STOCKPORT
METROPOLITAN BOROUGH COUNCIL

Transport for
Greater Manchester

STOCKPORT INTERCHANGE

TUNNEL ASSESSMENT

14113-WSP-SKX-XX-RP-G-0006

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PROJECT NO. 70031899
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APPENDICES

1 INTRODUCTION

1.1 AUTHORISATION

On the instruction of Transport for Greater Manchester (TfGM), and in accordance with our fee proposal dated 21 September 2017, WSP has undertaken an assessment of the potential presence of tunnels beneath the proposed Stockport Interchange.

1.2 BACKGROUND & SCOPE OF WORKS

The geotechnical design of the Stockport Interchange scheme is supported by the following documents;

- AECOM, 2015. '*Phase 1 Geotechnical and Geo-Environmental Desk Study Report: Stockport Bus Station'* Project 60340298, Reference: GEO/02
- AECOM, 2016, '*Stockport Interchange – Ground Investigation Report',* Job No. 60340298, Reference: 60340298/GEO/02
- Geotechnics, 2016, '*Stockport Bus Station: Factual Report'*, Project No: PN153428

Neither of the AECOM reports mentions the potential presence of tunnels below the site. However, the Geotechnics factual report states *'It is understood that tunnels are present below part of the site. These are presumed to be former mill water race excavations through the rock extending from the site of existing and former mills to the River Mersey'.*

In order to obtain further information with respect to the potential presence of these tunnels, desk based research and a walkover survey were undertaken to try and better understand whether these features are present and, if they are, what and where they are, whether they are visible, what impact they might pose to the scheme and what survey techniques could be used to accurately position them below the development.

1.3 SOURCES OF INFORMATION

This report has been prepared using the information sources detailed below:

- Site walkover completed by WSP on 06 October 2017;
- Historical Ordnance Survey maps and town plans obtained from Envirocheck;
- British Geological Survey 1:50,000 map "*Stockport Sheet 98*" Solid Edition
- Photographs available online from the Stockport Local Heritage Library;
- Information held by Stockport Heritage Trust; and,
- Information contained in *"Subterranean Stockport*" and conversation with the author, Emma Brown.

1.4 CONFIDENTIALITY STATEMENT

This report is addressed to and may be relied upon by the following:

Transport for Greater Manchester
2 Piccadilly Place
Manchester
M1 3BG

This assessment has been prepared for the sole use of the above named party. This report shall not be relied upon or transferred to any other parties without the express written authorisation of WSP. No responsibility will be accepted where this report is used in its entirety, or in part, by any other party.

Information provided by others is taken in good faith as being accurate. WSP cannot and will not accept liability for any deficiencies in third party information.

General limitations are presented in **Appendix A**.

2 SITE INFORMATION

Site Address	Stockport Bus Station, Stockport, SK3 0EH
National Grid Reference Coordinates	SJ 89241 90231
Area	Approx. 1.6ha
Site Location and Boundaries	The site is located in the west of Stockport town centre, approximately 250m north of Stockport train station. The site is bounded to the north by the River Mersey; to the east by Wellington Road; to the south by Daw Bank Road (beyond which is a former mill and two low rise offices) and to the west by Swaine Street (beyond which two light industrial units, car parking, and the Stockport viaduct). A site location plan is presented in **Appendix B**.
Current Site Use	The site is currently a bus station.
Site Description	The site currently comprises seven asphalt surfaced roadways and associated passenger shelters. The bus station is generally flat lying, being located in the bottom of the Mersey valley. The northern boundary of the site is formed by the River Mersey which is cut into the underlying sandstone to form a steep sided gorge. Ground levels rise steeply to the south up the southern flank of the Mersey Valley.
Proposed Development	It is understood that the new development will comprise the following; ▪ A new interchange; ▪ A multi-storey residential development; ▪ A pedestrian link bridge from the interchange to Stockport Railway Station; ▪ A new vehicular bridge across the River Mersey, linking to Astley Street on the northern bank of the river; and, ▪ Associated landscaping.
Geology	The ? map from the British Geological Survey identify the underlying geology to be the is Chester Formation (Sherwood Sandstone). No drift deposits or Made Ground are identified within the site boundaries.

3 TUNNEL ASSESSMENT

3.1 SITE WALKOVER

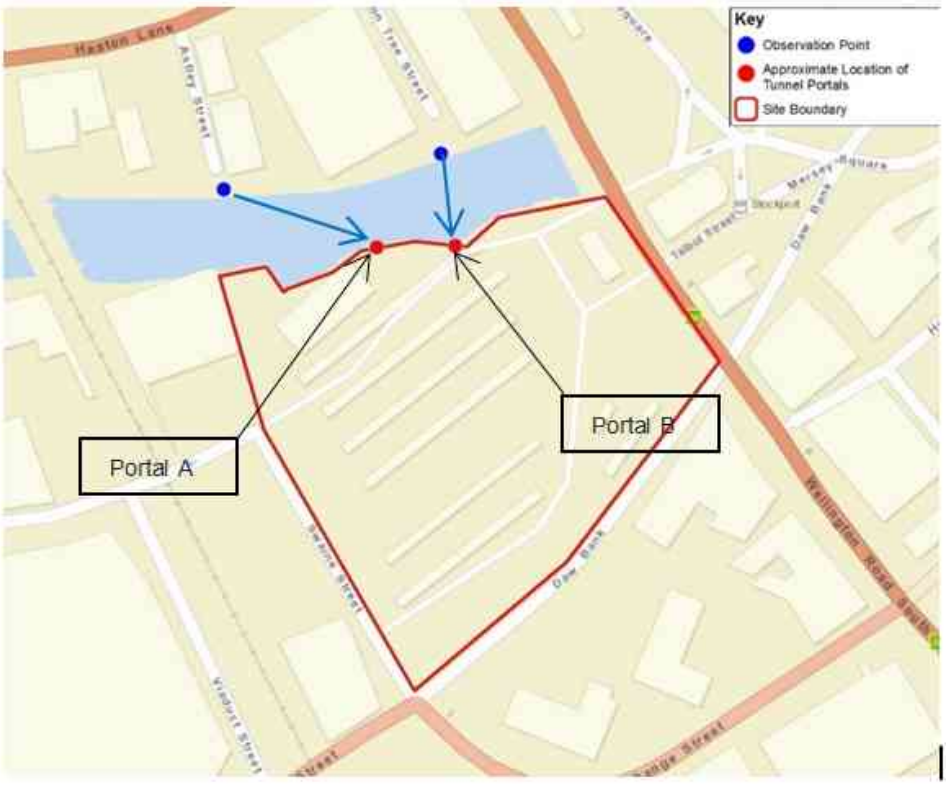
A site walkover was undertaken on 06 October 2017.

The southern bank of the River Mersey (i.e. the site's northern boundary) was inaccessible, but was viewed from Astley Street and Cotton Tree Street on the northern bank (see plan below).

Dense foliage prevented a full view of the southern bank. The eastern portion of the southern bank appears to be formed from near vertical sandstone with a height of approximately 6 - 7m (evidence of bedding was observed in the sandstone, with an apparent shallow dip to the west). The western section of the bank appears to be lined with sandstone blocks of varying size.

Two potential tunnel openings (which have been named Portal A and Portal B), were observed, the details of which are provided overleaf.

Plan of Walkover Photo Locations and Observed Tunnel Portals



PORTAL A

Portal A appears to be an unlined tunnel entrance cut directly into the sandstone bedrock (see Plates 1 and 2). The portal appears to be partially submerged beneath the river.

Plate 1: Portal A from Astley Street

Plate 2: Portal A from Astley Street

PORTAL B

Portal B appears to be semi-circular brick lined tunnel entrance positioned mostly above the water level of the river.

Plate 3: Portal B from Cotton Tree Street

Plate 4: Portal B from Cotton Tree Street

3.2 HISTORICAL MAPS

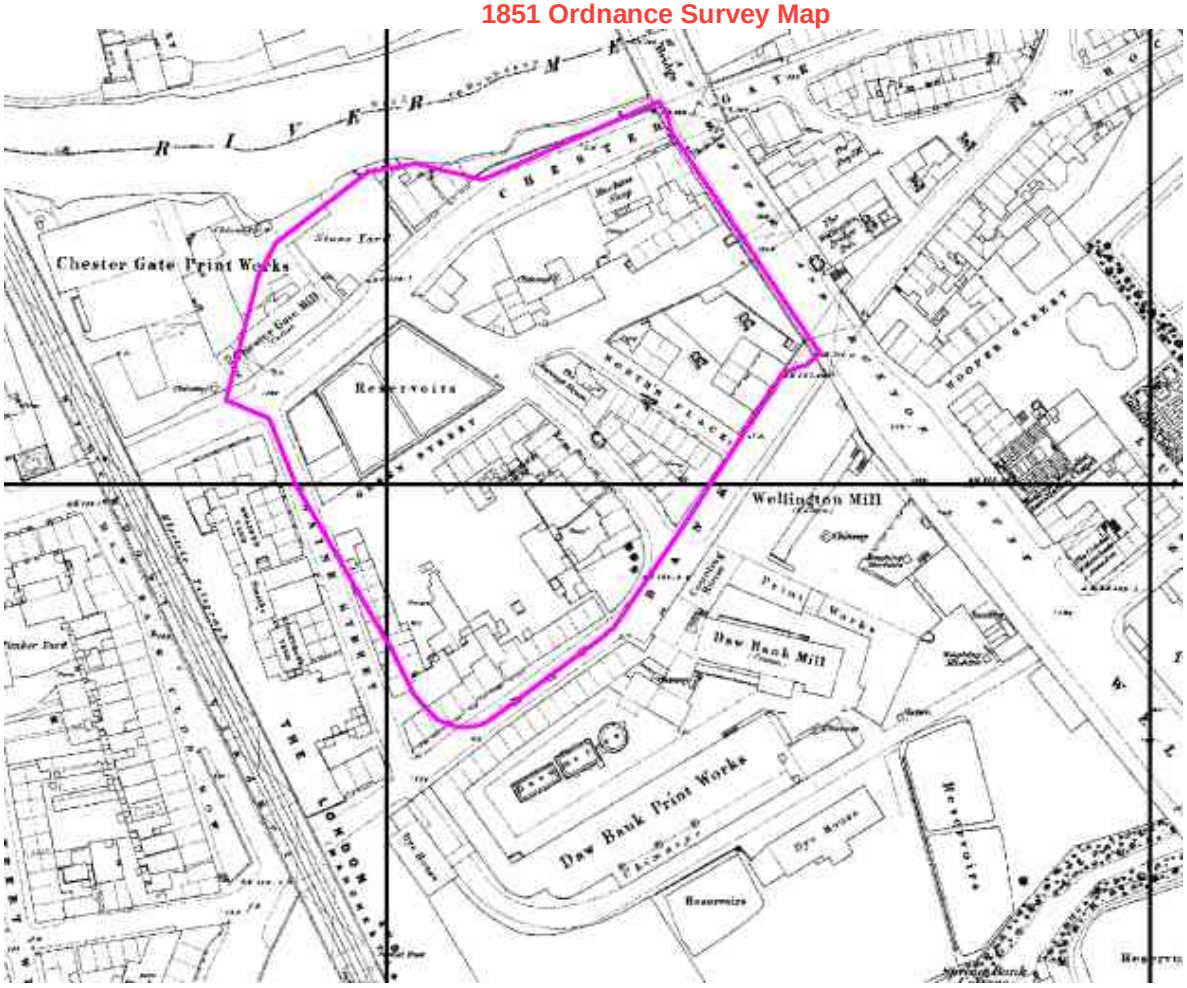
The general history of the site is presented in the AECOM Phase 1 Desk Study Report [1] and this section is intended to provide additional detail on the history of the mills around the site.

Much of Stockport's industrial heritage is based around mills serving the cotton industry, with the River Mersey providing some of the water required for the industrial processes involved and acting as a receiver of waste water and products. To enable industrial development further from the River Mersey, numerous tunnels were dug to deliver water to the mills and to discharge the waste water.

An extract from the 1851 Ordinance Survey map is produced below. This shows the site to be occupied by housing and industrial/commercial developments, including Chester Gate Print Works and Chester Gate Cotton Mill. A reservoir is shown on the southern side of Chester Gate, possibly serving the mill and the print works.

Immediately to the south of the site are Wellington and Daw Bank Mills (both shown as cotton mills), Daw Bank Print Works and a gasometer. Two reservoirs are present to the south beyond Wellington and Daw Bank Mills. These reservoirs would have been at a higher elevation than the mills and print works and it is not unreasonable to assume that they supplied them with water.

1851 Ordnance Survey Map



[1] AECOM. 2015. *Phase 1 Geotechnical and Geo-Environmental Desk Study Report: Stockport Bus Station.* Project: 60340298. Reference: GEO/02

Wellington Mill is shown to have been converted to a hat factory between 1895 and 1898 and by the 1950s was being used as a depot. According to the Stockport Metropolitan Borough Council website [2], the hat factory closed in 1997 and the building was reopened as the Hat Works Museum in 2000.

Dawbank Mill is shown on historical maps until 1922 when it is no longer labelled on the map and the mill appears to have been demolished by 1934.

Chester Gate Mill and Chester Gate Print Works are both marked as Chestergate Clothing Works in 1910, which is present until around 1959, when it is labelled as, "Works". By 1971 part of the works has been demolished, with only a section adjacent to the viaduct remaining until the present day.

3.3 HISTORICAL PHOTOGRAPHS

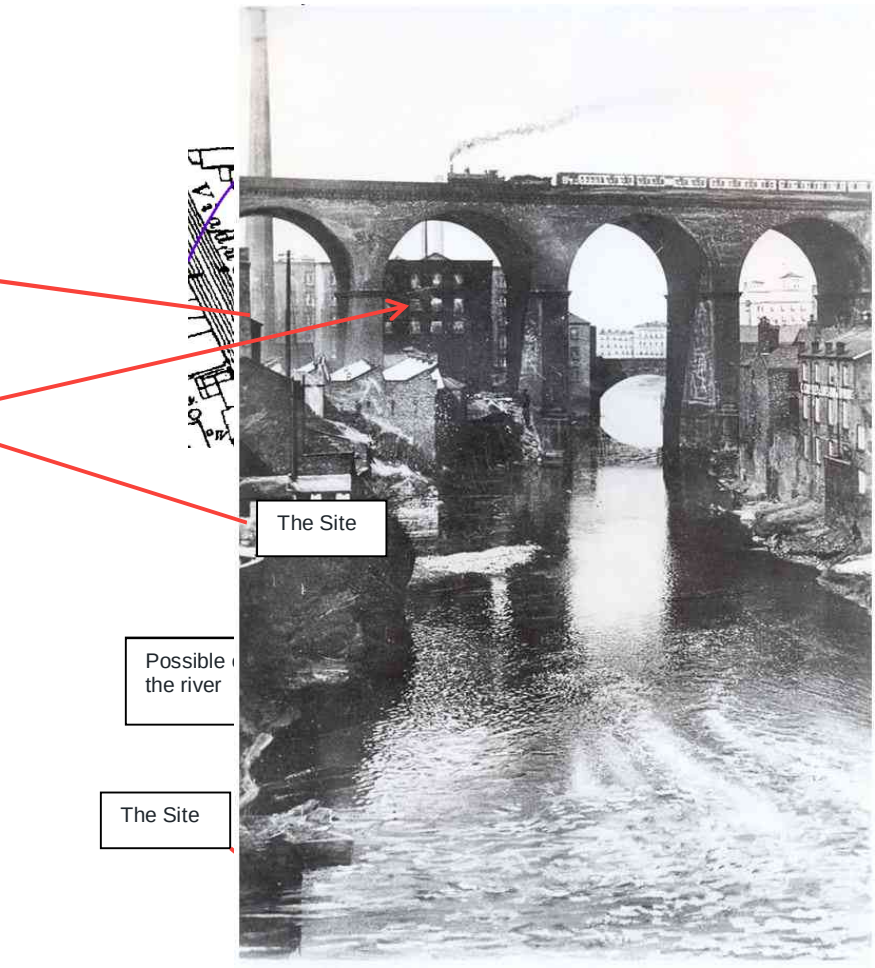
Two historical photographs available from the Stockport Image Archive [3] are presented below. Both were taken westwards from Wellington Bridge, looking towards Stockport Viaduct.

Both photographs appear to show an outfall into the river on the southern bank i.e. emanating from the site. The position of the outfall appears to be close to an engineered section of the bank, just upstream from a clothing works shown on historical maps.

Plate 5: Stockport Viaduct from Wellington Bridge c.1908

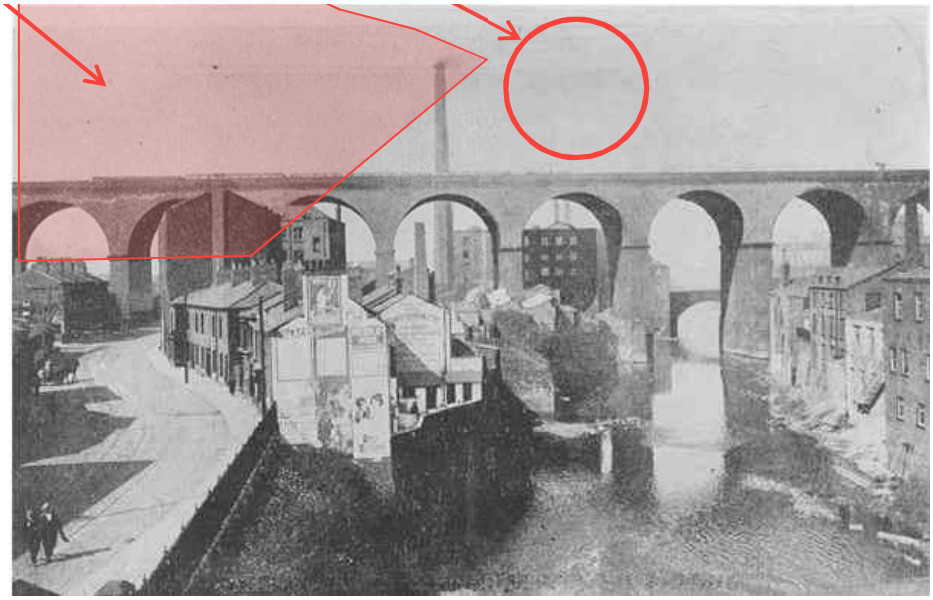
[2] Stockport Metropolitan Borough Council. 2017. *Hat Works*. [Online]. [Accessed 10/10/2017]. Available from https://www.stockport.gov.uk/topic/hat-works

[3] Stockport Metropolitan Borough Council. *Stockport Image Archive*. [Online]. [Accessed 10/10/2017]. Available from http://old.stockport.gov.uk/sia



Ordnance Survey Map dated 1910

Plate 6 Stockport Viaduct from Wellington Bridge c.1920



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3.4 CONSULTATION WITH LOCAL INTEREST GROUPS

Stockport Heritage Trust and the Derbyshire Caving Club were contacted as part of the study to ascertain if they had records of any tunnels below the site.

Whilst Stockport Heritage Trust keeps a variety of historical maps, which detail numerous tunnels servicing mills around Stockport, their coverage does not extend to the site. However, Emma Brown, a member of both the Caving Club and Stockport Heritage Trust, has explored many of the tunnels present along the River Mersey, including this study area. Her book entitled, "*Subterranean Stockport*" [4] details her findings and describes two tunnels at the location of the existing bus station.

The first tunnel is named as Fernley Gully and is described as "*a low brick archway, filled almost to the top with silt and crowned with a heavy fringe of ferns*". Consultation with the author suggests that this is Portal B discussed in Section 3.1, although her indicated location appears to be inaccurate.

The second tunnel, named as '*Binns' Deep'*, is described as being located just to the west of Fernley Gully and is described as an approximately 2m high, 1m wide tunnel cut into the sandstone.. Emma Brown describes exploring the tunnel for an unspecified distance until her progress was halted by the tunnel being bricked up. At this point she could evidently *"hear buses above*". Binns' Deep was not viewed during the recent walkover and was likely obscured by vegetation on the bank. Plates 7 and 8 were taken within Binns' Deep.

[4] Brown, E. 2016 *Subterranean Stockport*. Stroud: Amberley Publishing.

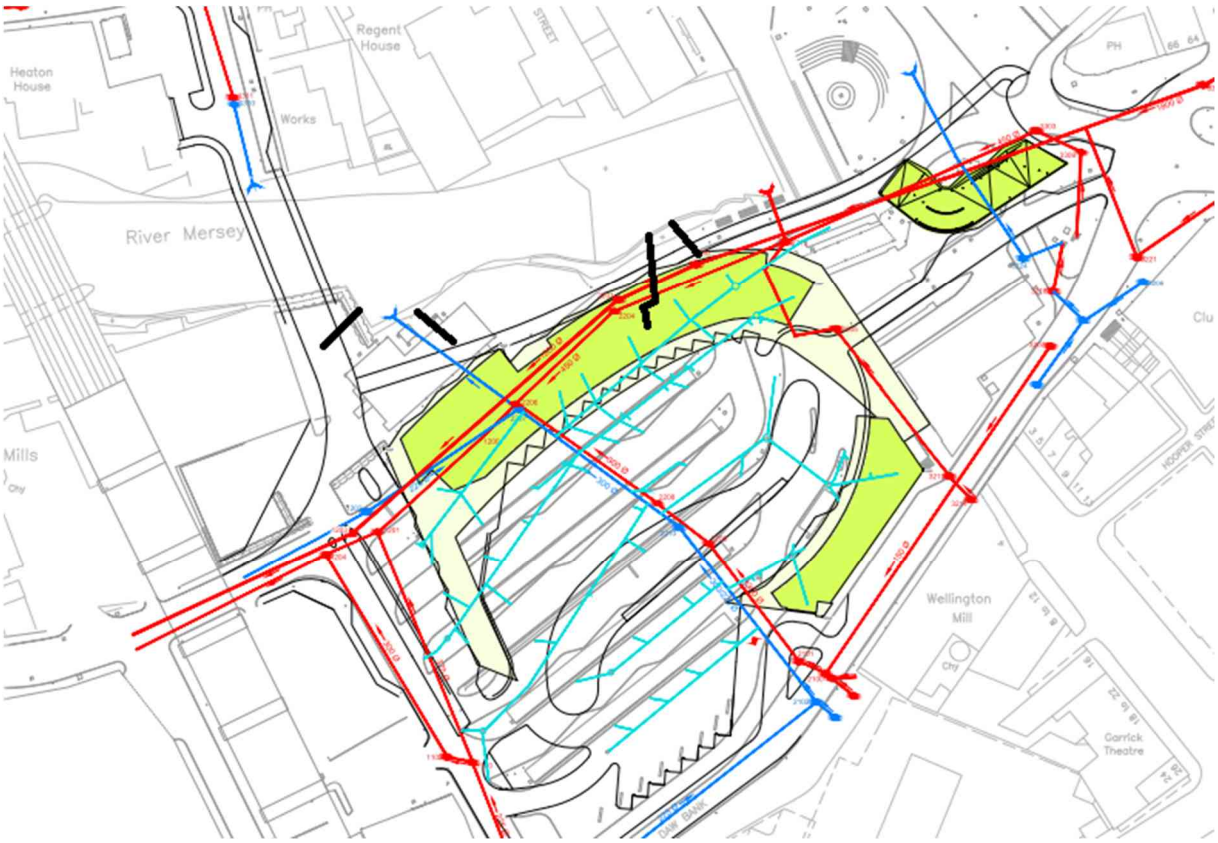
Plate 7: Binns' Deep tunnel cut into the sandstone

Plate 8: Bricked up section of Binns' Deep

Emma Brown also provided a marked up a plan indicating the approximate location of the tunnels she is aware of and these have been transposed onto the development layout below.

It can be seen that there are two tunnels (not included in her book) close to the outfall shown on the historical photographs in the west of the site. It is noted that one of these seems to correspond well with the position of a surface water sewer. The other is indicated to outfall below the location of the proposed new bridge. She did not annotate Portal A on her plan but, when questioned, indicated that she was aware of it.

Plan provided by Emma Brown showing approximate location of known tunnel entrances



3.5 DISCUSSION

Based on the data obtained it appears that there are potentially five tunnels which may project below the site, as summarised on **Figure 1** in **Appendix B**. However, it should be appreciated that much of the evidence is provided by a third party source and has not been verified due the inability to adequate view / safely access the bank. It is possible that further tunnels may be present that have not been identified or accurately located.

With regard to the future development, the principal geotechnical risks posed to the proposed redevelopment by the presence of tunnels beneath the site are considered to be;

- potential collapse of the tunnels affecting future foundations or external paved areas;
- the potential for piles (the most likely foundations solution) to penetrate tunnels during their formation; and,
- the risk of piles, which will likely gain most of their capacity in end bearing, terminating very close to the crown of a tunnel, possibly leading to over stressing of the ground and leading to significant deformation/collapse.

In order to quantify the risks to the scheme and, if the risks are considered to be significant, allow the development of appropriate mitigation measures, further works are considered necessary. It is considered that these works would be best undertaken in a phased approach with the initial phase comprising;

- A detailed survey of the southern bank of the River Mersey (along the boundary of the site and extending a short distance upstream and downstream to look for evidence of tunnel openings. This may require boat access and some vegetation clearance to enable a detailed survey to be performed.
- Accurate surveying of all observed tunnels (position, height, width and, if practicable, length and azimuth).

The results of these works could be used to design a second phase of works to locate the tunnels across the site and to allow the design of appropriate mitigation measures. Enquiries with several geophysical specialists suggest that non-invasive techniques are unlikely to provide the degree of accuracy required and it is possible that the positions will need to be established by forming a series of boreholes and using a Cavity Auto Laser Scanning System to determine the orientation and condition of the tunnels.

Alternatively hand held laser scanning surveys could be undertaken within the tunnels, however this is subject to access restrictions caused by the river level and it may only be possible to safely undertake such a survey during the summer months when the level of the River Mersey should be lower.

Appendix A

GENERAL LIMITATIONS

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

GENERAL

1. WSP UK Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report.

2. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP UK Limited standard Terms and Conditions as included within our proposal to the Client.

3. Project specific appointment documents may be agreed at our discretion and a charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP UK Limited reserves the right to amend the fee should any changes to the appointment terms create an increase risk to WSP UK Limited.

4. The report needs to be considered in the light of the WSP UK Limited proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report and any previous works referenced within the report.

PHASE 1 GEO ENVIRONMENTAL AND PRELIMINARY RISK ASSESSMENTS

Coverage: *This section covers reports with the following titles or combination of titles: phase 1; desk top study; geo environmental assessment; development appraisal; preliminary environmental risk assessment; constraints report; due diligence report; geotechnical development review; environmental statement; environmental chapter; project scope summary report (PSSR), program environmental impact report (PEIR), geotechnical development risk register; and, baseline environmental assessment.*

5. The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. WSP UK Limited cannot be held responsible for any disclosures that are provided post production of our report and will not automatically update our report.

6. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP UK Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

7. It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the site.

8. WSP UK Limited does not warrant work / data undertaken / provided by others.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

INTRUSIVE INVESTIGATION REPORTS

Coverage: *The following report titles (or combination) may cover this category of work: geo environmental site investigation; geotechnical assessment; GIR (Ground Investigation reports); preliminary environmental and geotechnical risk assessment; and, geotechnical risk register.*

9. The investigation has been undertaken to provide information concerning either:

- **i.** The type and degree of contamination present at the site in order to allow a generic quantitative risk assessment to be undertaken; or
- **ii.** Information on the soil properties present at the site to allow for geotechnical development constraints to be considered.

10. The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

11. For contamination purposes, the objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters.

12. For geotechnical investigations the purpose is to broadly consider potential development constraints associated with the physical property of the soils underlying the site within the context of the proposed future or continued use of the site, as stated within the report.

13. The amount of exploratory work, soil property testing and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions.

14. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

15. The inspection, testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. As part of this assessment, WSP UK Limited has used reasonable skill and care to extrapolate conditions between these points based upon assumptions to develop our interpretation and conclusions. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation. Conditions can change between investigation points and these interpretations should be considered indicative.

16. The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective

effects of any future changes or amendments to these values. Specific assumptions associated with the WSP UK Limited risk assessment process have been outlined within the body or associated appendix of the report.

17. Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

18. Where soil contamination concentrations recorded as part of this investigation are used for commentary on potential waste classification of soils for disposal purposes, these should be classed as indicative only. Due consideration should be given to the variability of contaminant concentrations taken from targeted samples versus bulk excavated soils and the potential variability of contaminant concentrations between sampling locations. Where major waste disposal operations are considered, targeted waste classification investigations should be designed.

19. The results of the asbestos testing are factually reported and interpretation given as to how this relates to the previous use of the site, the types of ground encountered and site conceptualisation. This does not however constitute a formal asbestos assessment. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and / or trace loose asbestos fibres within the soil matrix at the site.

20. If costs have been included in relation to additional site works, and / or site remediation works these must be considered as indicative only and must be confirmed by a qualified quantity surveyor.

EUROCODE 7: GEOTECHNICAL DESIGN

21. On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.

22. In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. The report is likely to represent a Ground Investigation Report (GIR) under the Eurocode 7 guidance.

DETAILED QUANTITATIVE RISK ASSESSMENTS AND REMEDIAL STRATEGY REPORTS

23. These reports build upon previous report versions and associated notes. The scope of the investigation, further testing and monitoring and associated risk assessments were selected on the basis of the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

24. The outputs of the Detailed Quantitative Risk Assessments are based upon WSP UK Limited manipulation of standard risk assessment models. These are our interpretation of the risk assessment criteria.

25. Prior to adoption on site they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP UK Limited. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

GEOTECHNICAL DESIGN REPORT (GDR)

26. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. All the relevant information needs to be provided to allow for a GDR to be produced.

MONITORING (INCLUDING REMEDIATION MONITORING REPORTS)

27. These reports are factual in nature and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of an earthworks or remedial works.

28. The data is presented and will be compared with assessment criteria.

Appendix B

FIGURES & DRAWINGS

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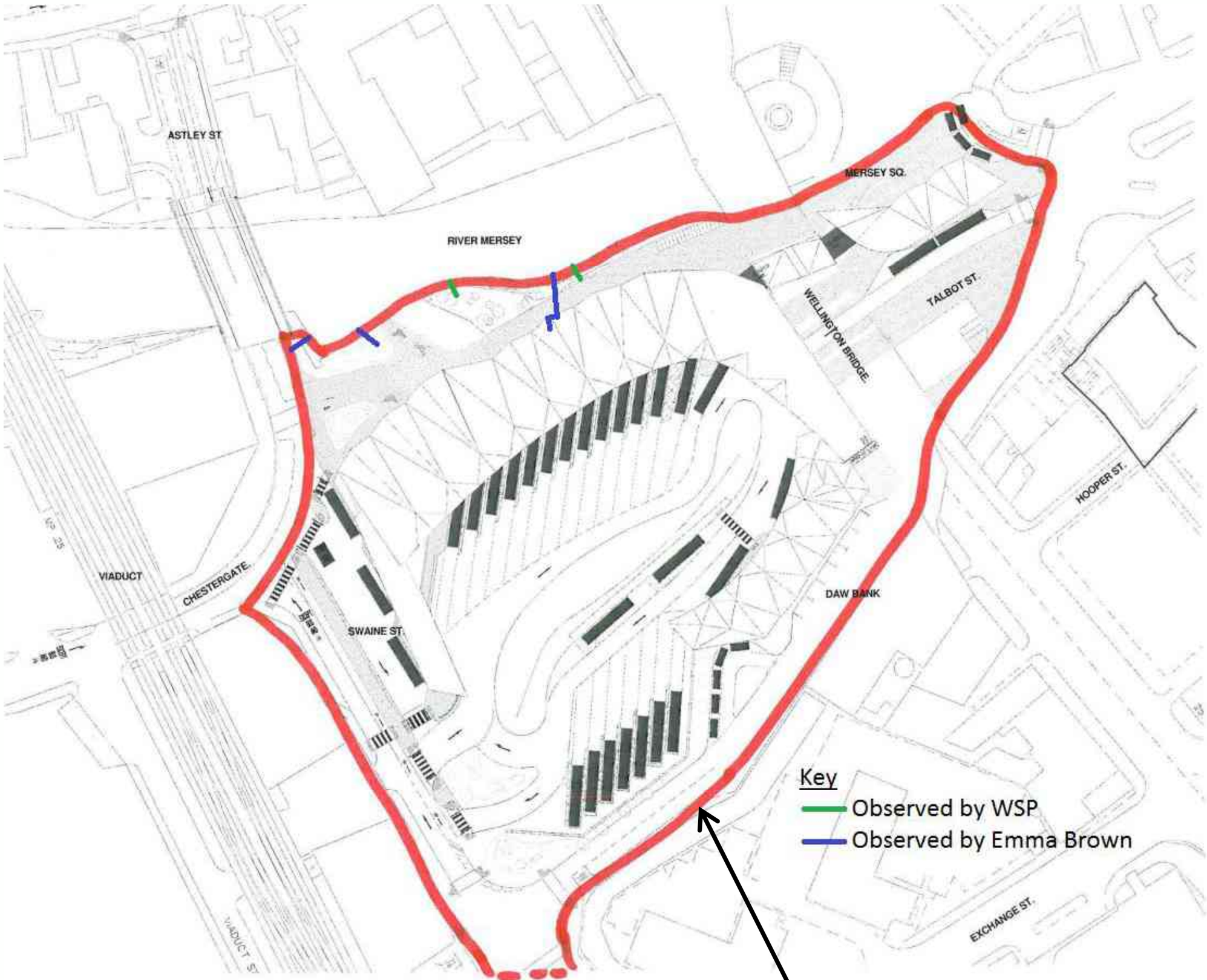

The Site

wsp
Site: Stockport Interchange
Ref: 70031899
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