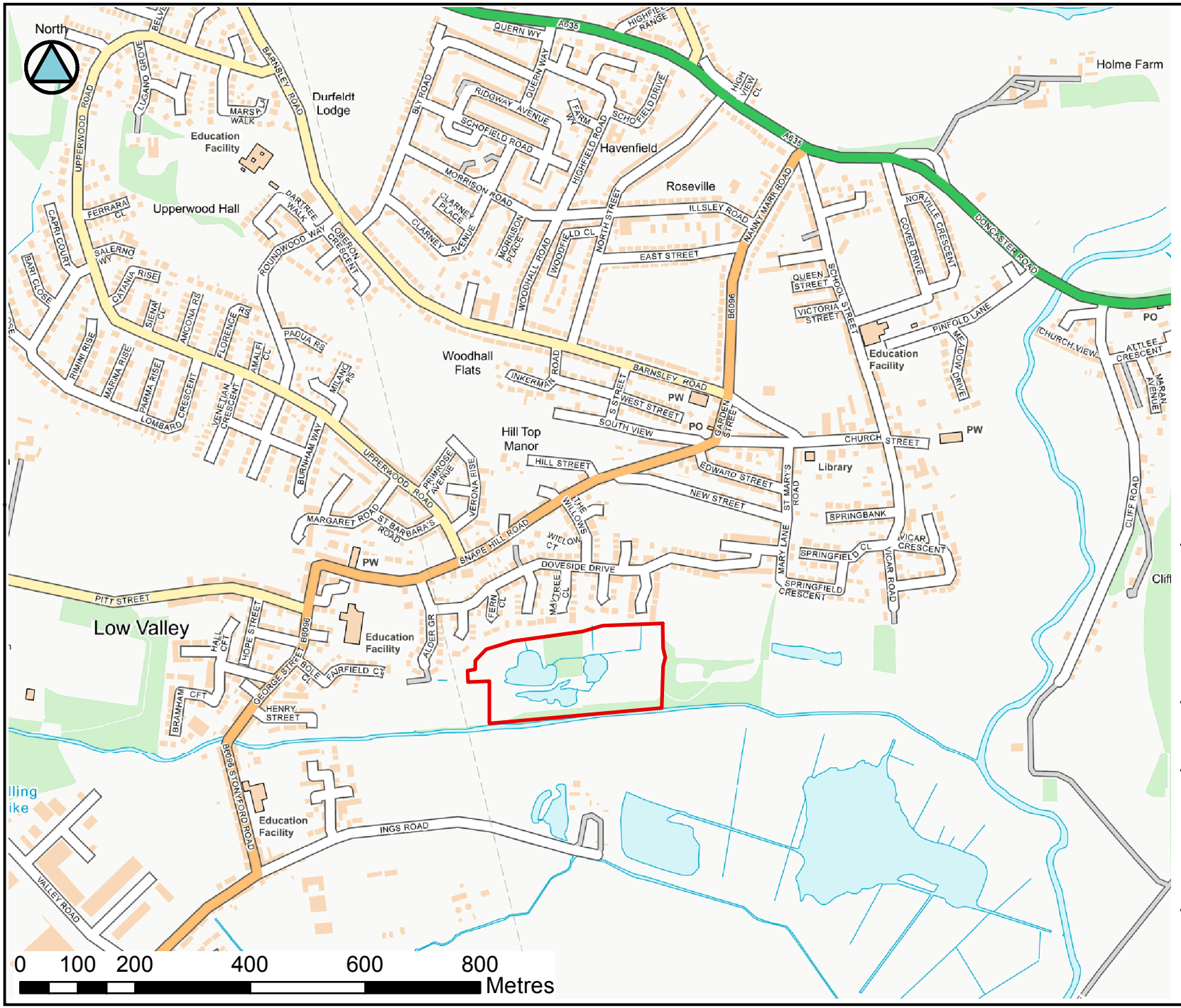
Map 1 Site Location

Map 2 Site Topography

Map 3 Superficial (Drift) Geology

Map 4 Bedrock Geology

Map 5 Potential Sources of Contamination

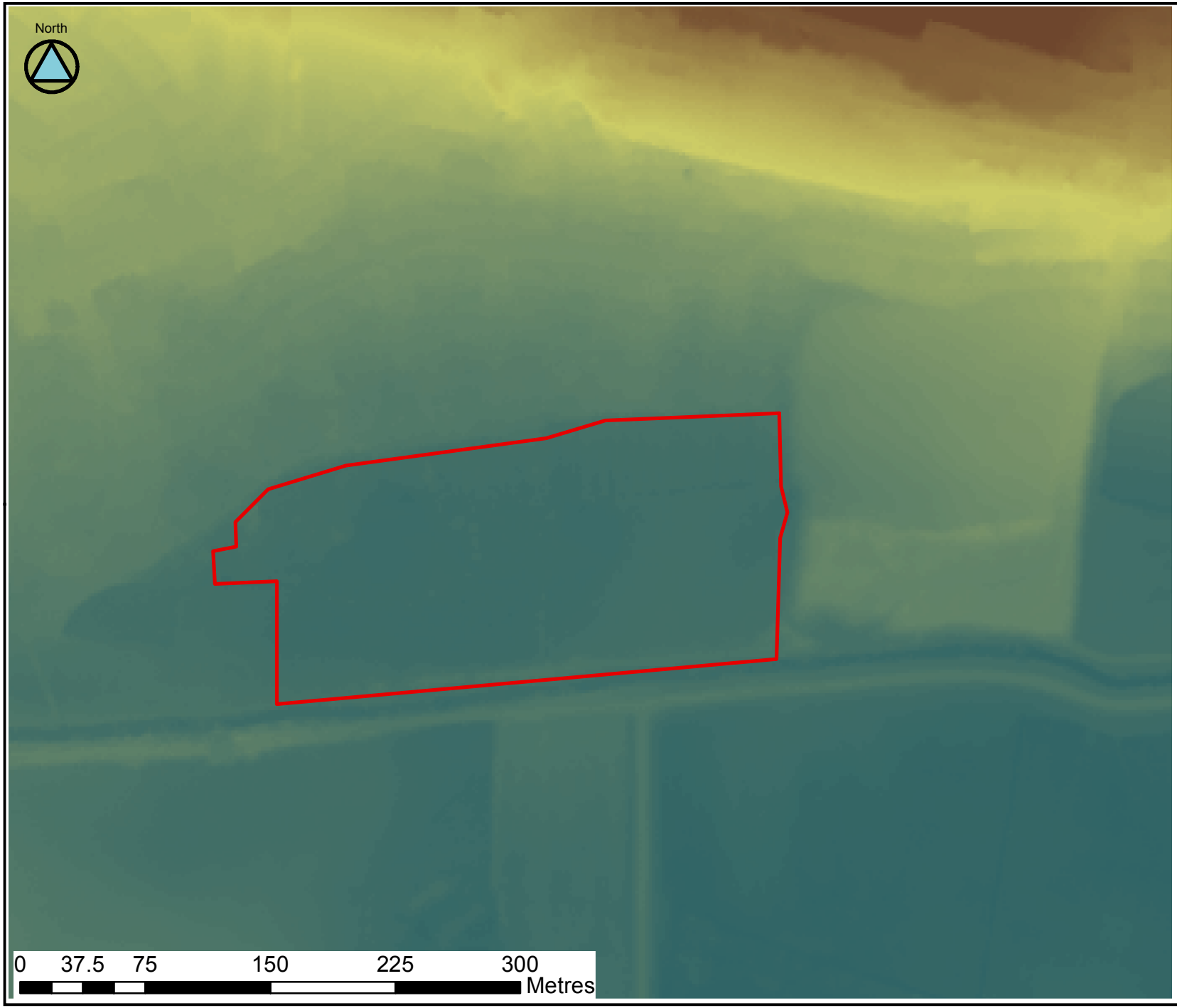


LEGEND

Site Boundary

JBA consulting

Map 1
Site Location



LEGEND

Site Boundary

LIDAR

Elevation mAOD

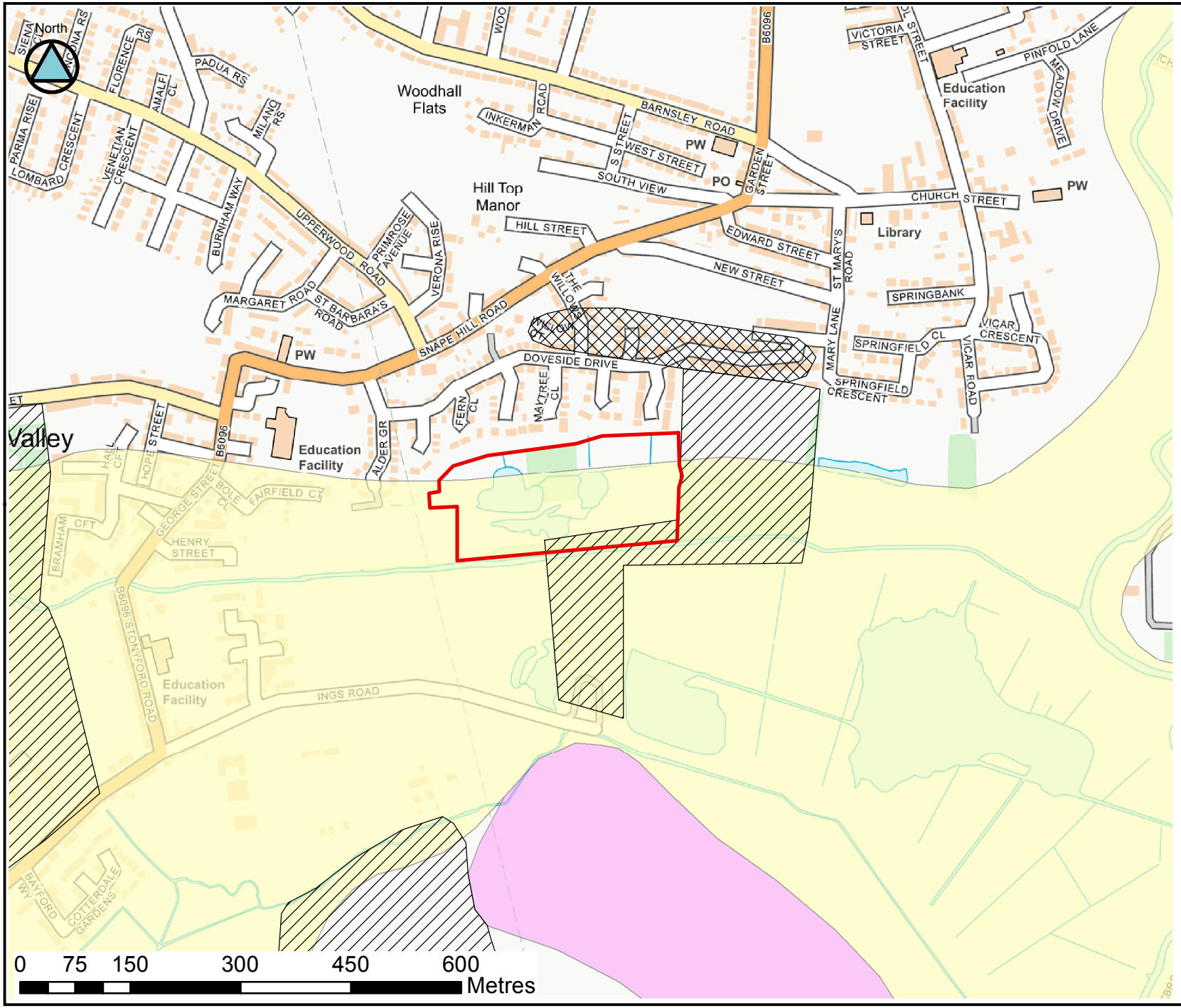
High : 59.415

Low : 20.38

JBA consulting

Map 2

Site Topography



LEGEND

Site Boundary

Geology

Artificial Ground

- INFILLED GROUND
- MADE GROUND (UNDIVIDED)
- WORKED GROUND (UNDIVIDED)

Geology

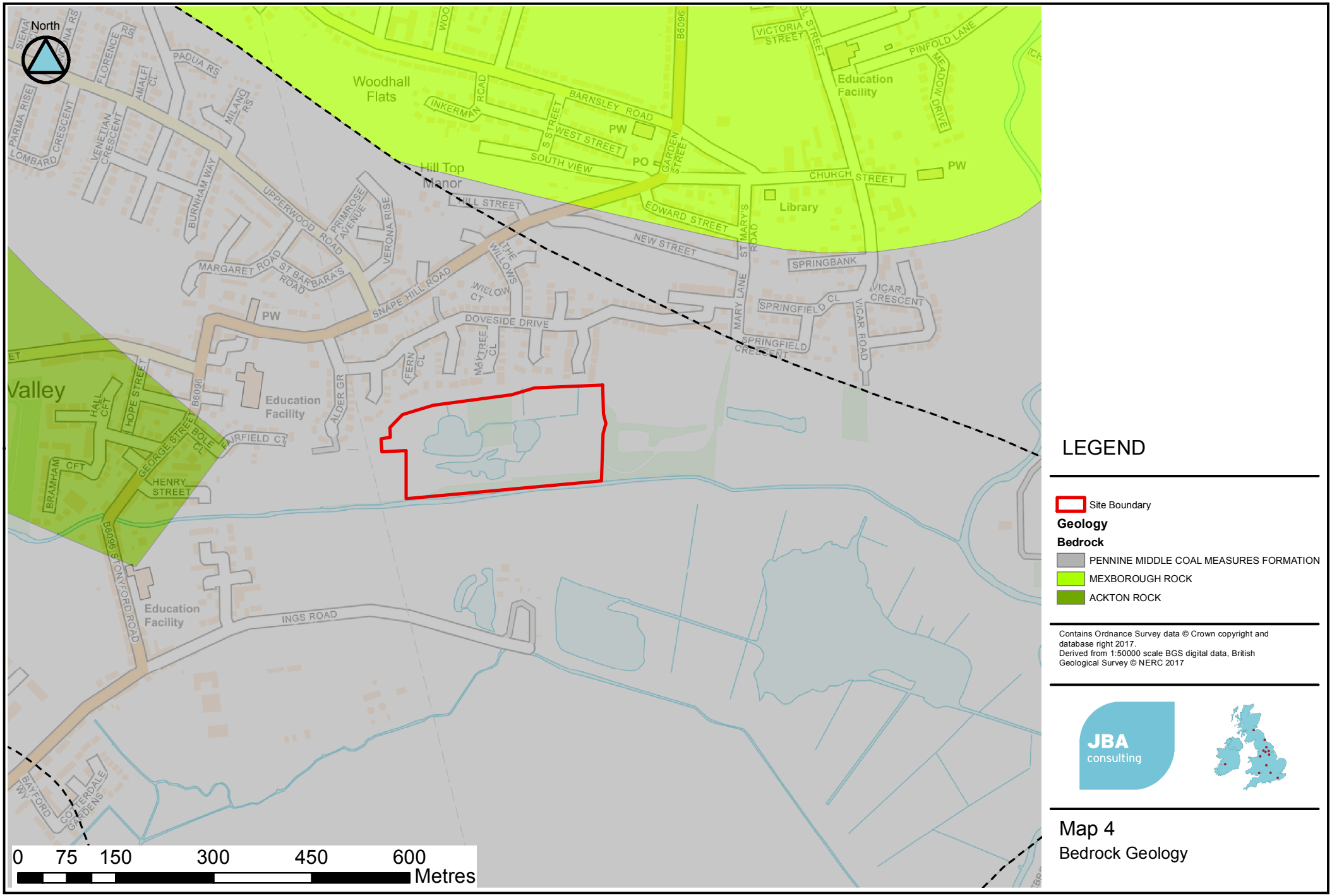
Superficial

- ALLUVIUM
- GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE

JBA consulting

Map 3

Superficial (Drift) Geology



LEGEND

Site Boundary

Geology

Bedrock

- PENNINE MIDDLE COAL MEASURES FORMATION
- MEXBOROUGH ROCK
- ACKTON ROCK

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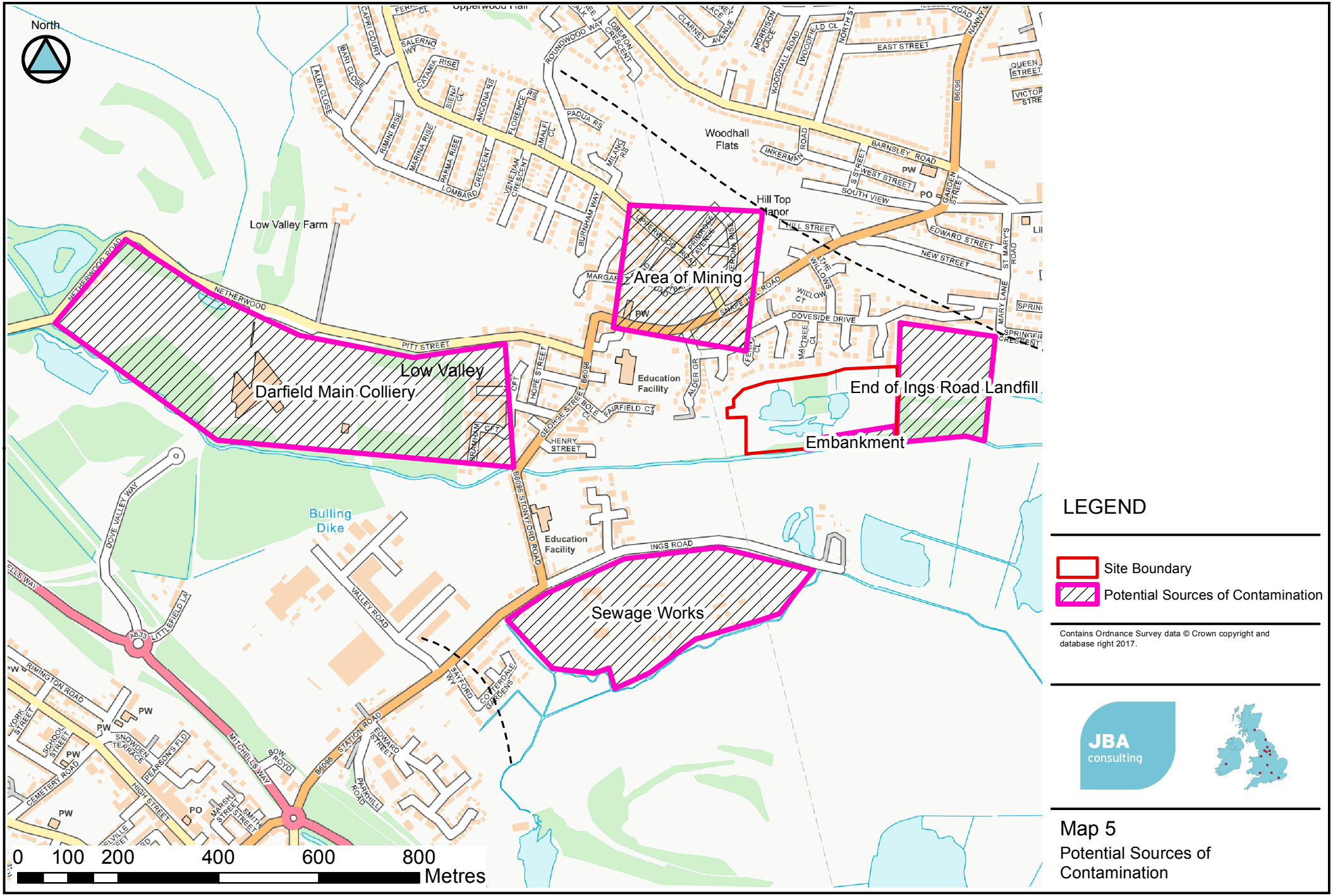
Map 4

Bedrock Geology



LEGEND

- Site Boundary
- Potential Sources of Contamination

JBA consulting

Map 5

Potential Sources of Contamination

B Envirocheck Report

C Methodology for Preliminary Environmental Assessment

Site History

Ordnance Survey maps of Britain are available from the late 1880s to the present time. These maps provide an excellent record of historical uses of a site. This can be very important in assessing the potential for environmental liabilities associated with a site, since the site owner may be held responsible for historic pollution which could be released, even if it is not caused by current activities operating on the site. Historical maps can show if the facility was, for example, the location for a former industrial site, mineral working or landfill.

Historic map extracts supplied by Landmark were reviewed. Details of the maps studied are contained in Appendix B.

Site Sensitivity

The vulnerability of the site with respect to the potential for contamination of the surface and subsurface aqueous environments was assessed using British Geological Survey (BGS) data and Environment Agency (EA) data on groundwater and surface water sensitivity. With respect to groundwater, and wherever possible surface water, likely receptors in the form of abstractions have been obtained from Landmark (Envirocheck report contained in Appendix B). Information, pertaining to the classification of the aquifer, nature and direction of groundwater flow, distance to licensed abstractions, nature of overlying strata and whether the site was located within a groundwater protection zone was sought from EA and available map information from the BGS, in order to determine the hydrogeological sensitivity. The 1:25,000 Ordnance Survey sheet for the area was used to determine the location of surface watercourses, the quality of which were then determined through consultation with EA data. The combination of distance to the watercourse and its quality were used to assess its sensitivity to pollution. Based on all the available information a summary assessment of vulnerability to contamination of surface and sub-surface waters was made.

Public Registers

In relation to this site, and due to the time constraints of this exercise, the information from the public register was accessed from a commercially available database operated by Landmark. The data supplied covers a 1 km buffer area around the site boundary. This is the only method by which the required information can be gathered in the time available. This database contains the information supplied to it by EA, and the other statutory authorities; however, for the purposes of this report JBA does not accept any liability for the accuracy or otherwise of the information obtained from Landmark.

Qualitative Risk Assessment Methodology

Risk assessment is the process of collating known information on a hazard or set of hazards in order to estimate actual or potential risks to receptors. The receptor may be human health, a water resource, a sensitive local ecosystem or even future construction materials. Receptors can be connected with the hazard under consideration via one or several exposure pathways (e.g. the pathway of direct contact). Risks are generally managed by isolating or removing the hazard, isolating the receptor, or by intercepting the exposure pathway. Without the three essential components of a source (hazard), pathway and receptor, there can be no risk. Thus, the mere presence of a hazard at a site does not mean that there will necessarily be attendant risks. The following risk assessment thus focuses on those parts of the site where hazards or potential hazards have been identified and is not general to the whole site.

Hazards

Potential sources of contamination are identified for the site, based on a review of the current and previous site uses. Not only the nature but also the likely extent of any contamination is considered, e.g. whether such contamination is likely to be localised or widespread.

Receptors

The varying effects of a hazard on individual receptors depends largely on the sensitivity of the target. Receptors include any people, animal or plant population, or natural or economic resources

within the range of the source which are connected to the source by the transport pathway. Receptors can, in addition, extend to remediation processes and future construction materials that may be adversely affected by on-site contamination. In general, however, receptors can be divided into a number of groups dependant on the final use of the site.

Pathways

The mere presence of contamination does not infer a risk. The exposure pathway determines the dose delivered to the receptor and the effective dose determines the extent of the adverse effect on the receptor. The pathway which transports the contaminants to the receptor or target generally involves conveyance via soil, water or air.

Exposure Assessment

By considering the source, pathway and receptor, an assessment is made for each contaminant on a receptor by receptor basis with reference to the significance and degree of the risk. In assessing this information, a measure is made of whether the source contamination can reach a receptor, determining whether it is of a major or minor significance. The exposure risks are assessed against the present site conditions. The assessment of risk presented here has been based upon the procedure outlined in DEFRA Circular 01/2006. In addition, DEFRA, with the Collaborative Centre of Excellence in Understanding and Managing Natural and Environmental Risks, Cranfield University, has published guidance on risk assessment (Guidelines for Environmental Risk Assessment and Management). A guide to good practice for contaminated land risk assessment has also been produced by CIRIA (CIRIA C552 2001). This guidance from DEFRA and CIRIA states that the designation of risk is based upon a consideration of both:

- The likelihood of an event (probability); [takes into account both the presence of the hazard and receptor and the integrity of the pathway].
- The severity of the potential consequence [takes into account both the potential severity of the hazard and the sensitivity of the receptor].

Table A 1 provides a classification of the potential severity of contamination risks occurring at the site.

Table A 1 Classification of Associated Hazard [Potential Severity] (modified from CIRIA C552)

Classification	Associated Hazard [Potential Severity]
Severe	Short-term (acute) risks to human health likely to result in significant harm. Short-term risk of pollution to a sensitive water resource or ecosystem. Catastrophic damage to crops/buildings/property/infrastructure, including off-site soils. Short-term risk to a particular ecosystem or organism forming part of such an ecosystem.
Medium	Chronic damage to human health. Risk of pollution of sensitive water resource or ecosystem. Significant change in a particular ecosystem. Significant damage to crops/buildings/property/infrastructure (on or off-site). Contamination of off-site soils.
Mild	Pollution of non-sensitive water resources. Significant damage to crops/buildings/property/infrastructure (on or off-site).
Minor	Harm, although not necessarily significant harm which may result in a financial loss. Easily preventable, non-permanent health effects on humans, or no effects. Easily repairable damage to crops/buildings/property/infrastructure.

Table A 2 outlines the probability of contamination risks classifications used within this assessment. Where no pollution linkage occurs, there is no likelihood of contamination risk.

Table A 2 Classification of Probability

Classification	Definition of Probability
High	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or 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	There is a pollution linage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linage but circumstances are such that it is improbable that an event would occur even in the very long-term.

Once the classification of consequence and probability has been assigned to a pollution linkage, the risk associated with it can be evaluated. Table A 3 shows how a risk category is assigned based on the consequence and probability. Definitions of each risk category and the investigation actions that are likely to be necessary in each case are given in Table A 4. These definitions and the risk matrix are based upon CIRIA C552.

Table A 3 Contamination Risk Matrix

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	Highly Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate/ Low Risk
	Likely	High Risk	Moderate Risk	Moderate/ Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/ Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/ Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table A 4 Description of the risk classifications and likely action required

Risk Category	Definition and likely actions required
Very high	There is a high probability of severe harm to a defined receptor, or there is evidence that severe harm is currently taking place. The risk is likely to result in a substantial liability. Urgent investigation (if not already undertaken) and remediation is likely to be required.
High	Harm to a designated receptor is likely. The risk, if realised, is likely to present a substantial liability. Urgent investigation (if not already undertaken) is likely to be required.
Moderate	Harm to a designated receptor is possible. However, it is either relatively unlikely that the harm would be severe, of if any harm were to occur it is more likely that the harm would be relatively mild. Investigation is likely to be required to clarify the level of potential liability and risk.
Low	Harm to a designated receptor is possible, but is likely to be mild at worst. Further investigation is not required at this stage.
Very low	There is a low possibility of harm to a designated receptor occurring, and if it were to be realised it would be likely to be mild at worst. Further investigation is not required at this stage.

Offices at
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Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
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Skipton
Tadcaster
Thirsk
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