

REPORT

Castlefield Viaduct, Manchester

Land Quality Desk Study and Preliminary Risk Assessment Report

Client: National Trust

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Executive Summary

Royal HaskoningDHV has been commissioned by the National Trust (the Trust) to undertake a Land Quality Desk Study and Preliminary Risk Assessment (PRA) for Castlefield Viaduct, Manchester. The PRA will inform proposals to repurpose the historic viaduct structure into an elevated urban park with integrated active travel hub.

The Trust's vision is for the urban park to be utilised in a variety of ways, ranging from exhibitions, fruit and vegetable growing, sculptures, work space, onward travel information, community meeting and green space. A Phase 1 Pilot Scheme 'micro park' will be delivered on the eastern section of the viaduct, for a 12 week period in the summer of 2021. The temporary scheme will be undertaken to test the design possibilities and opportunities at the viaduct and generate momentum and support for the proposed scheme.

Castlefield Viaduct is a Victorian railway viaduct built in 1893, located in Castlefield within Manchester City Centre. It is located approximately 200m west of Castlefield Train Station and 800m west of Manchester Oxford Road Train Station. The viaduct is currently unused and the land below, and surrounding the viaduct, comprises a canal basin, tow paths, car parks, a railway line and roadways. Land surrounding the viaduct is dominated by blocks of residential flats, a youth hostel, former warehouses and industrial buildings repurposed as offices, residential and gallery use. Open space and restaurants are located along wharf areas of the canal basin.

The railway is recorded as being dismantled in the late 1960s. The land underlying the viaduct was historically occupied by a roman fort, timber wharf, canal network and warehouses. The area surrounding the site has a long industrial history including use as railways, quaysides, wharfs, garages, gravel and sand pits, dye works, chemical works, paper mills, gas works and an abattoir.

Information provided by the British Geological Survey (BGS) indicates that the land below the viaduct is underlain by bedrock of the Chester Pebble Bed Formation which is classified as a Principal Aquifer.

Potential sources of contamination on the viaduct were identified as comprising railway land (ballast) and paint from the viaduct structure which may contain contaminants including metals, asbestos, phenols, sulphates, Polycyclic Aromatic Hydrocarbons (PAHs), fuel oils, lubricating oils, greases and herbicides. Below the viaduct and in the surrounding area, potential sources of contamination comprise Made Ground associated with demolished buildings, a timber yard and scrap metal yard, dockyards, an abattoir, silk and cotton mills, paper mills, automobile engineering works, iron works, smithy, fibreboard container factory, cleansing depot, concrete depot and a garage.

In relation to the use of the site as an urban park and transport hub, following permanent redevelopment of the site a moderate risk to human health of future site users has been identified as requiring further investigation to quantify whether this presents a development constraint.

1 Introduction

Royal HaskoningDHV has been commissioned by the National Trust (the Trust) to undertake a Land Quality Desk Study and Preliminary Risk Assessment (PRA) for Castlefield Viaduct, Manchester, M3 4RU, centred at Ordnance Survey National Grid Reference (NGR) 383005, 397626 (herein referred to as the 'site'). The PRA will inform proposals to develop the historic viaduct structure into an elevated urban park with integrated active travel hub. A site location plan is provided in Figure 1.1, at the end of this report.

1.1 Proposed Scheme

Castlefield Viaduct is an unused, 330m long, historic structure in the heart of Manchester. The Trust wish to bring the viaduct back into use by repurposing the structure into an elevated urban park and integrated active travel hub. The Trust's vision is for the urban park to be utilised in a variety of ways, ranging from exhibitions, fruit and vegetable growing, sculptures, work space, onward travel information, community meeting and green space.

A Phase 1 Pilot Scheme 'micro park' will be delivered on the eastern section of the viaduct, for a 12 week period in the summer of 2021. The temporary scheme will be undertaken to test the design possibilities and opportunities at the viaduct and generate momentum and support for the permanent scheme. The temporary scheme will comprise the use of the viaduct as a 'micro park' for community events and organised walking tours. An architectural narrative booklet has been produced for the scheme, referred to as the Castlefield Story Book by Twelve Architects in July 2020, and visualisations included within the booklet indicate installation of a footpath across parts of the viaduct, the erection of weather shelters and placement of planting containers.

The Phase 2 'permanent urban park and travel hub scheme' will comprise a permanent development on the viaduct inclusive of food and beverage stands, garden areas, exhibition stalls, seating areas, an events space and toilet facilities.

Figure 1.2 illustrates the Castlefield Viaduct site boundary.



The overall objectives of the PRA are as follows:

- To assist in meeting the objectives stated in Section 1.2, the scope of the project comprises:

- a site walkover survey to document the current land use and site setting;
- purchase and review a Groundsure Insights Report including historical maps to identify former land uses and potential contaminative activities on and surrounding the site;
- a review of publicly available regulatory databases and information relating to hydrogeological features, hydrogeology, land use, ecologically sensitive areas and geology to establish the environmental setting of the site and sensitivity of the location;
- the development of a preliminary CSM following a source-pathway-receptor contaminant linkage approach; and,
- provision of an outline of the environmental risks with regard to ground and groundwater, which may potentially arise as liabilities or constraints associated with the site.

1.4 Legislative Context and Guidance

The assessment was undertaken in the legislative context of:

- Part 2A of The Environmental Protection Act (1990); and,
- The National Planning Policy Framework (NPPF) (2012).

The following good practice and statutory guidance were considered, and the assessment was undertaken in general accordance with:

- Environment Agency (EA) 'Land Contamination: Risk Management Framework', May 2020;
- Manchester City Council 'Planning Guidance in Relation to Ground Contamination: Guidance Note for Applicants, Developers, Land Owners and Consultants, September 2016;
- British Standard 'Investigation of Potentially Contaminated Sites – Code of Practice', BS EN 10175:2011;
- Department of Environment Food and Rural Affairs (Defra) 'Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance', PB13735 (2012);
- British Standard 'Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds (VOCs)', BS 8576:2013;
- British Standard 'Code of Practice for Ground Investigations', BS 5930:2015;
- 'The Environment Agency's Approach to Groundwater Protection', February 2018, and,
- CIRIA 'Contaminated Land Risk Assessment – A Guide to Good Practice', C552 (2001).

1.5 Sources of Information

The following sources of information have been reviewed to inform the PRA:

- Groundsure Insights Report (2021) comprising historical maps, environmental sensitivity data and permitting records for a search area of 1km around the site boundary (reference number: GS-7712233);
- Groundsure Preliminary Unexploded Ordnance Risk Assessment (2021) (reference number: GS-7712199);
- The Coal Authority (2021) Consultants Coal Mining Report (reference: 51002453805001);
- British Geological Survey (BGS) Onshore GeoIndex Viewer;
- BGS Hydrogeological Map of Clwyd and the Cheshire Basin (Sheet No. 19), 1989;
- BGS Manchester Bedrock Map (Sheet number 85), 2010;
- BGS Manchester Bedrock and Superficial Map (Sheet number 85) 2011;
- Multi Agency Government Information for the Countryside (MAGIC) map application;
- Blue line boundary plan, Ref. 3586, provided by the Trust;
- Castlefield Viaduct Appendix A, National Trust, February 2021;
- Castlefield Viaduct story book architectural narrative booklet by Twelve Architects, July 2020; and,
- Castlefield Viaduct phase two temporary scheme specification v1.0 by Twelve Architects.

A site walkover survey was also undertaken on the 19th April 2021 by a Royal HaskoningDHV Environmental Consultant to verify current conditions at the site. The relevant findings and photographs of the site walkover are provided in Appendix A and incorporated into this report.

2 Site Setting

2.1 Site Location and Description

Castlefield Viaduct is a Victorian railway viaduct built in 1893, located in Castlefield within Manchester City Centre. It is located approximately 200 metres (m) west of Castlefield Train Station and 800m west of Manchester Oxford Road Train Station. The viaduct is owned by the Department for Transport and is currently unused.

The viaduct is linear in shape, being approximately 330m in length and approximately 14m wide, comprising eight spans. The viaduct is raised off the ground by approximately 16m. It is constructed predominantly of wrought iron/ steel and has decorative castellations along its length. Behind the castellations are bearing plates that support the end posts of 16 trusses, the longest of which reaches 53m. The viaduct is a Grade II listed structure.

The top of the viaduct is accessed by foot from Deansgate-Castlefield car park via a locked gate on the eastern site boundary (see Plate 1, Appendix A). Vehicular access to the Deansgate-Castlefield car park is made via a ramp off Albion Street. The ground surface of the car park is approximately 0.5m higher in elevation than the viaduct surface and there is a step down to the viaduct at the gate. There is no vehicular access onto the viaduct. Access onto the site by vehicles from Deansgate-Castlefield car park is prevented by a vehicle restraint system (VRS) barrier present along the eastern site boundary shared with Deansgate-Castlefield car park. If the VRS was removed, access by vehicles would be prevented due to the ground elevation difference between the car park and viaduct.

Historically, three railway tracks ran across the viaduct carrying trains in and out of Manchester Central Station. Today, the railway tracks are no longer evident and the surface of the viaduct is covered by a layer of railway ballast and vegetation.

The land below the viaduct is occupied by land parcels, roads, canals and a railway line as follows:

- Castle Street, a cobblestone road, is present beneath the eastern part of the viaduct and is oriented north to south.
- Duke Street is also located below the eastern part of the viaduct oriented in an east to west direction. Duke Street joins Castle Street at a T junction beneath the viaduct.
- The Bridgewater Canal Tow Path is present beneath the eastern part of the viaduct roughly orientated north to south. The tow path connects Castle Street to the wharfs that surrounding the canal network and canal basin, part of which is also below the viaduct. The tow path also leads to Castlefield Bowl which is an outdoor events area approximately 80m north of the viaduct.
- The Bridgewater Canal and two basins, which feed into the canal, are present below the length of the viaduct, orientated east to west. Two footbridges which cross the canal basin are also located below the viaduct (see Plate 5, Appendix A);
- A railway line runs below the eastern part of the viaduct (see Plate 2, Appendix A) towards Deansgate Station.
- Slate Wharf Bridge is also present beneath the western part of the viaduct which connects the Bridgewater Canal Tow path to Potato Wharf, located approximately 20m to the north of the viaduct.

The land parcels below the viaduct are owned by the following parties (moving west to east along the viaduct):

- Lend Lease Residential (NW) Ltd at the western end of the viaduct;
- Pemberstone Reversions Ltd; and,
- The Council & City of Manchester.

A site layout plan is provided in Figure 2.1, at the end of this report.

2.2 Site Walkover Survey

A site walkover was carried out by Royal HaskoningDHV on the 19th April 2021, a summary of the findings of the site walkover and photographs are presented in Appendix A, notable observations were:

- The railway which runs below the viaduct is supported by a brick structure (Plates 2 and 4, Appendix A);
- There is a staircase and lift on the northern side of the viaduct which provides access to Deansgate-Castlefield car park and the viaduct by foot (Plate 6, Appendix A);
- The ballast across the surface of the viaduct undulates by up to 0.2m in height and the average thickness of ballast is estimated to be 0.3m. The ballast is covered in vegetation comprising moss, plants and shrubs (Plates 12 to 15, Appendix A). Evidence of vegetation clearance along the top of the viaduct was observed. Windblown litter was present in and amongst the ballast. No observations were made on site of wooden railway sleepers associated with the railway lines which historically ran across the viaduct.
- The viaduct structure appears to be in a state of disrepair with heavy corrosion (rust) observed in places. Flakes of paint and metal fragments were observed on the surface of the ballast which were between 1cm to 15cm in length. These appear to have originated from the overhead metal beams that cross the viaduct. Patches of a bitumen/tar were also observed across the viaduct surface, approximately 2cm to 40cm in width. Scaffolding was also present along parts of the viaduct structure.
- A series of drainage grids were observed along the viaduct. They comprised six grids or sunken circular dips in the ballast, approximately 40cm in diameter. The grids were in a row with equal spacing in a north-south direction. In some locations, a metal channel below the base of the viaduct platform could be seen below the metal grids which water falls into. Downspouts were observed on most of the supporting columns which connected to covered grids at ground level below the viaduct. Standing water was observed in some lengths of metal 'I' beam structure on the eastern and western sides of the viaduct. There was evidence of water pooling at the surface of the viaduct, as patches of algae and mosses were observed indicating the surface water does not drain readily away from the structure.
- A concrete conduit with electricity cables was observed along part of the northern boundary of the viaduct. This was in poor condition with some concrete slabs missing and broken. Water collected in part of the viaduct structure on the southern and northern boundaries of the structure, indicating the drainage on the viaduct may be ineffective in some areas, as shown in Plate 17.
- A metal structure of unknown use is attached to one of the overhead beams on the southern side and eastern area of the viaduct, shown in Plate 11.
- There was evidence of a trespasser using the site, a tent and sleeping bag were observed in the eastern part of the site.

- Construction works were observed below and to the north of the viaduct. The works below the viaduct comprised the erection of wooden kiosks for outdoor food and beverage stalls. Construction of residential flats was taking place to the north west of the viaduct.

The site layout plan is presented as Figure 2.1, at the end of the report.

2.3 Surrounding Area

The viaduct is located within a mixed use setting; land uses adjacent to the site (up to 500m) are summarised within Table 2-1 below.

Table 2-1: Current Surrounding Site Uses

Direction	Description
North	Immediately to the north of the western half of the viaduct is Potato Wharf and the Bridgewater Canal and basins. Beyond Potato Wharf are blocks of residential flats (10m from the northern site boundary) and a construction site.
	Giant's Basin is located immediately north of the centre of the site with a YHA youth hostel present on its bank, approximately 60m from the northern site boundary. Beyond the youth hostel is a railway line, orientated in a south-east to north-west direction. The railway line is located approximately 280m north of the western half of the site and travels directly under the viaduct in the eastern part of the site. Beyond the railway line are residential houses, Liverpool Road and Manchester Liverpool Road Railway Station, 230m north of the site at its nearest point.
	To the north of the eastern half of the site is the Bridgewater Canal Tow Path, Castle Street, the railway line and an events area, referred to as Castlefield Bowl (50m from the northern site boundary). To the north of the easterly end of the viaduct is Duke Street, grassed areas, the Castlefield Urban Heritage Park and Beaufort Street (40m from the north site boundary at its closest point).
	The River Medlock is located approximately 40m to the north-west of the site, the river flows in a western direction and then to the south where it flows below the Dawson Street road bridge.
East	Immediately to the east of the site is Deansgate-Castlefield car park. The car park is flat and roughly level with viaduct (approximately 0.5m higher in elevation). The car park access road slopes down from the car park, along a former railway line to ground level at Trafford Street, approximately 450m east of the site. The car park area is raised above the surrounding ground level by red brick arches, which are accessed along Bridgewater Street to the north east of the site. The arches are used as commercial units and car parking facilities. Warehouses, commercial units, residential flats and offices are located in the wider area east of the site.
	A staircase which leads from ground level to the Deansgate-Castlefield car park is located to the north-east of the site. The staircase is located approximately 20m south of Beaufort Street and 10m from the eastern site boundary.
South	Immediately to the south is a tramline which runs parallel to the viaduct. Beyond the tramline is a railway line which also runs parallel to the viaduct and tramline. The Bridgewater Canal and canal basin are located to the south of the tram and railway lines.

Direction	Description
	Beyond the canal is Slate Wharf, Merchant Bridge and Castle Street, the buildings on Castle Street comprise art galleries, offices, residential flats, restaurants and bars. The railway archway immediately below the railway line to the west of Castle Street has been developed into a restaurant with associated outdoor dining area. Land parcels to the south of the viaduct are owned by Peel Land and Properties (Ports) Ltd, Peel Investments (North) Ltd, Castlefield Estates, and MJF Ssas Trustees Limited; and land to east is owned by TIGM. The Rochdale Canal is located approximately 50m south the site. It runs in an east to west orientation and terminates at Rochdale Canal Lock 92, approximately 30m east of a footbridge where Castle Street crosses the canal. A building, which was part of the former saw mill with a chimney, is located on the northern bank of the Rochdale Canal, approximately 50m east of the site. This building appears to have been repurposed for use as a gallery and residential apartments. Merchants Bridge footbridge crosses the Bridgewater Canal and connect Catalan Square on the northern bank to Slate Wharf on the southern bank. Slate Wharf is characterised by residential apartment blocks, Castlefield Green area of grass, canal quay, car parks and road network. The Slate Wharf Bridge is closed to public access via a locked gate and is located approximately 20m south of the viaduct beyond the tram and active railway lines.
West	Immediately west of the site is a parcel of vacant land covered in railway ballast which would have historically formed part of the railway which crossed the viaduct. This area tapers in width becoming narrower due to the change in trajectory of the tramline located immediately south. Egerton Street and Dawson Street (A56) are located approximately 50m west of the site, which runs in a north to south direction. The River Medlock flows below Dawson Street Bridge at this point. Land to the west is occupied by roads, residential and commercial buildings.

3 Environmental Setting

3.1 Geological Conditions

Information on geological conditions below the site has been collated from the Groundsure Insights Report provided in Appendix B and BGS datasets, including 1:50,000 scale geological mapping and historical BGS borehole records, provided in Appendix E. Geological conditions are summarised below.

3.1.1 Anticipated Geology

Information presented on the BGS online geology viewer¹, BGS bedrock and superficial map² and BGS bedrock map³ indicates that superficial deposits are absent and the site is underlain by the Chester Pebble Bed Formation. The BGS mapping indicates that the Chester Pebble Bed Formation as a whole reaches thicknesses of up to 440m in the surrounding area. A description of the formation is provided in Table 3-1.

Table 3-1: Geology

Stratum	Unit	Description
Bedrock	Chester Pebble Bed Formation	Fine to coarse grained sandstone, commonly pebbly with conglomerates and sporadic siltstones.

The BGS mapping indicates that superficial deposits are absent across the site. The nearest superficial deposits to the site boundary are recorded to be present approximately 70m south of the site, comprising Till. Glaciofluvial and Alluvium deposits are also recorded within 250m of the site.

3.1.2 Summary of Historical BGS Records

A review of historical borehole records, via the BGS online viewer, indicates that there are two boreholes located on the land underlying the viaduct; however, one of the boreholes is recorded as being confidential and so could not be reviewed. A summary of the ground conditions encountered within the borehole located on land below the viaduct, which could be viewed, is given below in Table 3-2 with a copy of the borehole log provided in Appendix C.

Table 3-2: Summary of BGS boreholes on land below the viaduct

Strata	Description	Depth (m bgl)
Made Ground	Hardstanding (setts).	0.00 - 0.15
	Ashes, stones, sand, brick fragments.	0.15 – 1.20
Bedrock	Very dense orange fine/medium grained sandstone.	1.20 – 3.00 (base of borehole)

There are an additional 176 historical boreholes located within 250m of the viaduct, of these 100 are available for view. A summary of the geology encountered within historical boreholes located within 50m of the site is provided below in Table 3-3.

Table 3-3: Summary of BGS boreholes within 20m of the viaduct

¹ BGS online viewer <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

² Geological Survey of England and Wales 1:50,000 geological map series, sheet 85, Manchester Bedrock and Superficial Deposits map <http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1009337> dated 2011

³ Geological Survey of England and Wales 1:50,000 geological map series, sheet 85, Manchester Bedrock map <http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1009338> dated 2010

Strata	Description	Depth (m bgl)
Made Ground	Descriptions of Made Ground included: ■ Setts; ■ Ashes, stones, sand and brick pieces; and, ■ Medium dense ask and brick pieces.	0.00 – 4.20
Superficial deposits/weathered bedrock*	Descriptions of superficial deposits included: ■ Gravel; ■ Stiff brown gravelly clay; ■ Stiff laminated silty clay; ■ Sand; and, ■ Silty sand.	1.90 – 6.10
Bedrock	Dense sandstone	0.50 – 6.25 (base of excavation)

*From the descriptions given on the borehole logs reviewed it is not certain whether the encountered gravels, clays, sands and silts are superficial deposits or weathered bedrock.

3.1.3 Mining and Mineral Extraction

The Coal Authorities Consultant Coal Mining Report, provided in Appendix D, indicates that the site is not located within an area affected by past underground mining, probable unrecorded shallow workings, spine roadways at shallow depth, mine entries, abandoned mines, outcrops, geological faults, opencast mines or Coal Authority managed tips.

The Groundsure Insights Report, provided in Appendix B, indicates that there are 19 records of surface ground workings on the land below the viaduct, these include 12 records of canals, four records of unspecified wharves, one quay, one unspecified ground workings and one timber wharf. An additional 24 records of surface ground working are located within 250m of the site, these include:

- Ten records relating to canals (closest located 240m west of the site);
- Eight records relating to quays (closest recorded 87m south of the site);
- One record relating to an unspecified ground working (located 77m south of the site);
- One record relating to a water body (located 3m south of the site);
- One record of a gravel pit (located 41m south east of the site);
- One record of a pond (located 153m south of the site);
- One record of a sand pit (located 164m south of the site); and,
- One record of a refuse heap (located 188m north west of the site).

3.1.4 Ground Stability

Ground stability hazard classification for the site, as detailed within the Groundsure Insights Report (Appendix B), are:

- negligible hazard of shrinking or swelling clay, with ground conditions predominantly non-plastic;
- low hazard of running sands;
- negligible hazard of compressible ground;
- very low hazard of collapsible deposits;
- very low hazard of landslides; and,
- negligible hazard of ground dissolution.

3.1.5 Radon Gas

The presence of radon gas is assessed in the UK according to the number of homes likely to be above the Action Level (200 Becquerel per cubic metre (Bq m³)). Under Building Regulations, the requirement for protection measures (as described in BRE, 2001) in the construction of new buildings, conversions or extensions is dependent on Radon Potential⁴.

Information resented on the UK Radon Map indicates that the site is located within a lower probability radon area (less than 1% of homes are estimated to be at or above the Action Level). Therefore, radon protection measures are not required within new buildings in the vicinity of the site.

3.1.6 Unexploded Ordnance

A Groundsure Preliminary Unexploded Ordnance (UXO) Risk Assessment has been obtained for the site (Appendix E). The risk assessment indicates that there are significant potential sources of British / Allied UXO (unexploded ordnance) in close proximity to the site. Given the proximity of the site and the significance of the sources, the risk for the land underlying the viaducts from British / Allied UXO is considered to be high.

The risk associated with German UXO is considered to be medium. The risk assessment notes that historical records indicate a medium level of bombing density across the borough in which the site was situated during World War II.

3.2 Hydrogeology

Hydrogeological information for the site has been collated from a Groundsure Insights Report (Appendix B), DEFRA MAGIC map application⁵ and BGS hydrogeological map⁶. The site is underlain by the Chester Pebble Bed Formation (sandstone) which is classified as a Principal Aquifer. A Principal Aquifer comprises layers of rock that have high intergranular and / or fracture permeability, meaning they usually provide a high level of water storage. They may also support water supplies and / or river base flow on a strategic scale.

The Glaciofluvial Deposits and Alluvium superficial deposits located within 250m of the site are classified as Secondary A Aquifers. These types of aquifer comprise permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. With the exception of a small area of Till located approximately 70m south of the site, which is classified as a Secondary A Aquifer. Till deposits are classified as a Secondary Undifferentiated Aquifer. This designation is given when it is not possible to attribute either category A or B to a rock type.

⁴ Public Health England, 2020 <https://www.ukradon.org/>

⁵ DEFRA MAGIC Map Application <https://magic.defra.gov.uk/MagicMap.aspx>

⁶ British Geological Survey 1:100,000 hydrogeological map series, sheet 19, Hydrogeological map of Clwyd and the Cheshire Basin, 1989 <http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1003989>

The Groundsure Insights Report (Appendix B) indicates that the land underlying the viaduct is located within an area of high Principal Aquifer groundwater vulnerability in the eastern half of the site and a low Principal Aquifer groundwater vulnerability area in the western half of the site. The land underlying the viaduct as a whole is considered to have a high leaching class for soils.

The Groundsure Insights Report indicates that the land directly underlying the viaduct is rated as moderate to high risk in relation to groundwater flooding occurring at the surface. The risk assessment in relation to groundwater flooding is based on a 1 in 100-year return period.

The site is located within the designated Water Framework Directive (WFD) groundwater body of the 'Manchester and East Cheshire Permo-Triassic Sandstone Aquifers' (Water Body ID: GB41201G101100). The chemical and quantitative classification for the groundwater body was recorded as poor in 2015.

Groundwater was encountered at depths of 5.20m bgl and 5.30m bgl within three of the historical BGS boreholes located within 50m of the site. Groundwater was encountered within a sandy layer within the superficial deposits/weathered bedrock at all three locations. The location of historical BGS logs is presented in Figure 3.1.

3.2.1 Groundwater Abstractions

The Groundsure Insights Report (Appendix B) indicates that there are no records of groundwater abstractions on the land directly underlying the viaduct; however, there are four groundwater abstractions recorded within 1km of the site. The nearest groundwater abstraction is recorded 306m north of the site, the abstraction is recorded as historical. The groundwater was abstracted for transfer between sources (post Water Act 2003). The remaining three groundwater abstractions are all recorded as historical and utilised for the purposes of cooling.

It should be noted that the data search has not included identification of unlicensed water supplies abstracting less than 20m³ of water per day (for abstractions below 20m³ per day, a licence is not required provided that the abstraction is part of a single operation).

3.2.2 Groundwater Source Protection Zones

Groundwater Source Protection Zones (SPZs) are defined around abstraction boreholes used for potable water supply, to delineate the area where release of a contaminant into the aquifer could impact on the abstraction⁷. The site is not located within an SPZ, the nearest SPZ is located 474m east of the site and is designated as a Zone III Total Catchment.

3.3 Hydrology

3.3.1 Hydrology and Drainage

Information provided in the Groundsure Insights Report (Appendix B) indicates that the Bridgewater Canal basin complex is located below the viaduct and this basin complex extends to the north and south. Off-site, the Rochdale Canal (located approximately 40m south of the site) can flow into the Bridgewater Canal via opening a lock gate. The Rochdale Canal terminates at a lock approximately 35m west of Castle Street which crosses the canal. The canal basin complex connects (off-site) to the River Medlock at a point approximately 250m west of the site and joins the River Irwell approximately 280m north west of

⁷ The Inner Zone (Zone 1) is the most sensitive and certain potentially hazardous activities are restricted in this area. Outside this are the Outer Zone (Zone 2) and the Total Catchment (Zone 3) which indicates the recharge area that contributes to the water.

the site. The River Medlock is located approximately 40m west of the site at the closest point, the river flows in a western direction and then to the south where it flows below the Dawson Street (Egerton Road) before flowing into the River Irwell further west.

The site is located within the WFD surface water body catchment of Medlock (Lumb Brook to Irwell) (Water Body ID: GB112069061152). Information on the Medlock (Lumb Brook to Irwell) has been collated from the EA's Catchment Data Explorer⁸. The overall water body classification of the waterbody was moderate, with a chemical rating of fail and an ecological rating of moderate in 2019. The EA's Catchment Data Explorer indicates that the chemical substances which have failed assessment criteria include: cypermethrin, polybrominated diphenyl ethers (PBDE), perfluorooctane sulphonate (PFOS) and mercury and its compounds.

3.3.2 Surface Water Abstractions

Information provided within the Groundsure Insights Report (Appendix B) indicates that there are no surface water abstractions on the land directly underlying the viaduct. Two historical surface water abstractions are recorded approximately 400m south-west of the site with the surface water body recorded as the River Irwell, the water was abstracted for the purpose of general cooling. There are no additional surface water abstractions located within 1km of the site boundary.

It should be noted that the data search has not included identification of unlicensed water supplies abstracting less than 20m³ of water per day (for abstractions below 20m³ per day, a licence is not required provided that the abstraction is part of a single operation).

3.3.3 River Flood Zones

The Groundsure Insights Report (Appendix B) indicates the land directly underlying the viaduct is an area with a high risk of flooding. The chance of flooding from rivers for high risk areas is greater than or equal to a 1 in 30 chance.

The Groundsure Insights Report also indicates that the land directly underlying the viaduct is located within a Flood Zone 2 area which indicates a 1 in 1000 (0.1%) chance of flooding each year.

3.4 Sensitive Land Use

Information contained within the Groundsure Insights Report (Appendix B) indicates that the site is not located within 250m of a Site of Special Scientific Interest (SSSI), Ramsar Site, Special Area of Conservation (SAC), Special Protection Area (SPA), National or Local Nature Reserve (NNR/LNR) or Ancient Woodland. The nearest designated site to the site is the Trafford Ecology Park LNR located approximately 3.5km to the west.

There are no Nitrate Vulnerable Zones (NVZs) located within 250m of the site. The nearest NVZ, Irwell / Manchester Ship Canal (Kearsley to Irlam Locks) NVZ, is located approximately 784m north-west of the site.

The viaduct structure is a Grade II listed structure which was constructed c. 1880. The viaduct is composed of cast iron and wrought iron with cast iron drum piers rising to square castellated towers supporting metal lattice parapets⁹.

⁸ <https://environment.data.gov.uk/catchment-planning/WaterBody/GB112069061152>

⁹ <https://historicengland.org.uk/listing/the-list/list-entry/1292315>

4 Historical Land Use and Regulatory Information

4.1 Site History

Historical OS maps contained within the Groundsure Insights Report (Appendix B) and a summary of the sites heritage within the Castlefield Viaduct story book by Twelve Architect, July 2020 have been reviewed to identify potentially contaminative former land uses within the site boundary, directly underlying the viaduct and within 1km of its surroundings.

The Castlefield Viaduct was constructed in 1893 to carry heavy rail traffic in and out of Manchester Central Station (now Manchester Central convention complex). The viaduct had three rail tracks to carry rail traffic. The viaduct cost £250,000 to construct equal to £20 million today. Manchester Central Station closed in 1969 and the viaduct fell into disuse with the tracks later dismantled. The viaduct has been derelict since then.

Prior to the creation of the viaduct, a timber wharf was present on the land underlying the viaduct from the earliest available mapping (1848). In addition to the timber wharf, part of the land underlying the viaduct was occupied by rectangular warehouses from the earliest available OS mapping (1848) until the 1990s, these buildings also extended to the north of the viaduct.

The area below and surrounding the viaduct has a long history of both industrial and commercial activities since the earliest available mapping to the present day. A number of residential properties have also surrounded the site, also since the earliest available mapping to the present day. Commercial and industrial activities that have been recorded within 500m of the site include railways, quaysides, wharves, gravel and sand pits, dye works, chemical works, papermills and abattoirs.

It should be noted that the historical maps within the Groundsure Insight Report represents an area greater than that illustrated on Figure 1.2; however, Table 4-1 has been divided to show the features 'on-site' (within the viaduct – the site), 'features on land directly underlying the viaduct' and 'off-site features within 500m of the site'.

Table 4-1: Historical Land Use

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
1848 (OS map 1:10,560)	Viaduct not constructed.	Three rectangular warehouses on the banks of two canal basins, occupy the land that today underlies the western half of the viaduct. Two smaller square buildings are located to the east of the warehouses, beyond which is a branch of a canal which extends off-site in a north – south direction. To the east of the canal, part of another rectangular building is present. To the east of the building is a pathway and an area labelled as an 'Ancient Site of Roman Mamucium' site. A timber wharf is located to the south of the two square buildings and is adjacent to a canal orientated in a west to east direction.	The two rectangular warehouses extend predominantly to the north but also to the south of the current site boundary. The large rectangular building to the east of the canal extends to the south of the current site boundary, as does the canal which extends to the south of the site before joining a larger canal which is orientated in a west to east direction. The canal (north – south orientation) continues southwards before also changing orientation from west to east. On the southern side of the canal 'Castle Quay Slate Wharf' is labelled (approximately 20m south of the current site boundary). At the southern edge of the wharf is a rectangular building labelled as a 'warehouse'. To the west of the wharf a gravel pit is recorded (approximately 40m south of the current site boundary). Castle Quay is recorded to the south of the canal (approximately 150m south of the current site boundary), a rectangular building labelled 'warehouse' and two smaller square to rectangular shaped buildings are shown to the south and east of the quay. A sand pit, St Georges Church and a saw mill are recorded to the south-west of the site (approximately 140m). Beyond these features and the warehouses described above are a large number of terraced houses. To the west of the site is vacant land, a tributary of the River Irwell, beyond which residential houses and Victoria Quay is labelled (300m to the west of the current site boundary). The

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
			Quay is adjacent to the River Irwell which flows in a south-west to north east direction 325m to the west of the site). On the western side of the river is the Sunny Side Silk and Cotton Mill (approximately 350m west). To the north of the current site boundary, is the tributary of the River Irwell, beyond which is a paper mill (150m north of the site). Beyond the paper mill is a chemical works, New Quay and Dye Works all of which are located on the southern edge of the River Irwell (approximately 300m north of the site). A cotton mill is recorded on the western bank of the River Irwell, approximately 350m north-west of the site. A railway is located approximately 250m north of the site at its closest point. The area to the east of the site is densely populated with terraced housing. A cotton mill is recorded approximately 500m east of the site.
1851 (OS map 1:1,056)	Viaduct not constructed.	The warehouse (partially located on the land which today directly underlies the site), to the east of the canal, is recorded as Kenworthy's Warehouse. A line labelled 'centre of the of course of the River Medlock', is shown under the site, orientated in a roughly north to south direction and extends beyond the site boundary to the north and south.	A timber yard is recorded to the immediate north of the timber wharf with a crane also recorded, a dock yard and smithy are recorded to the north of the timber yard approximately 20m north of the current site boundary. A coal wharf is recorded approximately 80m north of the site. Kenworthy's Dock Yard and a sail cloth manufactory are recorded to the east of the coal wharf (approximately 50m north of the site). A smithy is recorded on the Castle Quay Slate Wharf (approximately 100m south of the site).

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
			A timber yard is recorded adjacent to the gravel pit.
1876	Viaduct constructed	No records.	
1891 (OS map 1:500)	Viaduct not yet shown on historical mapping.	The timber wharf is no longer recorded. The two square buildings are no longer recorded.	Two sets of railway lines are recorded running adjacent to the site, both running in a west to east orientation. The timber yard to the north of the site is labelled 'wharf' and there has been an increase in the number of buildings present in the dock yard.
1893 (OS map 1:2,500)	Viaduct not yet shown on historical mapping.	No significant changes.	The railway extends to the west and east. The Castle Quay Slate Wharf and Castle Quay are now referred to as Castle Field Wharves. The smithy is no longer recorded. Four travelling cranes are recorded in this area. Both the gravel and the sand pit are no longer shown. Abattoirs are recorded approximately 150m north of the site and a paper mill located to the north of the site is now labelled 'Elm Street Mill, disused' A timber wharf is recorded approximately 30m south of the site. Castle Field Iron Works are recorded approximately 100m south of the site boundary. A series of mills and works are recorded 100m south west of the site including 'Hulme Mill', 'Egerton Works (Cabinet)', 'Worsley Mills (Braid)' and a cotton mill. The timber yard is recorded adjacent to the gravel pit is no longer recorded.

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
1894 – 1896 (OS map 1:10,560)	The viaduct is shown with one railway line running the entire length of the site in a west to east orientation. The tracks connect to Central Station.	A railway line has been constructed and runs beneath the viaduct (Manchester South Junction and Altrincham Railway).	The Manchester South Junction and Altrincham Railway extended to the north west and south east of the site. To the east of the site a large station is recorded (approximately 400m east of the site). Seven additional rectangular buildings are recorded between the former Castle Quay Slate Wharf and Castle Quay. The chemical works, New Quay and Dye Works approximately 300m north of the site has been redeveloped into a corporation yard. A station is recorded approximately 500m north of the site. The number of railway lines to the north of the site has increased with some smaller lines connecting to large warehouses. The cotton mill recorded approximately 500m east of the site is no longer labelled. Sunny Side Silk and Cotton Mill is no longer recorded.
1905 – 1906 (OS map 1:10,560)	No significant change.		The large station located approximately 400m east of the site is divided into Central Station and two goods stations. An iron works is recorded approximately 400m west of the site adjacent to a railway line. A gas works is located approximately 425m east of the site.
1908 (OS map 1:2,500)	Three sets of railway track are shown to cross the site.	No significant change.	Elm Street Mill located 150m north of the site is no longer shown. It has been replaced by an expansion of the abattoirs.

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
1922 (OS map 1:2,500)	No significant change.	A tank is labelled directly north of the site boundary. Directly beneath the site and extending to the north, south and east a rectangular shape is outlined labelled 'Site of Roman Fort'.	'Hulme Mill' and 'Egerton Works (Cabinet)' located 100m to the south west of the site are no longer shown and have been replaced by a 'Paper Store'.
1923 (OS map 1:10,560)	No significant change.	No significant change.	'Knott Mill' is labelled 250m south east of the site. The iron works recorded approximately 400m west of the site is no longer recorded however the building remains. A hospital is recorded approximately 380m north east of the site.
1931 – 1932 (OS map 1:10,560 & 1:2,500)	No significant change.	Two of the rectangular warehouses directly beneath the site are recorded as 'Acid Warehouse'. The tanks directly north of the site is no longer shown.	The two rectangular warehouses that extend to the north and south of the current site boundary are recorded as 'Acid Warehouses'. Kenworthy's Dock Yard and a sail cloth manufactory are no longer recorded (approximately 50m north of the site) and have been replaced by a large warehouse. A 'Printing Works' is located 90m north east of the site boundary. 'Castle Field Iron Works' located 50m south of the site is no longer shown and has been replaced by 'Saw Mills', 'Saw Mill and Joinery Works' and 'Castlefield Works (Paper)'. Three small circular silos are recorded adjacent to 'Canal Flour Mill' located approximately 80m south of the site. An 'Electrical Engineering Works' is located 200m south-west of the site.

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
			'Worsley Mills' are now labelled as manufacturing cardboard boxes. The corporation yard 300m to the north of the site is now labelled as a cleansing depot. A mineral yard is recorded approximately 400m north west of the site.
1938 (OS map 1:10,560)	No significant change.		
1949 (OS map 1:2,500 & 1:1,250)	The site is recorded as a 'Viaduct'.	One of the rectangular warehouses beneath the site is no longer shown and has been replaced by a smaller building.	A cold storage warehouse is located within the area occupied by the abattoir, as is a wholesale meat market (120m north of the site). A 'Saw Mill' and 'Works' are labelled 100m north of the site. A hide and skin works are recorded in the dock yard of the former timber yard (approximately 70m north of the site). A hide, skin and fat market is recorded approximately 180m north west of the site. A 'Boat Repair Works' is recorded north of the warehouse 50m north of the site in the location of the former Kenworthy Dockyard. An electricity sub-station is labelled adjacent to the print works 90m north of the site. A fibreboard container factory is recorded approximately 120m south west of the site replacing the former 'Worsley Mills'.

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
			The large rectangular building to the east of the canal is no longer shown. Castlefield Wharves are no longer recorded. A shaft is recorded approximately 40m south of the viaduct approximately 50m west of the lock gate at the end of Rochdale Canal. A 'Refuse Heap' is labelled 150m south of the site.
1956 (OS map 1:1,250)	No significant change.		An automobile engineering works is recorded approximately 200m north east of the site. A ready mixed concrete depot is recorded approximately 80m north of the site. The 'Boat Repair Works' are no longer recorded. The 'Refuse Heap' 150m south of the site is no longer recorded.
1956 (OS map 1:10,560)	No significant change.		An automobile engineering works is recorded approximately 400m south-east of the site.
1960 - 1963 (OS map 1:2,500 & 1:1,250)	No significant change.	The acid warehouses are now recorded as warehouses.	The two rectangular warehouses that extend to the north and south of the current site boundary are now recorded as warehouses. The fibreboard container factory is recorded as a factory. A 'Garage' is labelled adjacent to the north east of the site. A second 'Garage' is labelled 25m to the south of the site.

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
			The shaft, recorded approximately 40m south of the viaduct, is labelled as disused. The automobile engineering works located approximately 200m east of the site is recorded as a 'Works'. The 'Printing Works' located 90m north east of the site boundary are no longer recorded. The 'Electrical Engineering Works' is located 200m south west of the site are no longer recorded. The hide and skin works recorded approximately 70m north of the site are no longer recorded.
1972 (OS map 1:10,000)	The railway track across the viaduct is shown in the western half of the site only and is no longer connected to Central Station.	No significant change.	Central Station is no longer labelled and the railway tracks which travelled from the site and towards the station and goods shed appear to have been dismantled and are only partially shown. A junction/roundabout is recorded approximately 300m south of the site. 'Knott Mill' is no longer recorded, the building is labelled as 'Works'. The automobile engineering works recorded approximately 400m south east of the site are no longer recorded, a works is recorded in its place.
1977 - 1982 (OS map 1:1,250 & 1:10,000)	The railway on the viaduct is recorded as dismantled.	Kenworthy's Warehouse appears to have demolished.	The abattoir is no longer recorded, the number of buildings has reduced and now three large rectangular buildings occupy the space.

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
			A building labelled 'Refuse Destroyers' is shown in the cleansing depot. Four rectangular and square buildings are recorded to the west of the warehouses, immediately adjacent to the northern boundary of the site. A hopper, conveyors and an electricity substation are shown immediately to the north east of the site. Central Station to the east of the site is recorded as disused, as is one of the goods stations. The other goods station is recorded as a car park. The hide, skin and fat market is no longer recorded.
1985 (OS map 1:10,000 & 1:1,250)	No significant change.		The works in the location of 'Knott Mill' are no longer recorded. The works located on the site of a former automobile works are no longer recorded. The disused goods station to the east of the site is recorded as a car park.
1986 (OS map 1:1,250)	No significant change.		A garage is recorded approximately 80m north of the site in the area formerly occupied by a timber yard.
1988 (OS map 1:10,000)	No significant change.		An exhibition centre is recorded in the location of the disused central station. No. 2 dock is no longer recorded to the south-west of the site.

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
			The mineral yard located approximately 400m north-west of the site is no longer recorded. The hospital located to the north-east of the site is no longer recorded. The gas works located to the east of the site is now recorded as a car park.
1990 – 1995 (OS map 1:1,250 & 1:10,000)	No significant change.	The two former acid warehouses are no longer recorded.	The two rectangular warehouses that extend to the north and south of the current site boundary are no longer recorded. The cleansing depot and refuse destructor is no longer recorded. An electricity substation is recorded approximately 170m north of the site. The cotton mill on the western bank of the River Irwell, approximately 350m north-west of the site is no longer shown. The shaft is no longer recorded to the south of the viaduct. Two new large buildings are recorded approximately 180m north west of the site. The garage to the east of the former acid warehouses is no longer recorded.
2001 (OS map 1:10,000)	No significant change.		Exhibition Centre is recorded as the Greater Manchester Exhibition Centre (GMEX). The building housing the former iron works (located approximately 400m west of the site) is recorded as a bus depot.

Map Dates	On-site features	Features on land directly underlying the viaduct	Off-site features (within 500 m of the site)
2010 (OS map 1:10,000)			The GMEX is renamed as the Manchester International Convention Centre (MICC).
2021 (OS map 1:10,000)			No significant change.

4.2 Regulatory Information

Regulatory information relating to potentially contaminative activities within the vicinity of the site has been summarised in Table 4-2. Further details are provided in the Groundsure Insights Report in Appendix B.

Table 4-2: Regulatory Information

Environmental Records	Description
Discharge consents	There are no recorded discharge consents located on the site; however, there are 51 discharge consents located within 500m of the site. The closest discharge consent is located 44m north-east of the site and relates to the discharge of sewage discharge – final/treated effluent with the receiving water listed as the Bridgewater Canal. The discharge consent is recorded as revoked.
Pollution incidents	There are no recorded pollution incidents located with the site; however, there are seven recorded within 500m of the site. The closest pollution incident occurred 172m north-west of the site in June 2001; the pollutant involved is recorded as diesel which had a minor impact to water (Category 3 incident).
Registered landfill, historical landfill or other waste disposal sites	The EA records show that there are no active landfills within 500m of the site. There is one recorded historical landfill located within 500m of the site. The landfill is located 352m north-west of the site. The type of waste the site was permitted to accept is not recorded within the information reviewed neither is information relating to the operation dates. There is one historical waste site that is located immediately adjacent to the northern boundary of the site (NGR: 383070, 397665). The record relates to a scrap yard, details of the licence holder and dates of operation are not included in the information reviewed. A second historical waste site is located 11m south-west of the site (NGR: 382825, 397578), the waste site is also recorded as a scrap yard with details of the licence holder and dates of operation are not included in the information reviewed. There are an additional 39 records of historical waste sites located within 500m of the site. There are three records of licensed waste sites located within 500m of the site, two of which are recorded as active and one inactive. All sites are located 164m north-west of the site and relate to mobile plant. The active licences are held by R E M Mobile Plant and Rec Remediation Ltd – Mobile Plant, the licences were issued in December 2006 for both sites.
Waste exemptions	There are 57 waste exemptions recorded within 500m of the site. The nearest exemption is for a site located 69m south of the site;

Environmental Records	Description
	the description of the activities undertaken is recorded as sorting and de-naturing of controlled drugs for disposal.
Integrated pollution prevention and control authorisations	There are no integrated pollution control records within 500m of the site.
Hazardous substances consents and handling notifications	There are no records of hazardous substances consents and handling notification recorded within 500m of the site.
Control of major accident hazards sites (COMAH)	There are no records of control or major accident hazard sites recorded within 500m of the site.
Registered radioactive substances	There are no records of registered radioactive substances recorded within 500m of the site.
Historical garages	There are three records of historical garages located below the site; additional details on the garages are not included within the information reviewed. There are an additional 89 records of historical garages located within 500m of the site.
Historical tanks	There is one record of an unspecified tank located below the site. There are an additional 157 records of historical tanks located within 500m of the site, these include: ■ unspecified tanks – 123 records; ■ tanks – 27 records; ■ gas works – 5 records; and, ■ gasometer – 2 records.
Historical energy features	There are 128 records of historical energy features located within 500m of the site, these include: ■ electricity substation – 117 records; ■ electricity transformers – 4 records; ■ gas works – 5 records; and, ■ gasometer – 2 records.
Recent industrial land uses	According to the Groundsure Insights Report, there are no records of recent industrial land uses on the site or underlying the site. Off-site recent industrial land uses within 500m of the site include: ■ conveyors (7m north-west); ■ hoppers and silos (16m north-west); ■ moorings and unloading facilities (23m south, 28m south, 34m north-east, 49m east, 151m south-west, 151m south, 172m south, 196m south-east); ■ scrap metal merchants (27m west); ■ unspecified works or factories (28m north-west);

Environmental Records	Description
	■ container and storage (38m north-west, 70m south, 98m south, 198m north-west, 204m south); ■ electrical features (79m north-east, 98m north, 132m south, 145m north-west, 162m north, 184m south-east, 202m north west, 208m west, 237m north-east); ■ tanks (95m south); ■ published goods (133m north-east, 194m south-east, 202m east); ■ travelling cranes and gantries (174m north-east); ■ special purpose machinery and equipment (183m north-east); ■ civil engineers (183m north-east); ■ tram, metro, light railway stations and stops (198m east); ■ recording studios and record companies (229m south-west); and, ■ railway stations, junctions and halts (244m south-east). There are three records of current or recent petrol stations located within 500m of the site. Two of the records relate to obsolete petrol stations located 96m south and 321m south of the site. An active petrol station (Sainsbury's) is recorded 458m north west of the site.
Historical industrial land uses	The following historical industrial land uses are recorded on or underlying the site: ■ wharves (including a timber wharf); ■ railway building ■ railway sidings; ■ quay; ■ unspecified depots; and, ■ unspecified ground workings. Within 500m of the site, the following historical industrial land uses are recorded: ■ railway buildings (64 records, closest recorded 0m north east of the site); ■ railway sidings (31 records, closest recorded 3m north-east of the site); ■ unspecified depot/commercial/industrial (35 records, closest recorded 19m north-east of the site); ■ gravel/sand pits (2 records, gravel pit located 41m south-east of the site, sand pit located 164m south of the site);

Environmental Records	Description
	■ wharves (2 records, closest recorded 64m south of the site); ■ warehouses (5 records, closest recorded 69m south-east of the site); ■ unspecified ground workings (5 records, closest recorded 77m south of the site); ■ quay/docks (7 records, closest recorded 87m south of the site); ■ paper mill (1 record, recorded 108m north-west of the site); ■ goods shed/depot/station (15 records, closest recorded 135m north of the site); ■ corporation yard (5 records, closest recorded 176m north-west of the site); ■ unspecified mills (4 records, closest recorded 178m south-west of the site); ■ cleansing depot (2 records, closest recorded 181m north-west of the site); ■ refuse heap/unspecified heap (3 records, closest recorded 188m north-west of the site); ■ chemical works (1 record, located 200m north-west of the site); ■ automobile works (1 record, located 228m south of the site); ■ unspecified works (12 records, closest located 228m south of the site); ■ brewery (2 records, closest recorded 234m north-west of the site); ■ iron works (3 records, closest recorded 253m south-west of the site); ■ dye works (2 records, closest recorded 272m north of the site); ■ silk and cotton mill/cotton mill (4 records, closest recorded 280m west of the site); ■ saw mill (1 record, located 312m south-west of the site); ■ railway stations (13 records, closest recorded 198m east of the site); ■ unspecified tank (6 records, closest recorded 371m south of the site); ■ hospital (9 records, closest recorded 385m north-east of the site); ■ mineral yard (3 records, closest recorded 410m north-west of the site);

Environmental Records	Description
	■ gas works/gasometer (6 records, closest recorded 424m east of the site); ■ bus station (1 record, located 440m east of the site); and, ■ glass works (1 record, located 486m south-east of the site).
List 1 dangerous substances	There are no List 1 dangerous substances records within 500m of the site.
List 2 dangerous substances	There are no List 2 dangerous substances records within 500m of the site.

5 Conceptual Site Model and Qualitative Risk Assessment

Land contamination is assessed through the identification of Potential Contaminant Linkages (PCLs). The assessment involves the development of a Conceptual Site Model (CSM) which describes the relationship between on and off-site potential sources of contamination (and contaminants), potential receptors to such contamination and anticipated pathways between the two. Where all three (source-pathway-receptor linkage) are present or considered to be present, they are described as a PCL which can be subject to the risk assessment process.

The following discusses the potential sources, pathways and receptors present.

5.1 Potential Sources

The Castlefield Viaduct has been used as railway land since its construction in 1876. The site is currently covered in ballast and the railway and associated sleepers appear to have been removed from the site. During the site walkover, paint flakes, which given the likely age of the paint potentially could contain metals such as lead and cadmium, were observed on the surface of the ballast and appeared to be flaking off of the viaduct structure. Asbestos containing materials were not observed on the viaduct structure at the time of the site walkover, although they may have been present in the past. It is noted within the 'Castlefield Viaduct Appendix A' document, provided by the Trust that in 2010 a de-scaling operation (with some painting) was undertaken to help prevent corrosion, and further works were carried out in 2012/13 to remove other potentially hazardous debris.

The land directly underlying the viaduct has been historically occupied by warehouses (also recorded as acid warehouses). The warehouses extended to the north of the viaduct. The land to the north of the viaduct formerly occupied by the warehouses has been recently redeveloped/is undergoing redevelopment into flats. Due to the recent nature of the redevelopment underlying this part of the site, investigation and assessment of the land for contamination will have been undertaken as part of the planning process. A letter from the EA, dated 8th January 2007 (reference SO/2006/100340/01-L01), relating to the development of the area in which the warehouses were located confirms that a site investigation and risk assessment has been undertaken and states that *'elevated concentrations of petroleum hydrocarbons encountered at the site are unlikely to pose a significant risk to the controlled waters receptors identified. Therefore, we do not require specific remedial action for the protection of controlled waters receptors at this time'*.

It is noteworthy that there is the presence of elevated concentrations of petroleum hydrocarbons underlying the former warehouses which were located beneath the site.

Potential sources of contamination on the viaduct and directly beneath the site are discussed in Table 5-1 and Table 5-2, respectively.

Table 5-1: Potential Sources on the Viaduct Structure

Potential Source	Associated Contaminants
Railway land and ballast (on viaduct structure)	Metals, asbestos, phenols, sulphates, Polycyclic Aromatic Hydrocarbons (PAHs), fuel oils, lubricating oils, greases and herbicides.
Metals and paint flaked off from viaduct structure (on viaduct structure)	Metals

Table 5-2: Potential Sources directly beneath the Viaduct Structure

Potential Source	Associated Contaminants
Made Ground associated with demolished buildings	Made Ground deposits associated with demolished buildings commonly contains localised areas of asbestos, PAHs, fuel and oil hydrocarbons and metals.
Timber wharf (below viaduct structure)	Contaminants of potential concern include metals and metal compounds, cyanides, sulphates, phenols, PAHs, creosote, paints and solvents (aromatic hydrocarbons and chlorinated aliphatic hydrocarbons), organotins, cyanides, biocides, fuels and oil hydrocarbons and asbestos.
Scrap metal yard (below viaduct structure)	Metals and metal compounds, cyanides, sulphates, phenols, PAHs, paints and solvents (aromatic hydrocarbons and chlorinated aliphatic hydrocarbons), fuels and oils, hydrocarbons and asbestos.
Former warehouses	Petroleum hydrocarbons.

Several current and historical activities undertaken within 500m of the site may have released contaminants into the ground, which may have subsequently migrated to the land underlying site via surface run-off and/ or migration in groundwater. These are identified in Table 5-3 below.

Table 5-3: Potential Off-site Sources

Potential Source	Associated Contaminants
Railway lines and travelling cranes	Fuel and oil hydrocarbons, metals and metalloids, PAHs, asbestos, sulphates and sulphides.
Dockyard and timber yard (immediately adjacent to the site)	Contaminants may be associated with materials to construct the dock and historical activities which may have taken place within the dockyard. Potential contaminants of concern include metals, phenols, PAHs, creosote, solvents, tributyltin, fuels and oils, asbestos and ground gases.
Garages (immediately adjacent to the site)	Fuel and oil petroleum hydrocarbons, volatile and semi-volatile organic compounds (VOCs and SVOCs) and vapours associated with above ground fuel tanks (if present).
Made Ground associated with demolished buildings and potentially infilled land former gravel and sand pits, former shaft)	Made Ground deposits associated with demolished buildings commonly contains localised areas of asbestos, PAHs and metals.
Other off-site industrial use: ■ Scrap metal yard ■ Abattoir ■ Silk and cotton mills ■ Paper mills ■ Automobile engineering works ■ Iron works ■ Smithy ■ Fibreboard container factory	Metals and metal compounds, phenols, PAHs, solvents (aromatic hydrocarbons and chlorinated aliphatic hydrocarbons), fuels and oil hydrocarbons and asbestos.

Potential Source	Associated Contaminants
■ Cleansing depot ■ Concrete depot ■ Refuse heap ■ Saw mill ■ Dye works ■ Bus Station ■ Hospital ■ Brewery ■ Glass works ■ Mineral Yard ■ Gas works ■ Garages ■ Potentially infilled shaft	

5.2 Potential Receptors and Pathways

Three potential scenarios have been identified in relation to the use of the site, these include:

- the site in its current condition (current CSM);
- the site during the Phase 1 'Pilot Scheme' being utilised as a 'micro park' this includes the introduction of a temporary footpath surface, the erection of temporary pop up shelters (assumed to be well ventilated) and placement of planters (Phase 1 Pilot Scheme CSM); and
- the site when it is permanently repurposed in Phase 2 as an urban park and travel hub. This will include the construction of food and beverage stands, gardens, stalls, seating areas, an events space and toilet facilities. It is assumed that raised planting beds will be created and a pathway between railway ballast and consumption of site grown vegetables is not considered (Phase 2, Permanent Urban Park and Travel Hub CSM).

Table 5-4 below outlines which potential receptors and pathways that would be associated by each of the three scenarios.

Table 5-4: Potential Receptors and Pathways

Receptors	Pathways	Current CSM	Phase 1 - Pilot Scheme CSM	Phase 2- Permanent Urban Park and Travel Hub CSM
Human Health				
Site users (visitors, trespassers and future workers and visitors)	Direct exposure through dermal contact, ingestion or inhalation of contaminants within the ballast cover across the viaduct or accidental direct exposure to paint flakes in areas not covered by future temporary walkway or other hard cover.	✓	✓	✓
	Inhalation of volatile contaminants.	X	X	✓
Development workers during construction	Direct exposure through dermal contact, ingestion or inhalation of ballast cover or paint flakes.	X	✓	✓
	Inhalation of volatile contaminants.	X	✓	✓
Controlled Waters				
Chester Pebble Bed Formation – Principal Aquifer	Migration via preferential pathways caused by piling (if required).	X	X	✓
Bridgewater Canal (below the viaduct and in immediate surrounding area)	Leaching, dissolution and migration of contaminants from the ballast covering the site via surface drainage and discharge into surface water receptors.	✓	✓	✓
River Medlock (40m west of the site)		✓	✓	✓
Buildings and Utilities				
Future buildings and utilities	Direct contact and permeation of water supply pipes.	X	X	✓

5.3 Preliminary Conceptual Site Model and Qualitative Risk Assessment

The CSM and PRA are presented in Table 5-5, Table 5-6 and Table 5-7 for each of the potential end use scenarios. Definitions of probability and consequence have been based on guidance outlined in CIRIA 552 and summarised in Appendix F. A combination of probability and consequences produces a risk level based on the risk evaluation and likely action required. The land contamination risk, which is a function of the probability and the consequence, can then be defined using the risk matrix. The limitations associated with the assessment are provided in Appendix G.

Table 5-5: Preliminary Conceptual Site Model for Current Use

Source	Pathway	Receptor	Associated hazard	Potential consequence of contaminant linkage	Likelihood of contaminant linkage	Risk classification	Justification
Historical site use as railway land, ballast layer covering viaduct and paint on the viaduct.	Direct exposure through dermal contact, ingestion or inhalation of ballast, paint flakes and associated dusts.	Site visitors and trespassers	Health risk	Medium	Low likelihood	Moderate to low risk	The viaduct is covered with a layer of ballast which may contain contaminants as a result of its historical use as railway land. In addition, the viaduct is painted, and flakes of paint were observed within the ballast. Given the likely age of the paint, these may contain elevated concentrations of metals. The site is visited infrequently by maintenance workers to undertake vegetation clearance. Site visitors may come into direct contact with contaminants within the ballast, but this will be on an infrequent basis. During the site walkover it was observed that the site was used by trespassers. These site users may also come into direct contact with contaminants within the ballast covering the surface of the viaduct.
	Leaching of contaminants and migration via surface water network.	Bridgewater Canal and River Medlock	Pollution of controlled waters	Medium	Low likelihood	Moderate to low risk	Contaminants have the potential to leach out of the ballast which covers the top of the viaduct and migrate via the surface water drainage network into the surrounding surface water.

Table 5-6: Preliminary Conceptual Site Model for Phase 1 - Pilot Scheme

Source	Pathway	Receptor	Associated hazard	Potential consequence of contaminant linkage	Likelihood of contaminant linkage	Risk classification	Justification
Historical site use as railway land, ballast layer covering viaduct and paint on the viaduct.	Direct exposure through dermal contact, ingestion or inhalation of soils and dusts.	Future site users	Health risk	Medium	Low likelihood	Moderate to low risk	The viaduct is covered with a layer of ballast which may contain contaminants as a result of its historical use as railway land. In addition, the viaduct is painted, and flakes of paint were observed within the ballast. Given the likely age of the paint, these may contain elevated concentrations of metals. If the site were to be redeveloped site visitors may come into direct contact with contaminants within the ballast if left exposed at surface; however, this is likely to be temporarily or permanently covered by a walkway proposed to be installed covering all or part of the ballast.
		Development workers during construction	Health risk	Medium	Low likelihood	Moderate to low risk	Construction workers may come into direct contact with contaminants within the ballast during development works; however, exposure to potential contaminants can be mitigated during development works associated with the temporary use of the site with the use of appropriate working methods and use of personal protective equipment (PPE).
	Inhalation of volatile contaminants.	Future site users	Health risk	Medium	Unlikely	Low risk	The proposed temporary weather shelters are likely to either have open sides or will be well ventilated due to Covid-19 restrictions. There will be limited potential for the

Source	Pathway	Receptor	Associated hazard	Potential consequence of contaminant linkage	Likelihood of contaminant linkage	Risk classification	Justification
							accumulation of volatile contamination within the structures.
	Leaching of contaminants and migration via surface water network.	Bridgewater Canal and River Medlock	Pollution of controlled waters	Medium	Low likelihood	Moderate to low risk	Contaminants have the potential to leach out of the ballast which covers the top of the viaduct and migrate via the surface water drainage network into the surrounding surface water.

Table 5-7: Preliminary Conceptual Site Model for Phase 2 – Permanent Urban Park and Travel Hub

Source	Pathway	Receptor	Associated hazard	Potential consequence of contaminant linkage	Likelihood of contaminant linkage	Risk classification	Justification
Historical site use as railway land, ballast layer covering viaduct and paint on the viaduct.	Direct exposure through dermal contact, ingestion or inhalation of soils and dusts.	Future site users	Health risk	Medium	Moderate likelihood	Moderate risk	The viaduct is covered with a layer of ballast which may contain contaminants as a result of its historical use as railway land. In addition, the viaduct is painted, and flakes of paint were observed within the ballast. Given the likely age of the paint, these may contain elevated concentrations of metals. If the site were to be redeveloped site visitors may come into direct contact with contaminants within the ballast if left exposed at surface; however, this is likely to be temporarily or permanently covered by a walkway proposed to be installed covering all or part of the ballast.

Source	Pathway	Receptor	Associated hazard	Potential consequence of contaminant linkage	Likelihood of contaminant linkage	Risk classification	Justification
	Inhalation of volatile contaminants.	Development workers during construction		Medium	Low likelihood	Moderate to low risk	Exposure to potential contaminants can be mitigated during construction with the use of appropriate working methods incorporated into a Construction Environmental Management Plan (CEMP) and use of PPE.
		Future site users		Medium	Low likelihood	Moderate to low risk	If the ballast across the viaduct contains volatile contaminants these may accumulate in newly created structures as part of the permanent repurposing of the site.
		Development workers during construction		Medium	Low likelihood	Moderate to low risk	Exposure to potential contaminants can be mitigated during construction with the use of appropriate working methods incorporated into a CEMP and use of PPE.
	Leaching of contaminants and migration via surface water network.	Bridgewater Canal and River Medlock	Pollution of controlled waters	Medium	Low likelihood	Moderate to low risk	Contaminants have the potential to leach out of the ballast which covers the top of the viaduct and migrate via the surface water drainage network into the surrounding surface water.
	Direct contact and permeation of water supply pipes.	Future buildings and utilities	Building and foundation corrosion and impact to potable water supplies	Medium	Low likelihood	Moderate to low risk	Potential contamination could impact on the integrity of concrete foundations through creating aggressive ground conditions. Potential organic contaminants could permeate potable water supplies and have detrimental impacts on human health.

Source	Pathway	Receptor	Associated hazard	Potential consequence of contaminant linkage	Likelihood of contaminant linkage	Risk classification	Justification
Sources below the viaduct and off-site as identified in Table 5-2 and Table 5-3.	Direct exposure through dermal contact, ingestion or inhalation of soils, dusts or vapours.	Development workers during construction if works are required to the viaduct structure at ground level, such as the installation of new access ways or via piling	Health risk	Medium	Low likelihood	Moderate to low risk	Exposure to potential contaminants can be mitigated during construction with the use of appropriate working methods incorporated into a CEMP and use of PPE.
	Creation of preferential migration pathways via piling or construction works at ground level.	Groundwater: Principal Aquifer (Chester Pebble Bed Formation) and surface water receptors (Bridgewater Canal, and River Medlock)	Pollution of controlled waters	Medium	Low likelihood	Moderate to low risk	If construction works are required at ground level such as excavation works or piling, this has the potential to mobilise contaminants within soils or groundwater underlying the site associated with historical activities. Piled foundations, if required, could also potentially create a preferential pathway between sources underlying the viaduct and receptors.

Source	Pathway	Receptor	Associated hazard	Potential consequence of contaminant linkage	Likelihood of contaminant linkage	Risk classification	Justification
	Direct contact and permeation of water supply pipes.	Future buildings and utilities	Building and foundation corrosion and impact to potable water supplies	Medium	Low likelihood	Moderate to low risk	If new foundations are required at ground level to serve the new development, potential contamination in soils underlying the viaduct could impact on the integrity of concrete foundations through creating aggressive ground conditions. If new water pipes are required at ground level to service the viaduct, potential organic contaminants in soils could permeate potable water supplies and have detrimental impacts on human health.

6 Conclusions and Recommendations

6.1 Conclusions

The key objectives of the desk study and PRA were to provide information on the current condition of the site with respect to contamination, characterise the environmental setting and identify potential land quality risks and constraints associated with the proposed scheme.

The site has been a railway viaduct since late 1800s with the railway recorded as being dismantled in the late 1960s. The land underlying the viaduct was historically occupied by a roman fort, timber wharf, canal network and warehouses. The area surrounding the site has a long industrial history including use as railways, quaysides, wharfs, garages, gravel and sand pits, dye works, chemical works, paper mills, gas works and an abattoir.

Information provided by the BGS indicates that the site is underlain by bedrock of the Chester Pebble Bed Formation which is classified as a Principal Aquifer.

Potential sources of contamination on the viaduct were identified as comprising railway land (ballast) and paint from the viaduct structure which may contain contaminants including metals, asbestos, phenols, sulphates, PAHs, fuel oils, lubricating oils, greases and herbicides. The volume of ballast is estimated as approximately 990m³ based on 0.30m depth, by 330m length and 10m width.

Below the viaduct and in the surrounding area, potential sources of contamination comprise Made Ground associated with demolished buildings, a timber yard and scrap metal yard, dockyards, an abattoir, silk and cotton mills, paper mills, automobile engineering works, iron works, smithy, fibreboard container factory, cleansing depot, concrete depot and a garage.

In relation to the use of the site as an urban park and transport hub, following permanent redevelopment of the site, the following potential risk have been identified as having a moderate risk rating or higher:

- Future site users via direct exposure through dermal contact, ingestion or inhalation of soils and dusts.

Further investigation and assessment of the above identified risk is required to quantify whether this presents a development constraint and to help in the development of appropriate mitigation measures.

6.2 Potential Contaminated Land Development Constraints

Identified potential development constraints and uncertainties relating to contaminated land are summarised as:

- The ballast which covers the viaduct has not been sampled or tested and it is uncertain whether the material contains concentrations of contaminants which have the potential to cause harm to human health or the environment.
- It is unknown whether the paint which covers the viaduct that appears to be in a poor condition, contains lead or other metal contaminants which have the potential to cause harm to human health.
- It is uncertain whether the viaduct surface water drainage system discharges to surface water receptors such as the canal or River Medlock.

- If earthworks or piling is required at ground level as part of the scheme, ground conditions are uncertain and the potential to mobilise contamination during construction and cause harm to human health or environmental receptors is unknown.

6.3 Recommendations

In order to determine whether the railway ballast present on the viaduct is suitable to remain in place upon development, it is recommended that a sampling exercise is undertaken on the fine-grained soil matrix surrounding the coarse stone of the railway ballast. The chemical characteristics of the ballast material can be characterised with the analysis of soil and soil leachate samples. It is anticipated that intrusive investigation will comprise:

- a series of hand dug pits in a grid system along the width and length of the viaduct; and,
- paint sampling exercise from the viaduct structure.

Following the sampling exercise data analysis and interpretation of returned laboratory data can be undertaken, and the CSM can be refined following assessment of risks to human health with respect to the potential future scenario and risks to drinking water pipelines. If the data assessment of the soil and soil-leachate concludes that the material is not suitable to remain on site, land contamination mitigation methods can be recommended which can be included in future repurposing design, or a waste classification assessment can be undertaken to inform suitable disposal options.

The soil sampling exercise also offers a benefit to support understanding potential risk to workers during future construction management planning, and it is recommended that a ballast fines/soil sampling exercise is undertaken prior to the installation of any cover system or walkway.

Considerations for further works are dictated by the elements of the repurposing design. Below provides a non-exhaustive list of considerations that the Trust should make during the evolution process of the feasibility study and permanent design. All recommendations are considered to be conditional on the final design and use of the site:

- Civil engineering – currently an assumption that a bridge proposed for the permanent Phase 2 permanent urban park and travel hub scheme can be supported from the viaduct and piling to provide support is not required. This is subject to change should Historic England find this design unacceptable on a Grade II listed structure. As such, intrusive investigation to obtain soil samples for both geo-environmental and geotechnical purposes will be required at ground level, and assessment of potential risks to controlled waters through piling at as contamination pathway.
- Creating an opening in the base of the viaduct platform - the proposed new bridge would be formed by a gap in the lattice girder structure; however, but other options, such as creation of a hole in the base of the viaduct may be considered. In this case, capture of water collected in the base of the viaduct should be contained to ensure a run off pathway is not created with respect to human health of site users below any aperture.
- Drainage system alterations or improvements from the viaduct may need to be installed and soil leachate analysis from the ballast fines/soil sampling exercise above can support the understanding of the possibility of mobilisation of potential contaminants from the ballast during installation of any new system.
- Installation of drinking water mains – assessment of contaminants potentially present within soils and consideration of isolating future drinking water pipes via barrier pipe or conduit system.
- Installation of permanent structures connected to the soils and accumulation of vapours in permanent poorly ventilated buildings or structures.

- Installation of 'green stuff' such as vegetable plots or fruit growing areas – a recommendation is made that any planting is within raised beds disconnected from ballast.
- Painting of the viaduct structure is not currently planned. Deteriorating conditions of the paint works may cause release of metals such as lead, and future painting works may require removal of old paint which could cause a short-term rapid release of metals. Consideration should be made to any proposed method of paint removal and dust management controls should be incorporated if required.
- A detailed UXO study is recommended prior to the start of any intrusive works at ground level, as the land underlying the site has been classified as a medium to high risk in relation to UXOs.

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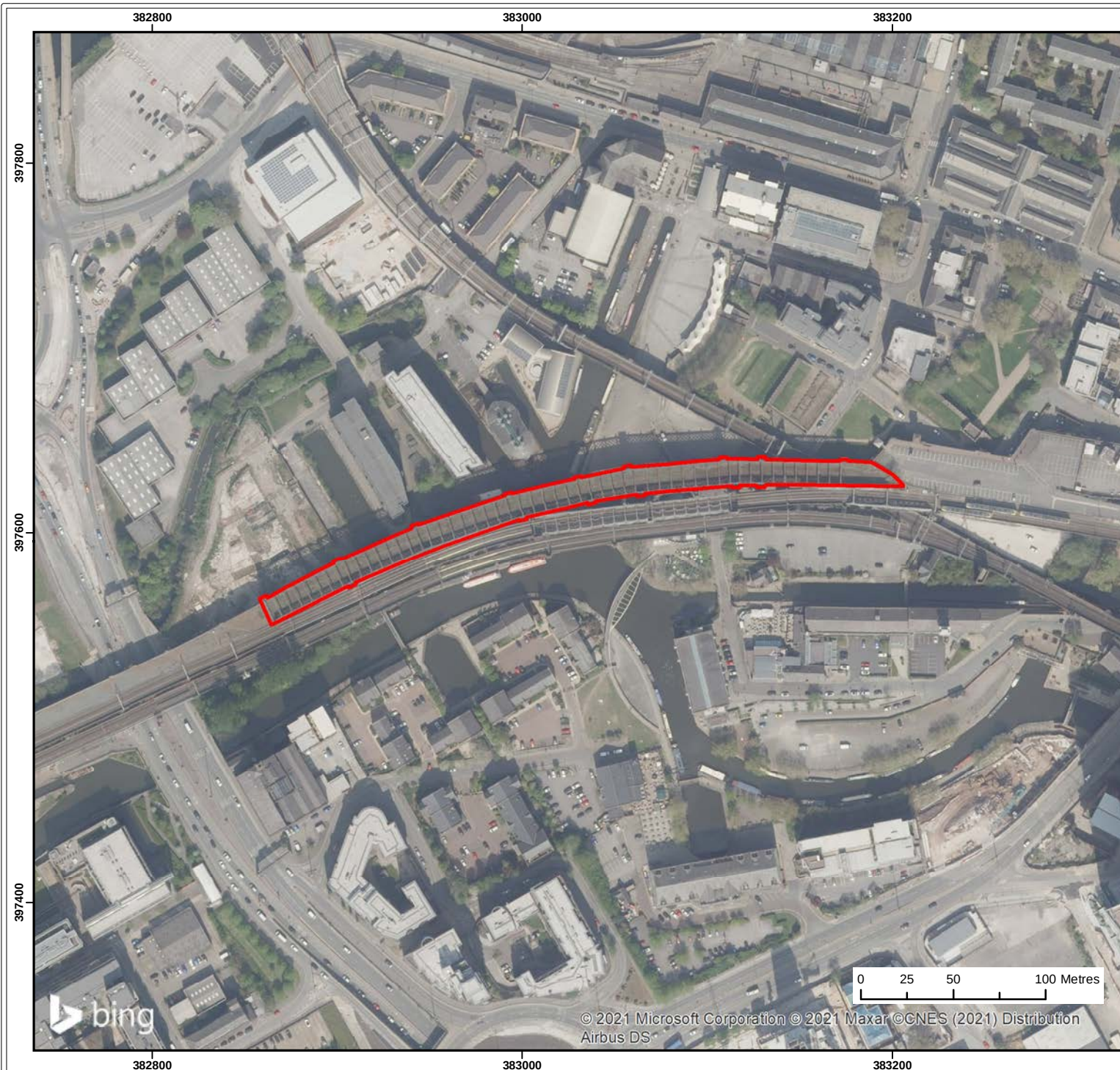
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Figures

Figure 1.1: Site location plan

Figure 2.2: Site layout plan

Figure 3.1: Historical BGS borehole location plan



Legend:

Red Line Boundary

Data Sources: © HaskoningDHV UK Ltd, 2021

Base map: © OpenStreetMap (and) contributors, CC-BY-SA.

Client:	Project:
National Trust	Castlefield Viaduct

Title:
Site Location Plan

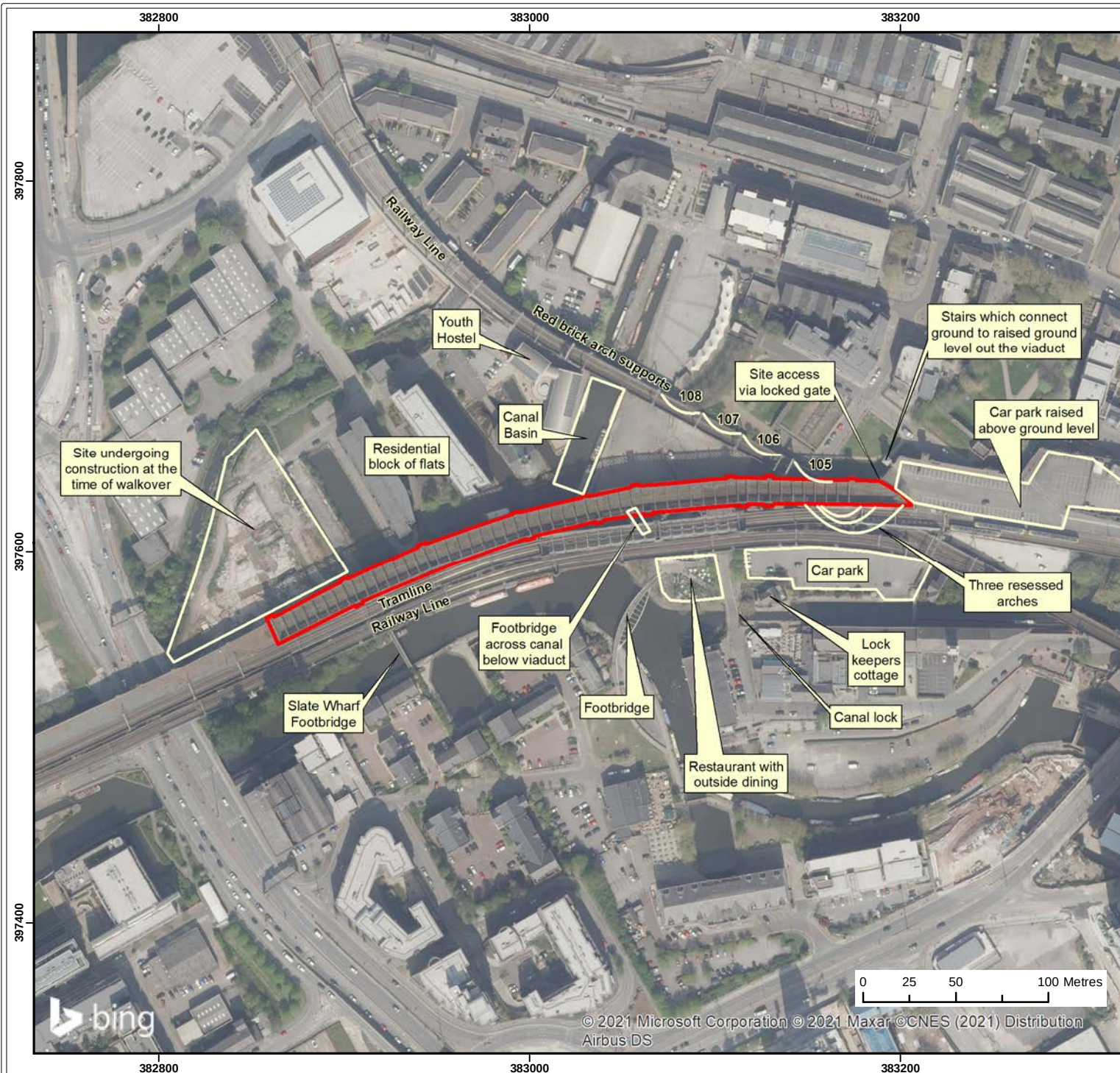
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Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	28/04/2021	GC	KD	A4	1:3,000

Co-ordinate system: British National Grid



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Legend:

Red Line Boundary

Data Sources: © HaskoningDHV UK Ltd, 2021
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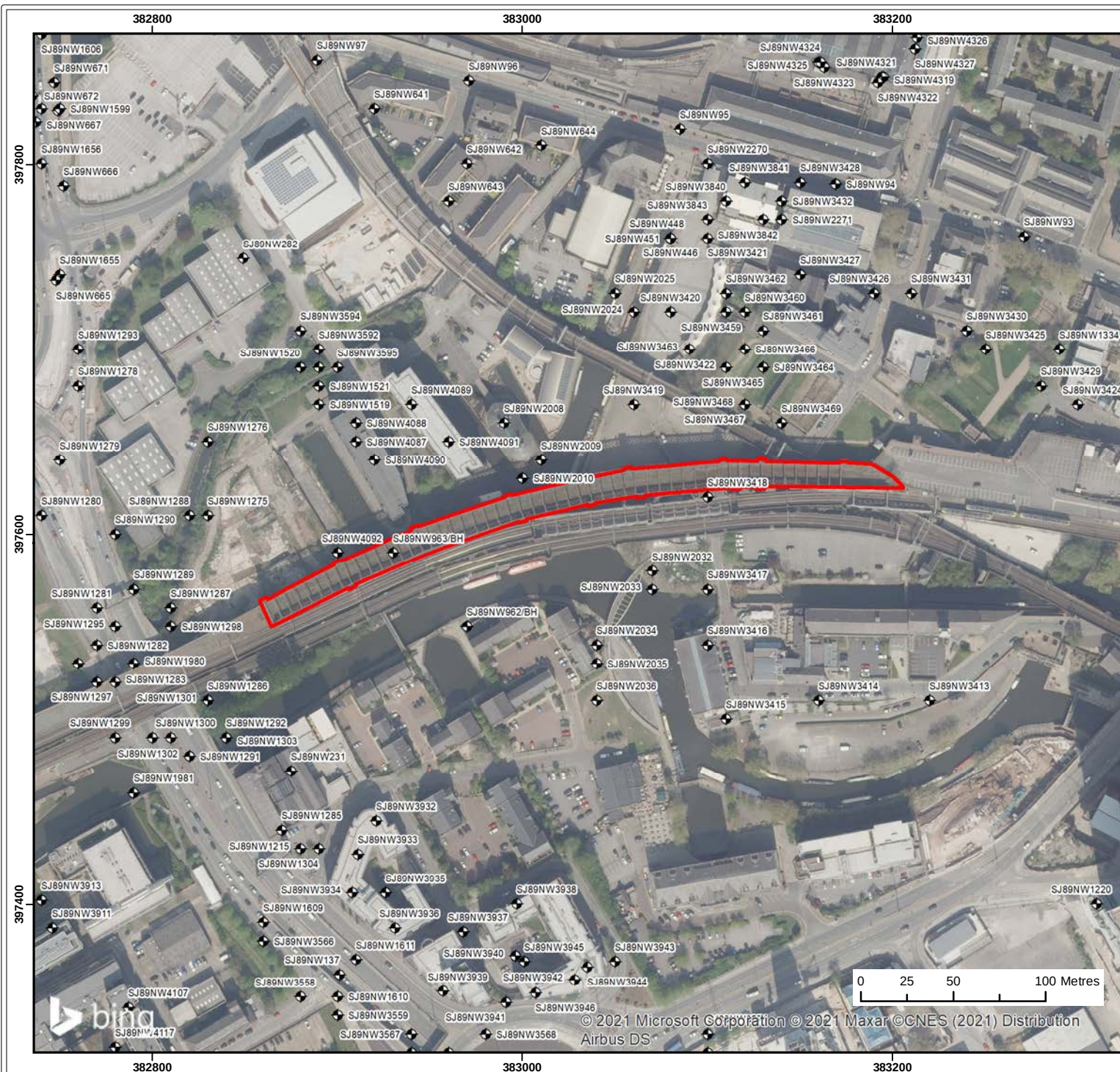
Title:
Site Layout

Figure: 2.1 Drawing No: PC2387-RHD-ZZ-XX-DR-Z-0002

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	28/04/2021	GC	KD	A4	1:3,000

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Legend:

-  Red Line Boundary
-  BGS Borehole Location

Data Sources: © HaskoningDHV UK Ltd, 2021, © BGS, 2021.
Base map: © OpenStreetMap (and) contributors, CC-BY-SA.

Client:	Project:
National Trust	Castlefield Viaduct

Title:
Historical BGS Borehole Location Plan

Figure:	3.1	Drawing No:	PC2387-RHD-ZZ-XX-DR-Z-0003
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Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Appendix

Appendix A – Site Walkover Photographic Plates

Appendix

Appendix B – Groundsure Insights Report

Appendix

Appendix C – BGS Historical Borehole Logs

Appendix

Appendix D – Coal Authority Consultants Coal Mining Report

Appendix

Appendix E – Groundsure Preliminary Unexploded Ordnance Risk Assessment

Appendix

Appendix F – Qualitative Human Health and Environmental Risk Assessment Methodology

Appendix

Appendix G - Limitations

