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HS2

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 5: Appendix WR-005-0MA08

Water resources and flood risk

MA08: Manchester Piccadilly Station

Flood risk assessment

M331

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Department for Transport

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1 Introduction

1.1.1 This report is an appendix to the water resources and flood risk assessment. It presents the flood risk assessment for the Proposed Scheme in relation to the Manchester Piccadilly Station area (MA08).

1.1.2 This appendix should be read in conjunction with:

- Volume 2, Community Area reports;
- Volume 3, Route-wide effects;
- Volume 4, Off-route effects; and
- Volume 5, Appendices.

1.1.3 The water resources and flood risk assessments include both route-wide and community area specific appendices. The route-wide appendices comprise:

- a Water Framework Directive (WFD) compliance assessment (Volume 5: Appendix WR-001-00000); and
- a Draft water resources and flood risk operation and maintenance plan (Volume 5: Appendix WR-007-00000).

1.1.4 For the Manchester Piccadilly Station area, the relevant hydraulic modelling report (Volume 5: Appendix WR-006-00008) should also be referred to together with the water resources assessment (Volume 5: Appendix WR-003-0MA08).

1.1.5 Additional information relevant to this assessment is set out in Background Information and Data (BID):

- Water resources assessment baseline data (BID WR-004-0MA08)[1]; and
- Water Framework Directive compliance assessment baseline data (BID WR-002-00001)[2].

1.1.6 Maps referred to throughout this assessment are contained in the Volume 2, MA08 Map Book: Map Series CT-05 and CT-06.

1.1.7 Issues associated with the Sequential Test and Exception Test in the National Planning Policy Framework (NPPF) are discussed on a route-wide basis in Volume 3.

[1] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data Water resources assessment baseline data,* BID WR-004-0MA08*.* Available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-manchester-environmental-statement.
[2] High Speed Two Ltd (2017), High Speed Rail (West Midlands – Crewe), *Background Information and Data, Water Framework Directive compliance assessment baseline data,* BID WR-002-00001. Available online at: http://www.gov.uk/government/collections/hs2–phase–2b–crewe–manchester–environmental–statement.

1.2 Scope, assumptions and limitations

1.2.1 The purpose of this flood risk assessment is to consider the flood risk implications of the permanent works associated with the Proposed Scheme within the Manchester Piccadilly Station area.

1.2.2 Temporary works have not been assessed unless they are of a significant scale compared to the permanent works proposed and have the potential to adversely affect flood risk.

1.2.3 The risk of flooding to site compounds and stockpiles will be managed through the draft Code of Construction Practice (CoCP) (see Volume 5: Appendix CT-002-00000). As far as practicable, site compounds have been located outside of Flood Zone 3. However, where this is not possible, a sequential approach will be applied to the allocation of use within the compounds, seeking primarily to avoid using areas at flood risk wherever practical, but where this is unavoidable using areas at risk of flooding for the least vulnerable components and those that will avoid/limit the potential for off-site impacts. The sites will be registered with the Environment Agency Flood Warning and Flood Alert service, if available.

1.2.4 All sources of flood risk are considered, other than tidal flooding.

1.2.5 Receptors considered in this assessment include the Proposed Scheme itself, other existing infrastructure assets, residential, commercial and agricultural buildings and property potentially affected by the Proposed Scheme.

1.2.6 The assessment has involved an initial scoping study using existing available information, including data provided by statutory consultees and stakeholders. Visual surveys have been undertaken of accessible water features to verify the dimensions of key hydraulic structures. Not all structures have been visually surveyed due to access constraints. Hydraulic modelling techniques, or other suitable quantitative methods, have been adopted in locations where the potential for adverse impacts on flood risk were identified in the scoping study. Details of the modelling decision tree process are provided in the Environmental Impact Assessment Scope and Methodology Report (SMR) Technical Note: Flood risk (see Volume 5: Appendix CT-001-00001). Hydraulic modelling has made best use of existing models provided by the Environment Agency. No new channel survey data have been obtained. Floodplain geometry was, however, updated using Light Detection and Ranging (LiDAR) data.

1.2.7 The hydraulic analysis work has been based on conservative assumptions about the potential hydraulic impacts of the structures proposed. All hydraulic calculations will require refinement during design development using additional topographical survey data. The models will then require further development to reflect the design development of hydraulic structures and flood risk mitigation measures.

1.2.8 The Volume 2, Community Area report for the Manchester Piccadilly Station area describes the avoidance strategy and mitigation measures included in the design to limit the temporary and permanent effects of the Proposed Scheme as far as is reasonably practicable. This flood risk assessment therefore assesses the impacts and effects arising

following the implementation of the avoidance and mitigation measures, and reports on whether any additional mitigation may be needed where the Proposed Scheme may result in significant effects.

1.3 Location and extent

1.3.1 The location and extent of the Manchester Piccadilly Station study area is shown in Figure 1.

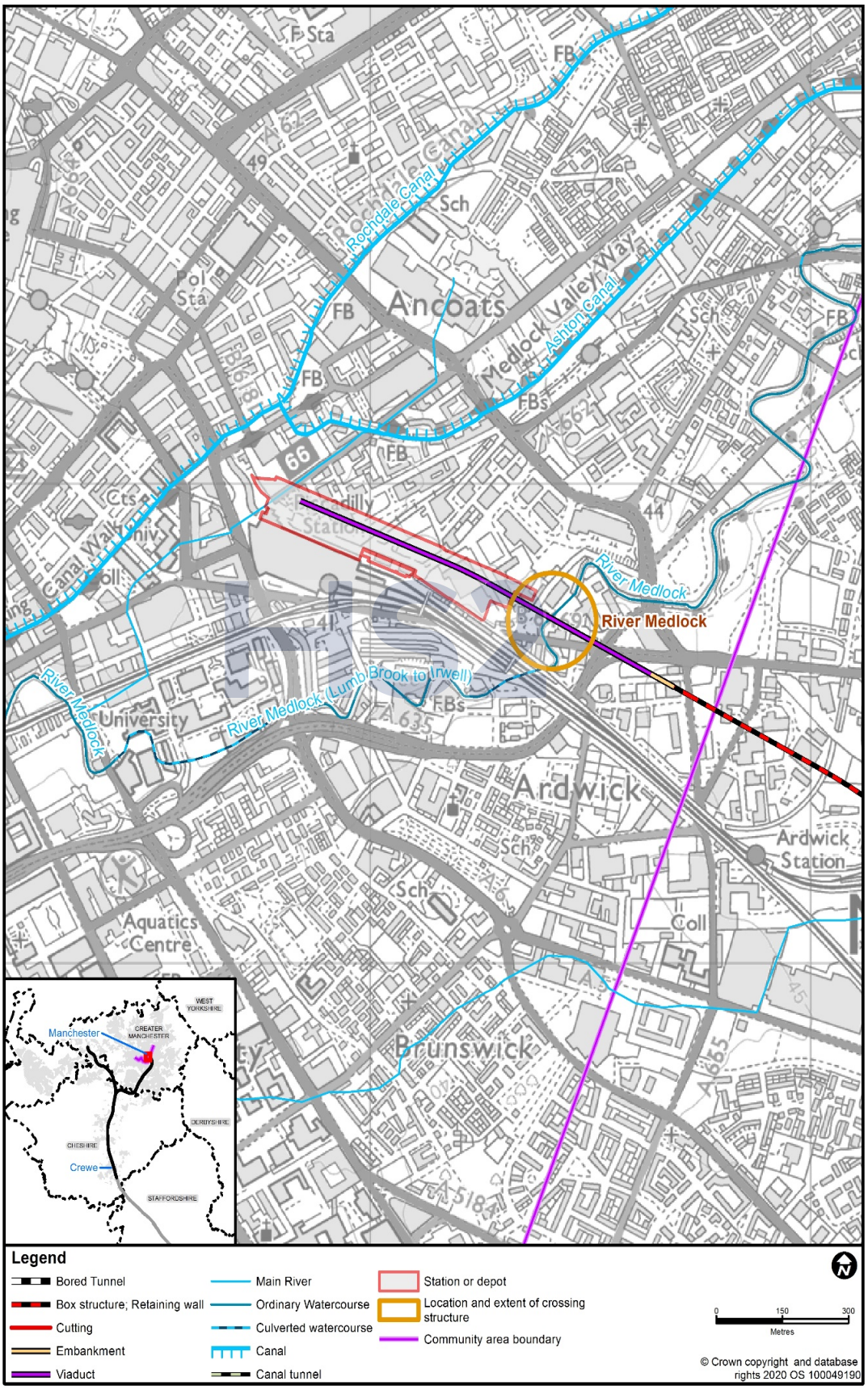
1.3.2 The study area extends 500m from the route of the Proposed Scheme as the Manchester Piccadilly Station area is fully urbanised. All flood risk receptors have been identified within these limits. If modelling assessments identified potential impacts beyond these limits, the study area has been extended accordingly.

1.3.3 The extent of the land required during construction of the Proposed Scheme, Environment Agency Flood Zones 2 and 3[3], as well as the areas at risk from surface water flooding are shown on Volume 5, Water resources and flood risk Map Book, Map Series WR-01 – Surface Water Baseline. The flood zone information is based on the Environment Agency's Flood map for planning (rivers and sea) and the risk of flooding from surface water maps (RoFSW)[4].

[3] Flood Zone 2 comprises land assessed as having between a 1 in 100 (1.0%) and 1 in 1,000 (0.1%) annual probability of river flooding; Flood Zone 3 comprises land assessed as having a 1 in 100 (1.0%) or greater annual probability of river flooding.

[4] Environment Agency (2021), *Long term flood risk information.* Available online at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/.

Figure 1: Location and extent of the study area



2 Policy context and consultation

2.1 National

2.1.1 The Proposed Scheme design has been developed in general accordance with the requirements of the NPPF. This aims to prevent inappropriate development in areas at risk of flooding and to ensure that, where development is necessary in areas at risk of flooding, it is safe, will not increase flood risk elsewhere and, where possible, reduces flood risk overall. The Sequential Test and Exception Test in the NPPF aim to achieve these policy objectives.

2.1.2 The Flood and Water Management Act 2010 requires the Environment Agency to 'develop, maintain, apply and monitor a strategy for flood and coastal erosion risk management in England'. The Environment Agency therefore has oversight of all matters related to flood risk and is a statutory consultee for flood risks associated with main rivers and reservoirs. The Environment Agency has been consulted throughout the process of undertaking this assessment and has provided extensive data and guidance on the interpretation of policy.

2.2 Regional and local

2.2.1 Under the Flood and Water Management Act 2010, the statutory consultee for all matters related to local flood risk, including works affecting ordinary watercourses, is the Lead Local Flood Authority (LLFA). Manchester City Council (MCC) is the LLFA in the Manchester Piccadilly Station area. Discussions have been held with MCC and the Environment Agency technical specialists to agree the principles related to the hydraulic design of the Proposed Scheme and the approach adopted for the assessment of flood risk on main rivers and ordinary watercourses. The modelling is presented in the River Medlock Hydraulic modelling report (Volume 5: Appendix WR-006-00008).

2.2.2 The MCC Preliminary Flood Risk Assessment (PFRA)[5] was published in 2011 and the Local Flood Risk Management Strategy (LFRMS)[6] was published in 2014. The LFRMS contains a number of policies related to sustainable development, access to, and maintenance of, ordinary watercourses, and the need to consider environmental opportunities that reinforce the objectives of the River Basin Management Plan (RBMP)[7]. The Proposed Scheme design has sought to align with these objectives where reasonably practicable.

[5] JBA Consulting (2011), *Manchester City Council Preliminary Flood Risk Assessment.* Available online at: https://www.manchester.gov.uk/egov_downloads/MCC_PFRA.pdf.

[6] Manchester City Council (2014), *Manchester City Council Local Flood Risk Management Strategy.* Available online at: https://secure.manchester.gov.uk/downloads/download/5603/lfrms_documents.

[7] Environment Agency (2015), *North West River Basin Management Plan.* Available online at: https://www.gov.uk/government/publications/north-west-river-basin-district-river-basin-management-plan.

2.2.3 The Manchester City, Salford City and Trafford Councils have produced a Strategic Flood Risk Assessment (SFRA)[8] that covers the Manchester Piccadilly Station area. The key flood risk objectives outlined in the SFRA are to reduce surface water runoff, support Water Framework Directive delivery and prevent new development within sensitive development locations. The Proposed Scheme design has sought to align with these objectives where reasonably practicable.

[8] JBA Consulting (2011), *Manchester, Salford and Trafford Strategic Flood Risk Assessment.* Available online at: https://www.trafford.gov.uk/planning/strategic-planning/docs/manchester-salford-and-trafford-councils-level-2-hybrid-sfra-level-1-sfra-march-2010.pdf.

3 Flood risk baseline

3.1 Historical flooding incidents

3.1.1 The PFRA and SFRA published by MCC report no incidents of historical flooding from watercourses or surface water sources within 500m of the Proposed Scheme in the last 100 years.

3.1.2 A review of the Section 19[9] historical flood reports in the Manchester Piccadilly Station area showed one Section 19 report for a flood event within 10km of the Proposed Scheme, the Greater Manchester flood event on 26th December 2015[10]. The report has been reviewed but contains no information relevant to assessment of flood risk for the Proposed Scheme.

3.1.3 There has also been a recent flood event that occurred in March 2019[11] near to the Proposed Scheme. This may be subject to a future Section 19 flood investigation report, that will be reviewed and considered if available within the timeframe of this study.

3.2 Risks associated with main rivers and ordinary watercourses

3.2.1 The key flood risk from main rivers is that associated with the River Medlock. The only ordinary watercourses in the study area are fully culverted and will not be considered further.

3.2.2 The areas at risk of flooding from this watercourse, the receptors potentially affected, and the climate change allowances used in the assessment of impacts and effects are considered below. Receptors have been identified based on OS mapping and committed development information[12].

Risk from main rivers: River Medlock

3.2.3 A 1D–2D hydraulic model of the River Medlock has been developed to define the peak flood levels and extents associated with a range of annual probabilities, and details are reported

[9] Section 19 of the Flood and Water Management Act 2010 sets out the requirement for that on becoming aware of a flood in its area, a LLFA must investigate and report on which risk management authorities have relevant flood risk management functions and whether each authority has exercised those functions in response to the flood.

[10] Manchester City Council (2016), *Flood Investigation Report. Greater Manchester*. Available online at: https://www.greatermanchester-ca.gov.uk/media/1261/boxing-day-flood-report.pdf.

[11] Manchester Evening News (2019), *Day of chaos across the region as a MONTH'S rainfall deluges Greater Manchester in under 24-hours*. Available online at: https://www.manchestereveningnews.co.uk/news/greater-manchester-news/manchester-weather-rain-flooding-live-15983239.

[12] Provided by the local authorities (November 2019).

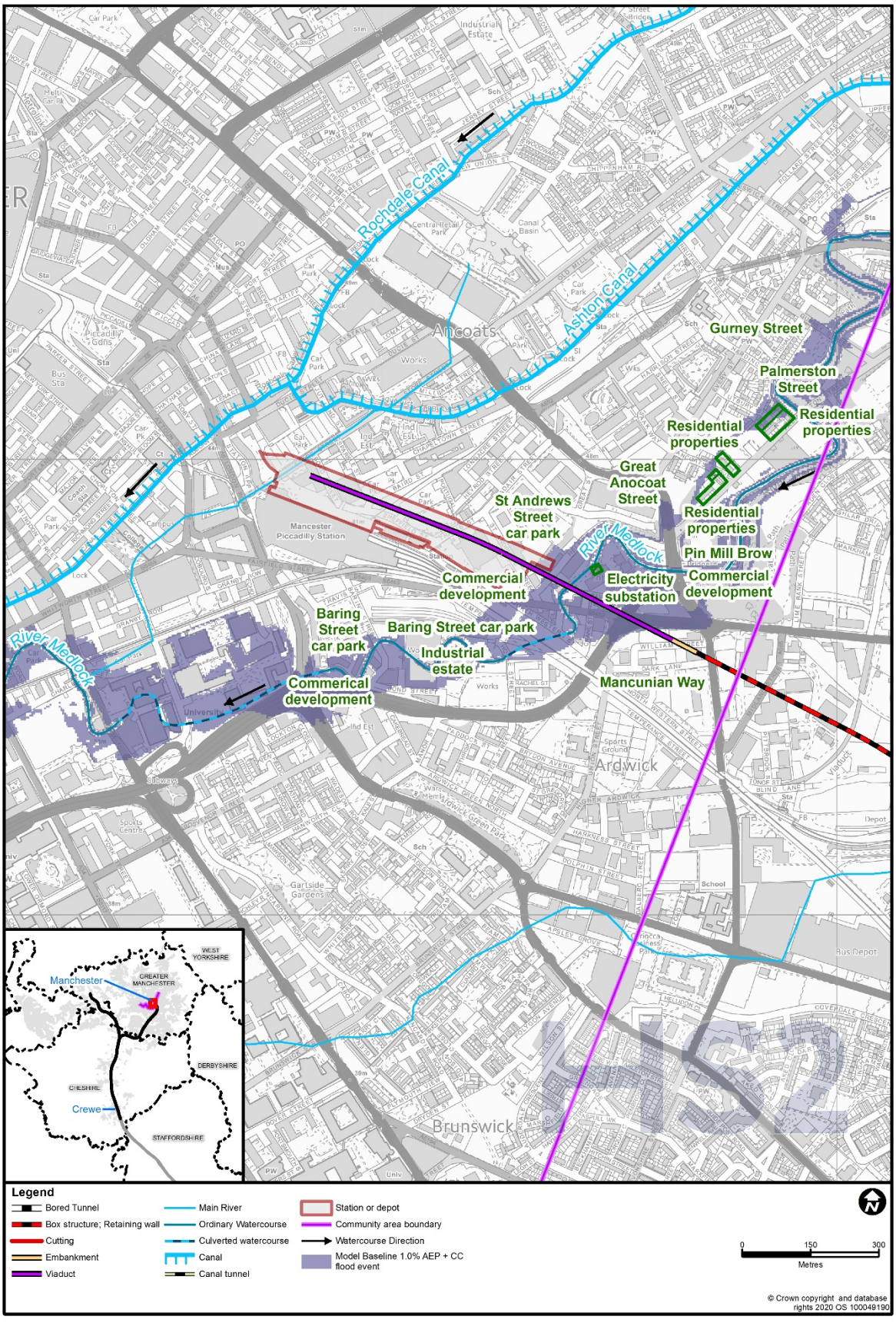
in Volume 5, Hydraulic modelling report, Appendix WR-006-00008. The hydrology in the existing Environment Agency River Medlock model has been revised using up-to-date flood records and the Flood Estimation Handbook (FEH) statistical method; no other updates have been made to the supplied baseline model. The inundation extents for the 1 in 100 (1.0%) annual exceedance probability (AEP) plus climate change (CC) flood event are shown in Figure 2.

3.2.4 The receptors upstream and downstream of the Proposed Scheme at potential risk from this watercourse are listed below. The relative vulnerability to flooding of each receptor, as defined in NPPF and Section 21 of SMR is also indicated:

- electricity sub-station (essential infrastructure);
- residential properties along Palmerston Street (more vulnerable);
- residential properties along Linton Close (more vulnerable);
- residential properties along Ancoats Grove (more vulnerable);
- several streets and roads including Palmerston Street, Gurney Street, Great Ancoat Street, and A665 Pin Mill Brow (less vulnerable);
- commercial property on A665 Pin Mill Brow and B6469 Fairfield Street (less vulnerable);
- Enterprise Park industrial estate (less vulnerable);
- car park at St. Andrew's Street (water compatible);
- Mancunian Way industrial estate (less vulnerable);
- commercial property on Nether Street and Baring Street (less vulnerable);
- A635 Mancunian Way (less vulnerable); and
- car park at Baring Street (water compatible).

3.2.5 In line with the SMR, a climate change allowance has been adopted to assess the future flood risk to receptors associated with each watercourse crossing using the Environment Agency guidelines. For catchment areas greater than or equal to 5km^2 in size the guidance recommends that a peak river flow allowance is used. The percentage uplift in peak river flow used to assess flood risk to receptors reflects the location of the receptor in the floodplain (flood zone) and its flood risk vulnerability classification. The upper end allowance in Flood Zone 3b of 70% increase in peak river flow has been adopted on a precautionary basis for this assessment.

Figure 2: Extent of the modelled 1.0% AEP + CC flood event, River Medlock



3.3 Risks associated with surface water

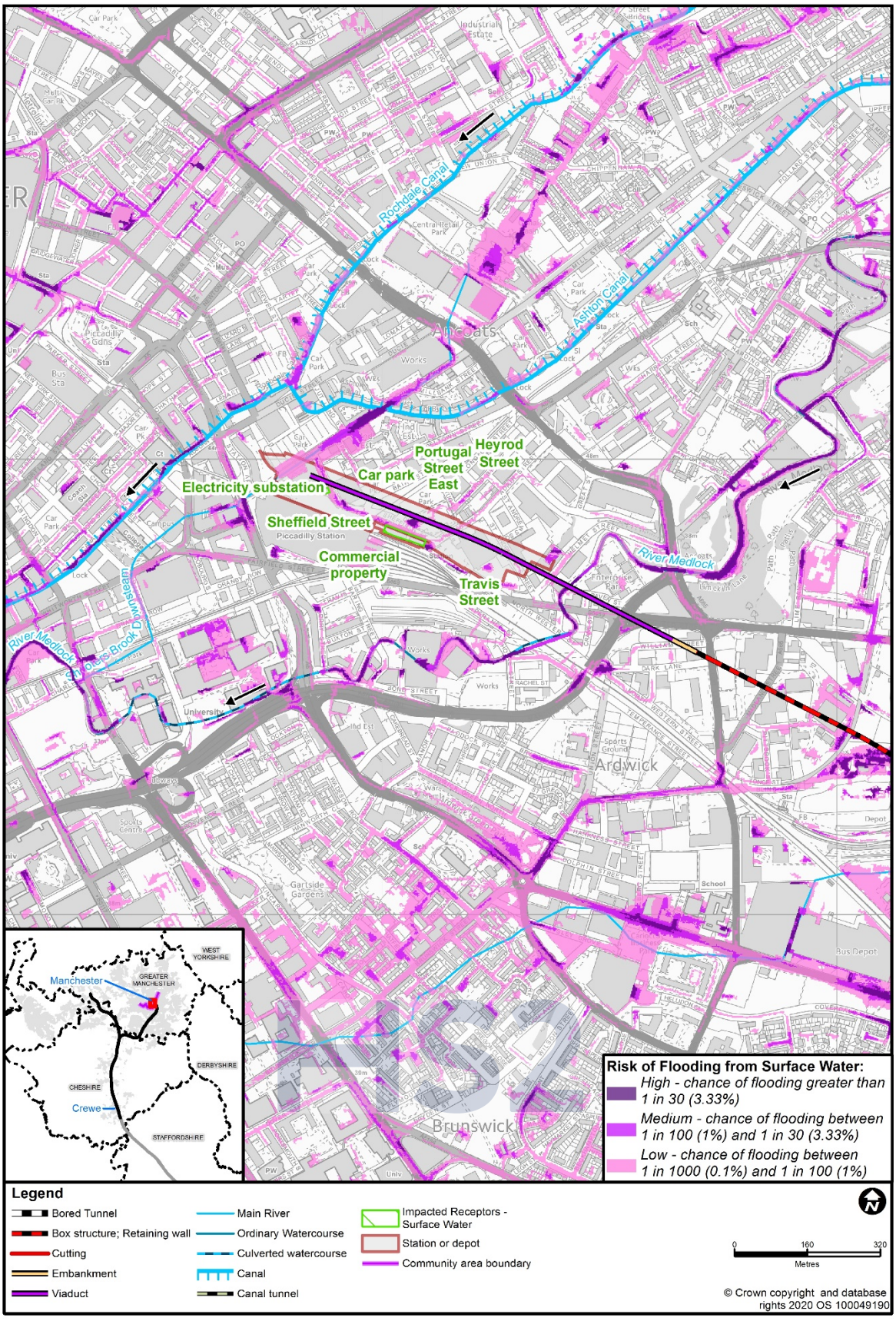
3.3.1 This section describes the risk associated with surface water as shown by the Environment Agency's RoFSW dataset for the 1 in 1000 (0.1%) annual exceedance probability (AEP) flood event. This dataset indicates where surface water flow paths cross the Proposed Scheme. Three surface water flow paths have been identified in the study area:

- Travis Street (less vulnerable) are at risk from a surface water flow path, as indicated in Figure 3;
- Heyrod Street (less vulnerable), Portugal Street East (less vulnerable) and car park (water compatible) are at risk from a surface water flow path at Heyrod Street, as indicated in Figure 3; and
- an electricity sub-station (essential infrastructure), commercial property (less vulnerable) and Sheffield Street (less vulnerable) are at risk from surface water flow path at Sheffield Street, as indicated in Figure 3.

3.3.2 In line with the SMR, a climate change allowance has been adopted to assess the future flood risk to receptors associated with each watercourse crossing using the Environment Agency guidelines. For catchment areas less than 5km^2 in size the guidance recommends that a peak rainfall intensity allowance is used. The percentage uplift in peak rainfall intensity used to assess flood risk reflects the location of the receptor in the floodplain (flood zone) and its flood risk vulnerability classification. The upper end allowance of 40% increase has been adopted on a precautionary basis for this assessment.

3.3.3 A summary of the baseline flood risk from surface water is provided in Table 1.

Figure 3: Extent of the Environment Agency's RoFSW[4] dataset, surface water flow paths



3.4 Risks associated with groundwater

3.4.1 The BGS susceptibility to groundwater flooding dataset[13] provides the main dataset used to scope the future risk of groundwater flooding. The assessment of susceptibility is based on rock type and estimated groundwater levels during periods of extended intense rainfall. The dataset shows groundwater flooding susceptibility, on a 50m grid, using the following three classes:

- A – limited potential for groundwater flooding to occur;
- B – potential for groundwater flooding of property situated below ground level; and
- C – potential for groundwater flooding to occur at the surface.

3.4.2 The BGS susceptibility to groundwater flooding dataset is a hazard dataset based on favourable geological conditions for groundwater flooding. The dataset is not based on risk and as such does not show the likelihood of a groundwater flooding event actually occurring.

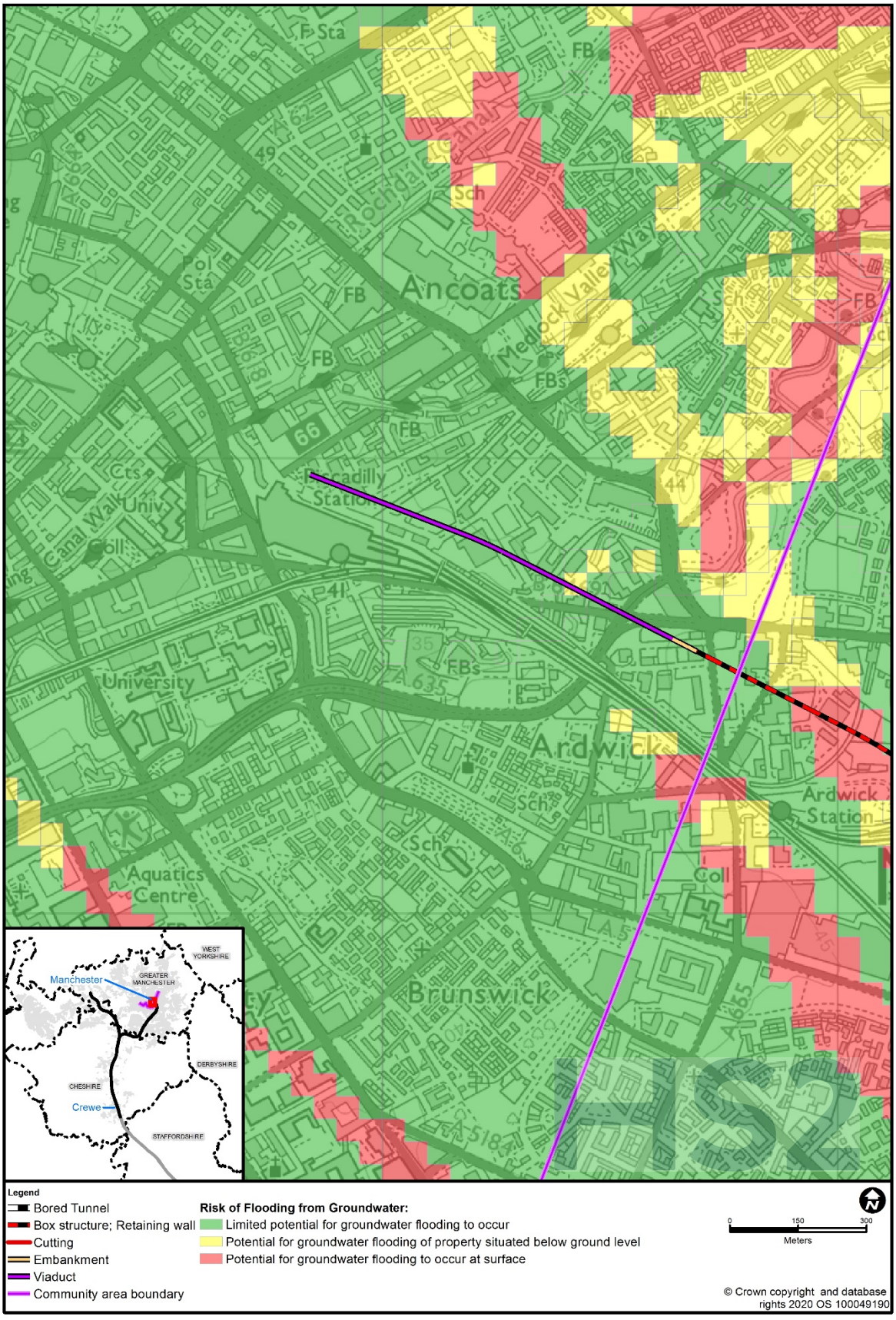
3.4.3 The BGS susceptibility to groundwater flooding dataset (presented in Figure 4) indicates that there is no significant potential for groundwater flooding to occur at surface within the Manchester Piccadilly Station area. However, there is potential for groundwater flooding to occur at properties below ground level at residential and commercial properties in the following locations:

- immediately north of the junction between A635 Fairfield Street and A665 Pin Mill Brow interchange; and
- residential properties along Palmerston Street.

3.4.4 Occurrences of higher groundwater flooding risk align with mapped areas of the Manchester Marl mudstone bedrock. This suggests that the groundwater flood risk is likely to be in part due to the effect of the bedrock preventing downward migration of water beyond the superficial deposits. The occurrence of higher groundwater flood risk along the River Medlock is likely to be the result of the interaction between the bedrock and superficial alluvium, as well as the nature of other superficial deposits (glacial till). The SFRA[8] does not report any historic groundwater flooding incidents within the study area.

[13] British Geological Survey (2018), *BGS susceptibility to groundwater flooding dataset*. Available online at: http://www.bgs.ac.uk/products/hydrogeology/groundwaterFlooding.html.

Figure 4: Susceptibility to groundwater flooding throughout the study area



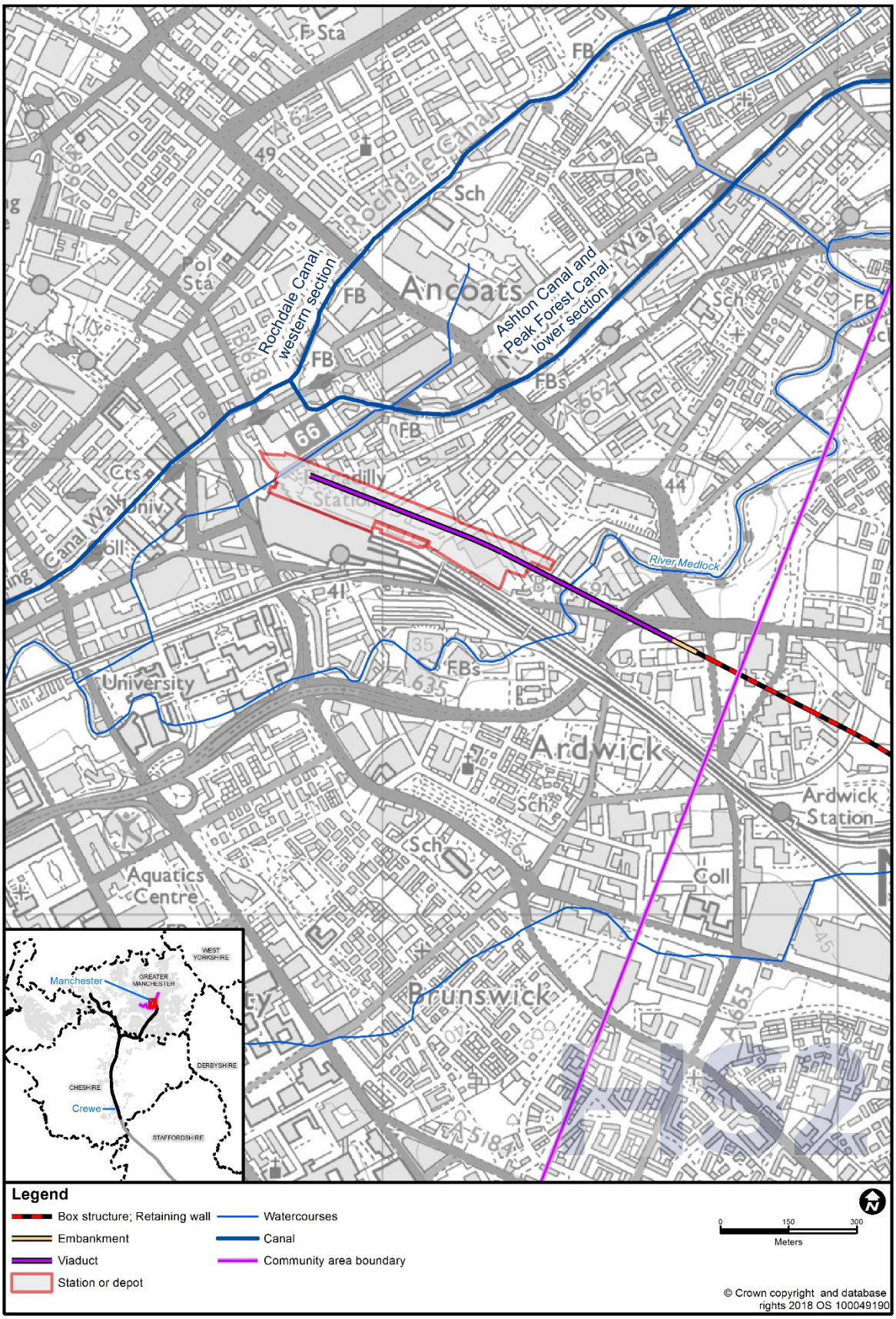
3.5 Risks associated with artificial sources

3.5.1 Flooding from artificial water bodies may occur due to failure of an impounding structure, such as a dam or canal embankment. The following features have been identified within the study area that are a potential source of flood risk:

- Rochdale Canal (located approximately 140m from Manchester Piccadilly Station) and Ashton Canal (located approximately 110m from Manchester Piccadilly Station) pass through the Manchester Piccadilly Station area. The Proposed Scheme viaduct and station do not cross either canal, therefore, flood risk to the canal will be unchanged. In the event of canal embankment failure or overtopping of the canal however, flood risk could be posed to the Proposed Scheme; and
- major water supply pipelines and sewerage (foul and surface water) infrastructure has potential to cause flooding should it fail. However, this infrastructure, and its potential failure, is accounted for in the assessment of surface water flooding and in the design of the Proposed Scheme, as shown in Volume 2, MA08 Map Book: Map Series CT-05 and CT-06.

3.5.2 Figure 5 shows the location of artificial sources within the Manchester Piccadilly Station area and a summary of the baseline flood risk from artificial sources is provided in Table 1.

Figure 5: Artificial flood sources in the vicinity of the study area



3.6 Summary of baseline flood risk

3.6.1 Table 1 provides a summary of all the relevant sources of flood risk identified, the receptors potentially affected, their relative vulnerability and the climate change allowances used in the modelling assessments and calculations.

Table 1: Summary of baseline flood risk

Source/pathway	Receptors	Data source	Highest receptor vulnerability level	Climate change allowance used for assessment
River Medlock	Electricity sub-station (essential infrastructure)	1.0% AEP + CC flood extent	Essential infrastructure	70% (increase to peak river flow)
	Residential properties along Palmerston Street (more vulnerable)			
	Residential properties along Linton Close (more vulnerable)			
	Residential properties along Ancoats Grove (more vulnerable)			
	Several streets and roads including Palmerston Street, Gurney Street, Great Ancoat Street, and Pin Mill Brow (less vulnerable)			
	Commercial property on Pin Mill Brow and Fairfield Street (less vulnerable)			
	Enterprise Park industrial estate (less vulnerable)			
	Car park on St. Andrew's Street (water compatible)			
	Mancunian Way industrial estate (less vulnerable)			
	Commercial property on Nether St and Baring Street (less vulnerable)			
	A635 Mancunian Way (less vulnerable)			
	Car park at Baring Street (water compatible)			
Surface water flow along Travis Street	Travis Street (less vulnerable)	RoFSW 0.1% AEP flood extent	Less vulnerable	40% (increase in peak rainfall intensity)
	Morville Street (less vulnerable)			
Surface water flow along Heyrod Street	Heyrod Street (less vulnerable)	RoFSW 0.1% AEP flood extent	Less vulnerable	40% (increase in peak rainfall intensity)
	Portugal Street East (less vulnerable)			
	Car park (water compatible)			
	Electricity sub-station			

Source/pathway	Receptors	Data source	Highest receptor vulnerability level	Climate change allowance used for assessment
Surface water flow along Sheffield Street	Commercial property on Sheffield Street	RoFSW 0.1% AEP flood extent	Essential infrastructure	40% (increase in peak rainfall intensity)
Groundwater at River Medlock	Residential properties along Palmerston Street (more vulnerable)	BGS susceptibility to groundwater flooding dataset	More vulnerable	N/A
	Industrial properties north of A665 Pin Mill Brow (less vulnerable)			
	Every Street (less vulnerable)			

4 Flood risk impacts and effects

4.1 Rivers and ordinary watercourses

Viaducts

4.1.1 The Proposed Scheme within the Manchester Piccadilly Station area will include the Piccadilly approach viaduct, a crossing of the River Medlock. Hydraulic modelling of this watercourse has been used in the design and assessment of the Proposed Scheme to determine the likely impact on flood levels from intermediate piers, or any other permanent features associated with the Proposed Scheme that are within the flood zones or predicted flood extents.

4.1.2 The modelling has been used to provide greater certainty over the magnitude of impacts the Proposed Scheme is likely to have on the 1.0% AEP plus an allowance for climate change (CC) flood level.

4.1.3 Details of the hydraulic modelling assessments undertaken of this watercourse can be found in the supporting hydraulic modelling report contained in Volume 5, Hydraulic modelling report, Appendix WR-006-00008. The results of the assessment are reported below.

River Medlock

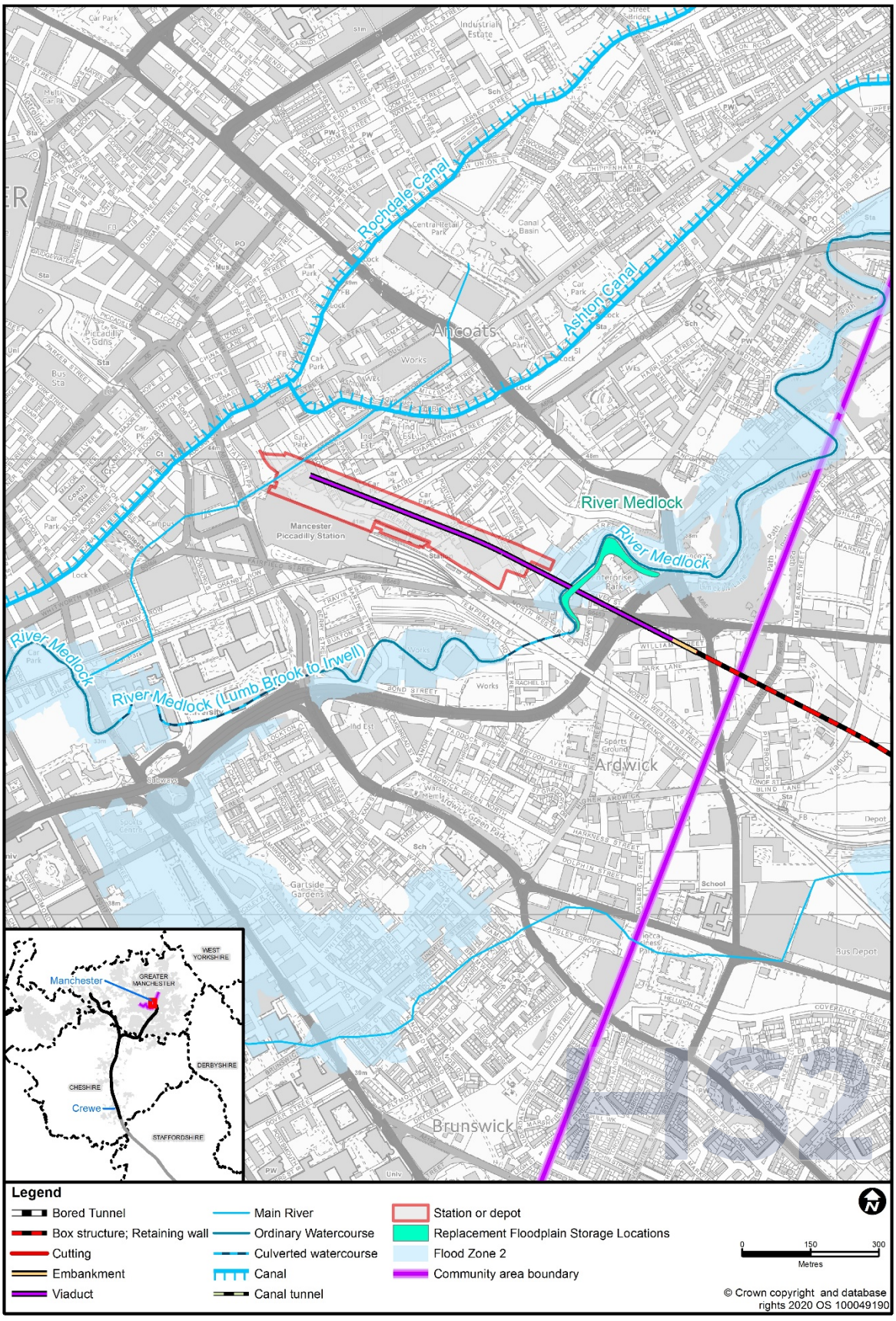
4.1.4 The Piccadilly approach viaduct is approximately 470m in length. Hydrological peak flows were updated from those provided by the Environment Agency, using up-to-date flood records and the FEH statistical method.

4.1.5 The baseline model has been edited to represent the Proposed Scheme as follows:

- inclusion of the Piccadilly approach viaduct piers;
- removal of buildings to be demolished as part of the Proposed Scheme;
- inclusion of replacement floodplain storage (RFS); and
- extension of the existing culvert under the railway line immediately downstream of the Piccadilly approach viaduct by 10m to allow for a new road crossing.

4.1.6 RFS has been identified on a volume for volume basis upstream of the Proposed Scheme crossing (Figure 6). This has been achieved by lowering the existing ground levels in the RFS by an average of approximately 0.5m.

Figure 6: Replacement floodplain storage area



4.1.7 The modelled impact of the Proposed Scheme, with RFS mitigation, on peak flood levels indicates the potential for:

- a decrease in peak flood levels of up to 1mm upstream of the Proposed Scheme crossing; and
- an increase in peak flood levels of up to 1mm downstream of the Proposed Scheme crossing.

4.1.8 The changes in peak flood level of plus or minus 1mm are classified as negligible impacts, resulting in a negligible effect. This has not been mapped as no impact would be shown.

4.1.9 An additional model run has been undertaken to include the removal of three redundant river crossing culverts. This opportunity has been raised for its potential to improve the River Medlock WFD status in the vicinity of the Proposed Scheme. These culverts are:

- the 70m long culvert at Enterprise Park, located immediately upstream of the Proposed Scheme crossing;
- the footbridge crossing located approximately 100m upstream from the Enterprise Park culvert; and
- the culvert beneath the B6469 Fairfield Street, located approximately 50m downstream from the Enterprise Park culvert.

4.1.10 This model run resulted in increased flood risk downstream of the Piccadilly approach viaduct. This is a result of an increase in channel conveyance due to the removal of the culvert flow restrictions. To compensate for the increase in downstream flood risk, further model runs were undertaken to include alternative hydraulic controls upstream and downstream of the Piccadilly approach viaduct. These model runs showed that it would be possible to offset the increase in downstream flood risk using a flow restriction upstream of the crossing, should this improvement opportunity be undertaken.

4.1.11 Further topographical survey, other surveys as required, hydraulic modelling, and refinement of the mitigation measures will be undertaken at design development with the aim of ensuring no impacts on peak flood levels.

4.2 Surface water

4.2.1 As outlined previously the RoFSW[4] dataset and inspection of topographical survey information has identified surface water flow paths that are not represented by any formal channel feature and so are not watercourses.

4.2.2 The surface water flow regime in the Manchester Piccadilly Station area will be altered from the baseline due to the demolition of buildings and construction of the Manchester Piccadilly High Speed station. The viaduct elevation and distance between the piers will be sufficient to allow any surface water flow paths to pass below. Any surface water flow paths intercepted by new infrastructure will be addressed as part of the highway and railway drainage design.

4.2.3 By following this design approach, the local flood risk characteristics are preserved and the risk to the receptors is unchanged.

4.3 Groundwater

4.3.1 The principal mechanism by which the Proposed Scheme may increase groundwater flood risk is where sub surface structures of lower permeability than the existing geology, such as lined tunnels or pile walls, may act as a barrier to groundwater flow. These barriers will have the potential to cause a rise in the groundwater level in the vicinity of the structures.

4.3.2 To assess the possible changes to groundwater levels and flow, and the associated change in groundwater flood risk, a high-level assessment of the groundwater conditions along the route of the Proposed Scheme has been undertaken. This assessment has identified where the Proposed Scheme is likely to interact with groundwater. The high-level assessment identified which elements of the scheme design such as cuttings, retaining walls, viaduct and bridge foundations, basements, excavations and temporary works will intercept aquifers and any that pose a groundwater flood risk. An assessment has been made of the degree to which the design features encroach on the aquifer and the potential changes in groundwater level and restrictions on groundwater flow. Receptors within the area at risk of potential changes in groundwater level or flow were then identified. The likely maximum zone of influence from any dewatering taking place has also been assessed. Further details of groundwater level changes are set out in the Volume 5, Water resources assessment Appendix WR-003-0MA08.

4.3.3 In the vicinity of the Proposed Scheme, there are small areas adjacent to the River Medlock, east of Helmet Street, where the BGS susceptibility to groundwater flooding data set[13] shows potential for groundwater flooding of basements. There will be the potential for groundwater level rise north of the Proposed Scheme due to the Piccadilly approach viaduct pile foundations and could result in an increased risk of groundwater flooding in this area. It is likely that the commercial properties (moderate value receptors) located in these areas will be demolished as part of the Proposed Scheme. Future development of this area is planned to be mixed commercial and industrial property (moderate value receptors) (allocations[14] MA08/096, 038, and 042) and a residential development (high value receptor) (allocation 044[14]). On a precautionary basis, pending further investigation, the potential impact is considered minor affecting moderate and high value receptors, resulting in moderate adverse effects, which are significant.

4.3.4 The Manchester Piccadilly High Speed station will include basement levels, incorporate space for two Metrolink stops and provide the Ashton Line connection (shown in Figure 7). The Proposed Scheme will therefore extend through the glacial till into the underlying Chester Formation. Groundwater level data provided by the Environment Agency shows that excavation for the basement and Ashton Line connection is not expected to intercept

[14] Further details of these allocations can be found in Volume 5: Appendix CT-004-00000, Planning data.

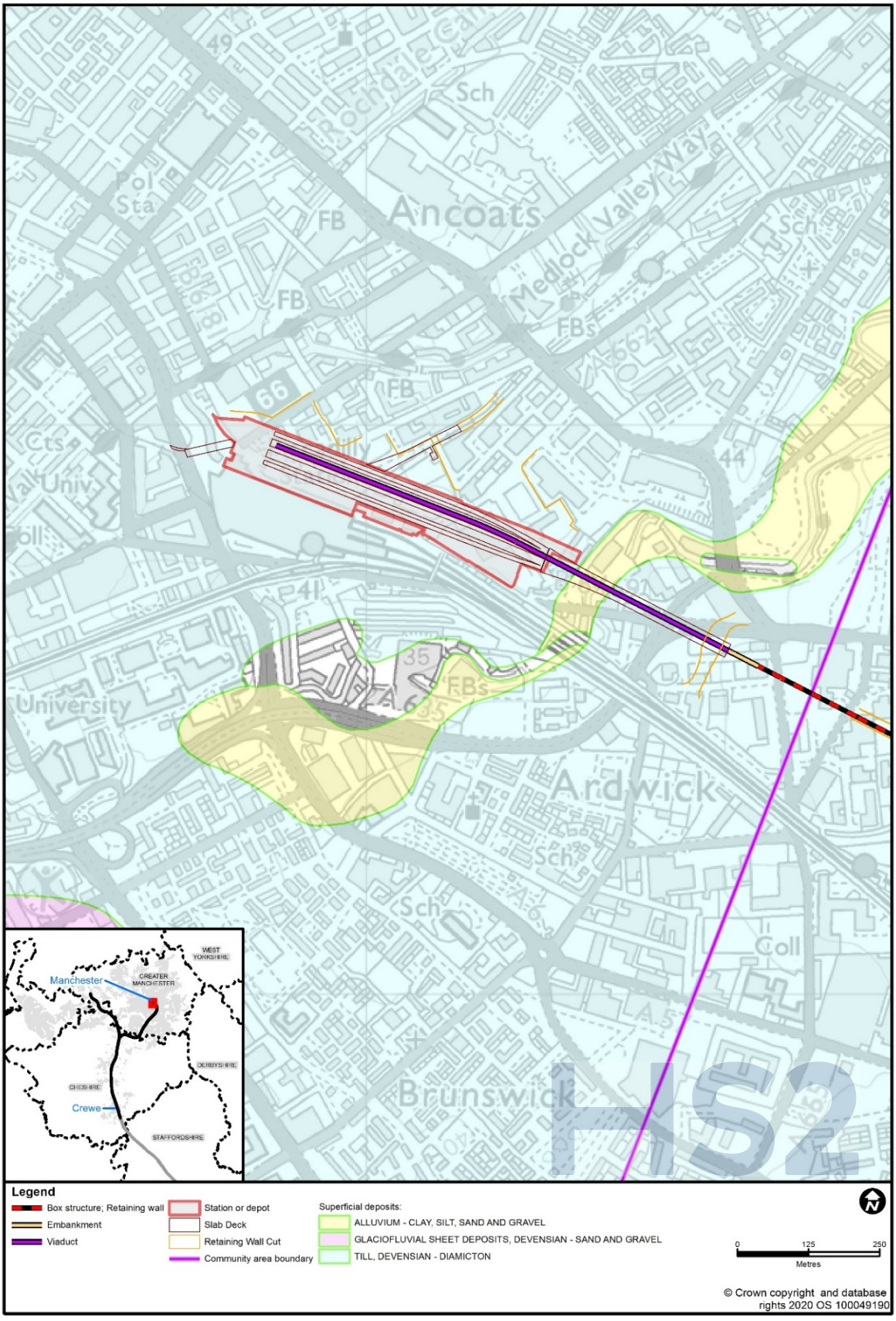
groundwater in the Chester Formation Aquifer. The below ground structures of the Manchester Piccadilly High Speed station and Ashton Line connection could form a significant barrier to any groundwater flow in the glacial till, potentially increasing the risk of groundwater flooding at the surface at times of high groundwater level or increase the risk of groundwater flooding of existing basements.

4.3.5 Two car parks to the north of the station will also include basement levels. These below ground works may form a complete barrier to groundwater flow in the glacial till, potentially leading to groundwater flooding on the up-gradient side of the structures but are unlikely to intercept the groundwater in the underlying Chester Formation. There is currently no information on groundwater levels in the glacial till. Therefore, on a precautionary basis, pending further investigation, this is assessed to be a potential major impact on receptors up-gradient of the station. The receptors include commercial buildings (moderate value), residential properties (high value) and an electrical substation (very high value). Therefore, the potential impact on groundwater flooding could lead to a major adverse effect, which is significant. Potential mitigation measures are discussed in Section 5.

4.3.6 There are several offline retaining walls in proximity to Manchester Piccadilly High Speed station (see Figure 7). They are assumed to extend through the glacial till into the Chester Formation. The retaining walls may form a barrier to groundwater flow in the glacial till and upper section of the Chester Formation in the immediate vicinity of the retaining walls although impacts are likely to be localised. This is assessed as a potential minor impact on receptors in proximity to the retaining walls. The receptors include commercial buildings (moderate value), residential properties (high value) and an electrical substation (very high value). Therefore, the potential impact on groundwater flooding could lead to a moderate adverse effect, which is significant.

4.3.7 The assessment has shown that there are no other features of the Proposed Scheme in the Manchester Piccadilly Station area that will act as a significant barrier to groundwater flow. Therefore, there are unlikely to be any significant increases in groundwater levels across the aquifers that could lead to increased risks of groundwater flooding as a result of the Proposed Scheme.

Figure 7: Manchester Piccadilly High Speed station, Ashton Line connection and retaining walls



4.4 Artificial sources

4.4.1 There are no artificial water bodies with potential implications for flood risk within the study area. The Proposed Scheme elevations have been designed to consider flood risk from the canal during design development.

4.4.2 Major water supply pipelines and sewerage (foul and surface water) infrastructure has been identified and are accounted for on the Volume 2, Map Books: Map Series CT-05 and CT-06. This infrastructure has been identified and diverted where appropriate. Measures will be taken to safeguard the local receptors during this diversion process.

4.4.3 The Proposed Scheme does not change the flood risk posed by failure of artificial water sources.

4.5 Off-site impacts and effects (surface water management)

4.5.1 Runoff from the footprint of the Proposed Scheme could occur more rapidly post-construction due to steeper slope angles and the permeability of the newly-created surfaces.

4.5.2 The design aim of drainage systems is to ensure that there will be no significant increases in flood risk, during storms up to and including the 1.0% AEP + CC event, as set out in the SMR.

4.5.3 Balancing tanks for new sections of highway and railway drainage have been sized on a precautionary basis, pending more detailed information about the permeability and runoff characteristics of existing and proposed ground surfaces[15].

[15] High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E21: Balancing ponds and replacement flood storage areas.*

5 Additional flood risk management measures

5.1.1 The next stage of the design process will involve incorporation of topographical survey information into the existing hydraulic models to improve how they represent the existing watercourses. The areas of RFS identified will be further refined in the models and the design of the viaduct and culverts will be developed with the aim of mitigating all impacts on peak flood levels as far as is reasonably practicable.

5.1.2 The hydraulic modelling of the River Medlock, including RFS mitigation, indicates that the Proposed Scheme does not lead to significant effects on flood risk. RFS has been provided to address the loss of floodplain caused by the intermediate piers of the Piccadilly approach viaduct crossing. The hydraulic model and mitigation will be further refined and developed during design development. If the redundant culverts are to be removed for environmental reasons, appropriate hydraulic controls will be introduced to mitigate for any adverse impacts on flood levels downstream resulting from improved channel conveyance. The approach and design of such controls will be undertaken in consultation with the Environment Agency.

5.1.3 There is potential for groundwater levels to rise to the northern side of the Proposed Manchester Piccadilly High Speed station basements, Ashton Line connection, car park basements and the Piccadilly approach viaduct pile foundations. Additional mitigation measures for the management of groundwater flood risk may be required. Following further investigations into the presence and quantity of groundwater in the glacial till, if needed, mitigation measures will be designed in consultation with the Environment Agency and the LLFA. These mitigation measures could include provision of behind retaining wall drainage to allow groundwater to flow around the station, or an integrated groundwater and surface water drainage system.

5.1.4 Further topographical survey, other surveys as required, hydraulic modelling, including incorporation of the RFS, design development, and refinement of the mitigation measures will be undertaken at design development with the aim of ensuring no potential effects on flood risk.

5.1.5 The above activities will be undertaken in close consultation with the Environment Agency and the LLFA. If any residual effects are identified, the affected landowners will also be consulted. The aim will be to ensure that no parties are affected by unacceptable increases in flood risk.

6 Summary of significant flood risk effects

6.1.1 Further assessment is required to determine the potential groundwater impacts to receptors from the basements at Manchester Piccadilly Station. If required, mitigation measures will be implemented and incorporated in the design to avoid increasing groundwater flood risk to receptors within the study area. Therefore, due to the flood risk management measures embedded in the design, there are no significant residual effects on flood risk.

6.2 Conclusions

6.2.1 This flood risk assessment presents the impacts and effects of the Proposed Scheme, taking into account avoidance and mitigation measures described in Volume 2, Community Area report for the Manchester Piccadilly Station area. Additional mitigation measures have been developed to further reduce the temporary and permanent impacts of construction stage activities, where there is potential for the Proposed Scheme to result in significant effects.

6.2.2 RFS mitigation has been identified to address the loss of floodplain caused by the intermediate piers of the Piccadilly approach viaduct. Further assessment and refinement of the models and mitigation measures, including any proposed design changes at design development will ensure any localised impacts on peak flood levels are mitigated and flood risk is unchanged as a result of the Proposed Scheme.

6.2.3 There is the potential for increased groundwater levels upstream of the Manchester Piccadilly Station basements and Piccadilly approach viaduct pile foundations and nearby retaining walls. On a precautionary basis, the potential impact due to these works is considered minor affecting potential future baseline moderate and high value receptors (mixed commercial, industrial, and residential property and committed developments), resulting in moderate adverse effects, which are not significant. The potential impact due to the Manchester Piccadilly Station, Ashton Line connection and car park basements on a precautionary basis is considered significant. Further site and ground investigations are required to assess the groundwater flood risk. If required, mitigation measures will be developed at the next design stage.

6.2.4 The assessment indicates that, subject to the implementation of the avoidance and mitigation measures identified, and the measures included in the Draft water resources flood risk operation and maintenance plan the Proposed Scheme will not result in any significant adverse effects on flood risk in the Manchester Piccadilly Station area.

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