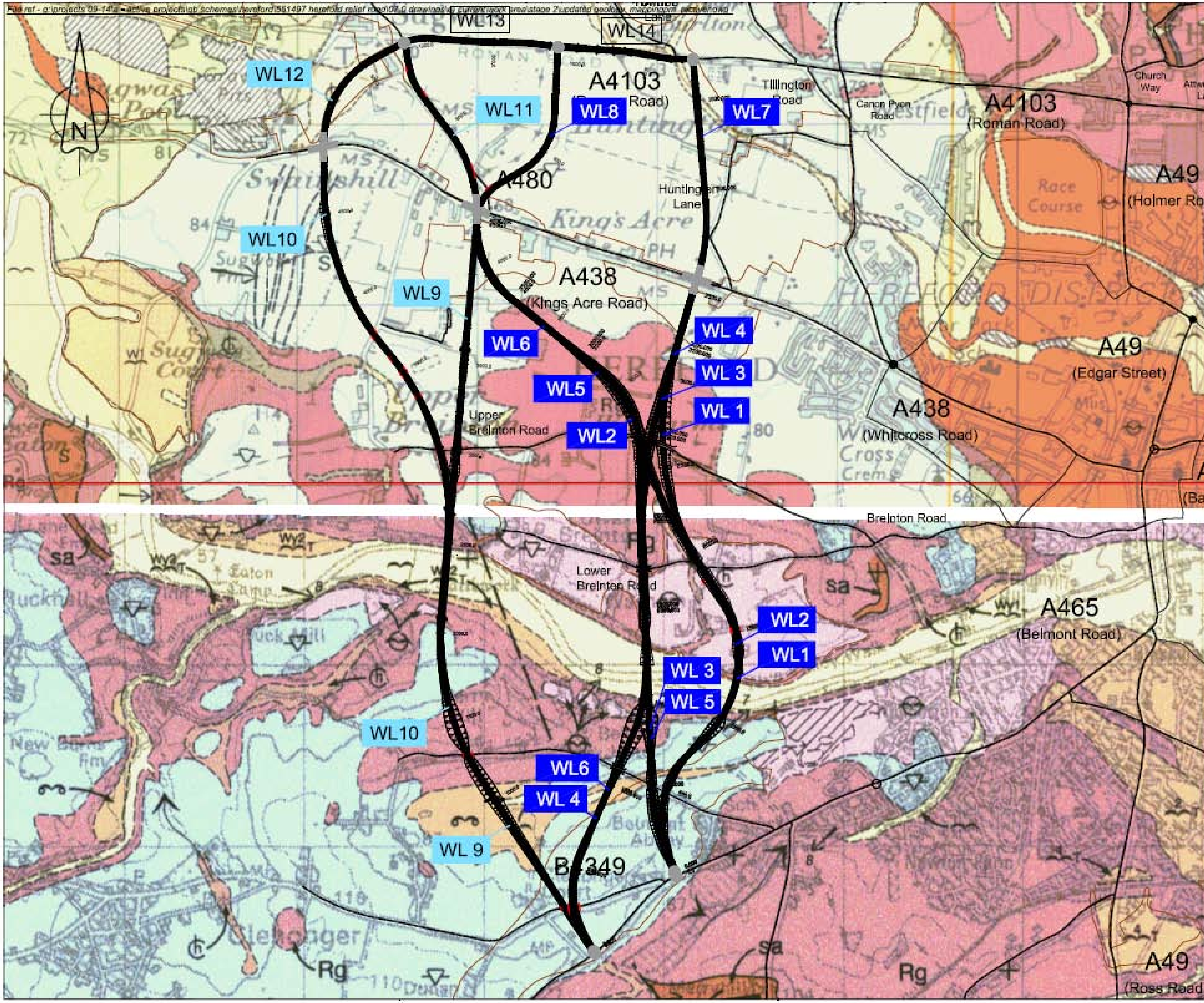


LEGEND

Drift Deposits

- Alluvium
- First and Second Terrace River Deposits of River Wye
- Head Deposits
- Fluvio- Glacial Sand and Gravel
- Glacial Deposits
- Morainic Deposits
- 2nd 3rd & 4th terrace deposits of River Lugg and Proto - Wye

Solid Geology

- Rg Raglan Mudstone Formation
- SMg St Maughan's Sandstone Formation

Rev	Revision details	Chkd	Appd	Date
P1	Text	.	.	.

Drawn: PMcN	Preliminary ✓
Design: ES	For comment
Chkd: SMcK	For tender
Appd: RM	For construction
Date: July 2010	As constructed
	Other

Client

Herefordshire Council

Project Name

Hereford Relief Road

Drawing Title

Geological Mapping - Western Corridor

Original Drawing Size: A3	
Scale: 1:20000	Dimensions: -

Figure No	Rev
A5,2	

Northern Corridor

A5.7.77. Four alignments have been developed within this corridor. Two options, NC1 and NC2 extend north easterly, then easterly from a proposed roundabout on the A4103 Roman Road and follow the same alignment from Ch 1500m to a proposed roundabout on the A49 Holmer Road.

A5.7.78. From this location, NC3 and NC4 extend in a south easterly direction and follow the same alignment for the first 800m before separating and then tying in at the same location at a proposed roundabout on the A4103 Roman Road.

A5.7.79. The following descriptions provide an over view of the potential ground conditions and earthworks for each link.

A5.7.80. The volume of material for earthworks and length of each link are shown in Table A5.7 at the end of this section.

A5.7.81. Map A0.03 in Appendix A indicates the individual links within the northern corridor. Fig A5.3 highlights the underlying geology below the northern corridor links.

Northern Corridor Links NC1 & NC2

A5.7.82. Both alignments commence at grade level at the same location but follow separate routes up to Ch 1500m.

A5.7.83. Between Ch 0 and Ch 200, NC1 predominantly lies at grade level before extending across Tillington Road as an overpass and associated approach embankments up to 6m high. NC2, follows a similar pattern and crosses Tillington Road, just north of NC1, as an overpass with embankments up to 5m high.

A5.7.84. Both alignments from around Ch 750m then extend for a short distance at grade level before extending as a substantial cutting up to 9m deep, NC1 from around Ch 900m and NC2 from Ch 1000m, to accommodate a proposed underpass below the A4110 Canon Pyon Road. The proposed cut for both options extends over a distance of 500m.

A5.7.85. From approximate Ch 1500m where both alignments merge, the alignment predominantly extends through minimal cut, less than 1m deep and on low embankment less than 1m high.

A5.7.86. The ground conditions for both links for the first 1000m will generally consist of glacial till, although this is likely to be shallow and underlain by bedrock consisting of mudstone. Shallow bedrock will be encountered around the proposed underpass at the A4110 Canon Pyon Road, negating the need for piled foundations.

A5.7.87. Morainic deposits consisting of sands and gravel will be encountered around 1.5m deep at Ch 1500m. Bedrock will be located below these deposits and will also lie at shallow depths from this location and the end of the alignment.

North Corridor Links NC3 & NC4

A5.7.88. Between Ch 0 and Ch 800, the alignment predominantly extends as a series of shallow cuttings and low embankment up to Ch 500m, before being carried over the Coldwells Road as an overpass and on associated embankment up to 10 high.

A5.7.89. Historical ground investigation information indicates silt up to 1.3m deep will underlie the start of the scheme, probably in narrow tracts over bedrock. Shallow bedrock consisting of sandstone will be encountered between 1 and 5m deep up to Ch 800m. If alluvium is encountered this may need to be removed or treated depending on depth and extent.

A5.7.90. NC3 then extends predominantly at grade level before crossing the railway line at approximate Ch 1700m as an over bridge with associated embankments up to 8m. Between Ch 1500 and 1600m historical maps indicate that a former brick pit has been filled in with rubble. This will be unsuitable material for a founding stratum of a road and will also present a potential contamination risk.

A5.7.91. NC4 also extends predominantly at grade level before crossing the railway line at approximate Ch 1750m as an over bridge with associated embankments also up to 8m high.

A5.7.92. Both alignments then tie in at a proposed roundabout on the A4103 Roman Road.

A5.7.93. The ground conditions for each alignment from where they split to their termination point will encounter alluvium generally consisting of silt up to approximately 1.5 to 2.0m deep, underlain by bedrock consisting of sandstone. More shallow bedrock will be encountered towards the end of each link.

A5.7.94. Where shallow bedrock underlies embankments and the proposed structure, this will provide a suitable founding stratum, negating the need for any special construction measures or piled foundations.

Preliminary Earthworks Summary for Northern Corridor

A5.7.95. The volume of material required for earthworks for each link within this corridor are shown in Table A5.7 below:

Table A5.7: Earthworks Volumes for Northern Corridor				
Route Link Chainages		Cut volume (m^3)	Fill volume (m^3)	Difference (m^3)
Link	Chainage (m)			
NC1	0 - 2642	148,074	54,866	+93,208
NC2	0 – 2753	178,630	48,255	+130,375
NC3	0 – 2330	15,818	176,318	-160,500
NC4	0 - 2331	17,327	248,650	-231,323

A5.7.96. Based on the information available and considering the extent of earthworks balance, length of link, number of structures and potentially contaminated sites, NC1 emerges as the geotechnically preferred alignment within the western half of the corridor. Either NC3 or NC4 could be considered for the eastern half of the corridor.

A5.7.97. NC3 has a better earthworks balance but does impact upon a contaminated site, which may prove problematic.

A5.7.98. A summary of the key geotechnical issues affecting each individual link is provided in Table A5.8 overleaf.

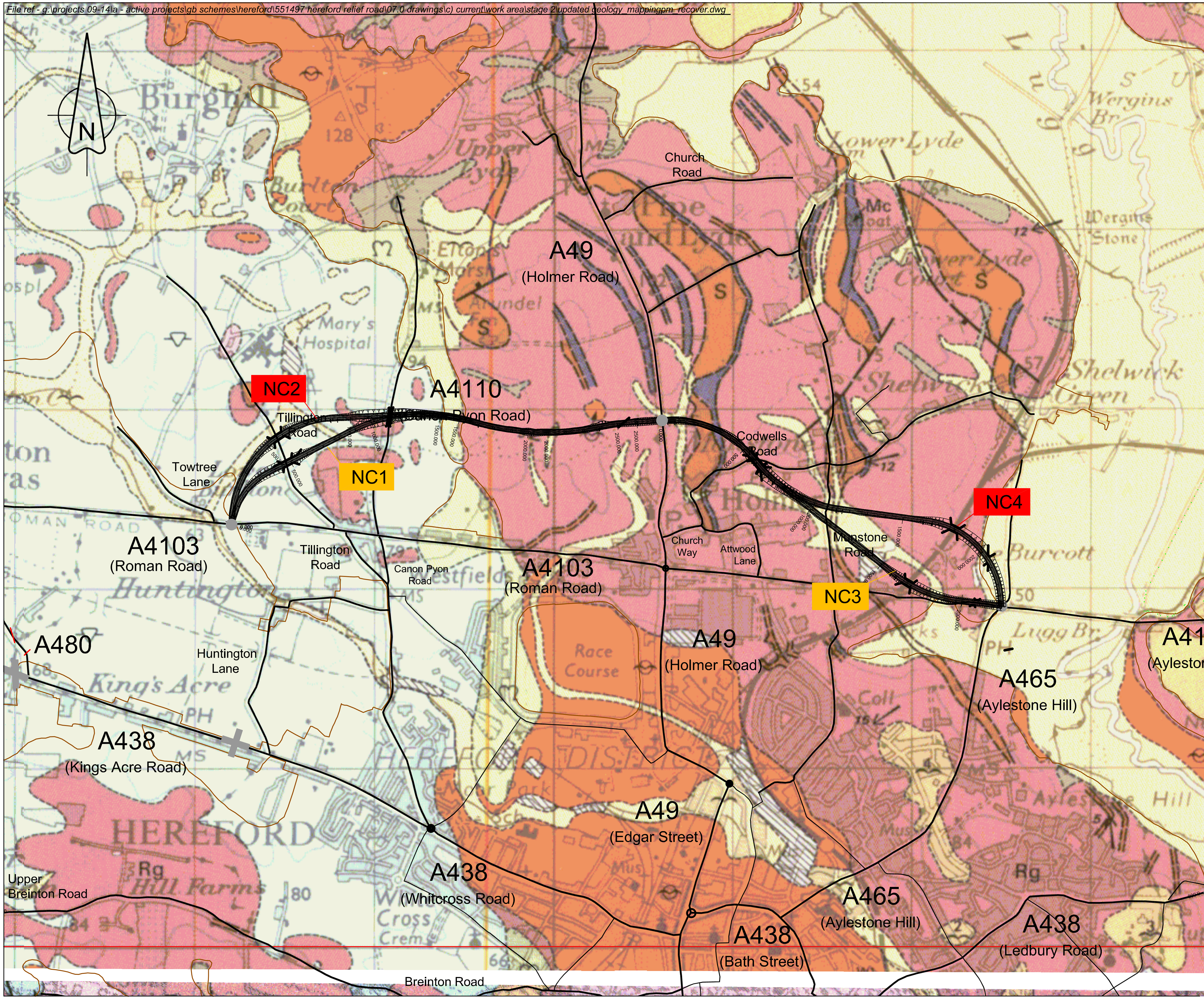
Table A5.8: Geotechnical Issues affecting the Northern Corridor

Issue	Alignment			
	NC 1	NC 2	NC 3	NC 4
Volume of earthworks	xx	xx	xx	xx
Fill re-usability	✓	✓	✓✓	✓✓
Amount of Rock Excavation	x	x	xx	xx
Alluvium / Soft ground	-	-	-	-
Contaminated Sites	-	-	x	-
No. of Structures	2	2	3	3
Structure foundation problems	✓	✓	✓	✓

Key

✓✓✓ / ✓✓ / ✓ / - / x / xx / xxx

Positive neutral negative



LEGEND

Drift Deposits

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Project Name
Hereford Relief Road

Drawing Title
Geological Mapping - Northern Corridor

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Dimensions : -

Figure No A5.3
Rev

Eastern Inner Corridor

A5.7.99. This 100m wide corridor encompasses one alignment which is split into three sections, namely, EL1, EL2, and EL3, extending in a southerly direction from a proposed roundabout on the A4103 Roman Road to the B4399 The Straight Mile Road.

A5.7.100. Map A0.04 in Appendix A indicates the individual links within the eastern corridors. Fig A5.4 highlights the underlying geology below the eastern corridor links.

Eastern Inner EL1

A5.7.101. EL1 extends from the above location predominantly on embankment up to 6m high, but generally between 2 and 4m before tying in with the A438 Ledbury Road at Ch 2114m.

A5.7.102. Ground conditions of alluvium and head deposits consisting of silts, clays, sands and gravel will be encountered throughout the length of the route. These will be underlain by shallow bedrock with occasional outcrops likely to be encountered at ground level. Any soft deposits may require treatment or removal depending on their extent and depth.

A5.7.103. A culvert is proposed at Ch 240m to carry the route over an existing stream. Deposits of alluvium will be encountered at this location.

Eastern Inner EL2

A5.7.104. EL2 commences from the termination point of EL1 and proceeds in a southerly direction through a series of shallow cuttings and low embankments before tying in with the B4224 Hampton Park Road at Ch 1296m.

A5.7.105. The ground conditions throughout this length of proposed route will consist of silty or clayey loam at shallow depth underlain by bedrock. Pockets of river terrace deposits consisting of poorly graded gravel will be encountered where the link ties into EL3.

A5.7.106. Soft deposits consisting of alluvium will be encountered around Ch 775 where the alignment will require a culvert to carry the road over a drainage ditch.

A5.7.107. A small sewage works is located approximately 75m east of the alignment at approximate Ch 700m. This area may pose a contamination risk depending on the exact use of the site and its history.

Eastern Inner EL3

A5.7.108. EL3 commences from the termination point of EL2 along the B4224 Hampton Park Road and proceeds in a southerly direction over the River Wye and its associated floodplain before tying in with the B4399 The Straight Mile Road at Ch 1293.

A5.7.109. The alignment extends predominantly on embankments up to a maximum height of around 5m but generally less than 2m. From Ch 300 to Ch 500m a proposed over bridge will carry the alignment across the River Wye.

A5.7.110. Soft deposits of alluvium will be encountered around the river and any structure at this location will require piled foundations.

A5.7.111. Throughout the remainder of the route river terrace deposits will be encountered up to 7m deep consisting of sand and gravel. Areas of made ground will also be encountered where the link ends indicating a potential contamination risk.

Preliminary Earthworks Summary for Eastern Inner Corridor

A5.7.112. The volume of material required for earthworks for each link within this corridor are shown in Table A5.9 below:

Table A5.9: Earthworks Volumes for Eastern Inner Corridor

Route Link Chainages		Cut volume (m^3)	Fill volume (m^3)	Difference (m^3)
Link	Chainage (m)			
EL1	0 - 2114	45,344	237,620	+192,276
EL2	0 – 1296	27,899	6,345	+21,554
EL3	0 – 1293	4,684	53,336	-48,652

A5.7.113. There is no preferred alignment within this corridor as it consists of three links which merge into one overall alignment. However, when comparing this corridor against the eastern outer corridor the earthworks practicality needs to be considered.

A5.7.114. The preferred links within the outer corridor require material to be imported, whereas this corridor generally equates to excess material. Depending on the earthworks requirements elsewhere on the scheme both corridors may be preferable.

A5.7.115. It should be noted however that EL2 and EL3 each impact upon a potentially contaminated site.

A5.7.116. A summary of the key geotechnical issues affecting each individual link is provided in Table A5.10 below.

Table A5.10: Geotechnical Issues affecting the Western Inner Corridor			
Issue	Alignment		
	EL 1	EL 2	EL 3
Volume of earthworks	xx	xx	xx
Fill re-usability	xx	x	x
Amount of Rock Excavation	✓✓	✓✓	✓✓
Alluvium / Soft ground	xx	xx	xx
Contaminated Sites	-	x	x
No. of Structures	0	0	1
Structure foundation problems	-	-	x

Key

✓✓✓ / ✓✓ / ✓ / - / x / xx / xxx

Positive neutral negative

Eastern Outer Corridor

A5.7.117. The Eastern Outer Corridor consists of 9 individual links some of which merge into one another and provide various route options throughout the overall corridor.

Eastern Outer EL4

A5.7.118. EL4 is located on the northern boundary of the corridor and involves utilising the existing road network from west to east by upgrading and widening over a distance of 729m between the A4103 Roman Road / A465 Aylestone Hill roundabout junction and the Lugg Bridge.

A5.7.119. The alignment predominantly extends on embankment over alluvium, up to 8m high, but generally between 4m and 6m, with 11 culverts proposed to carry the road over existing drainage ditches and minor watercourses. It is also proposed to widen the existing River Lugg Bridge where the alignment ties in with this bridge. Any proposed widening of the bridge will require piled foundations due to the deep alluvium.

A5.7.120. Historical borehole information at approximately Ch 700m indicates the presence of made ground up to 4m deep, underlain by alluvium up to 10m. Bedrock consisting of sandstone and mudstone underlies the alluvium.

A5.7.121. The earthworks balance for this link indicates 195,000m3 of material would need to be imported.

Eastern Outer EL5

A5.7.122. EL5 is similar to that of EL4 and follows the same alignment up to the point of the Lugg Bridge and then extends to a point along the A465 Aylestone Hill Road approximately 240m east of the priority junction with the A465 at Ch 1242m.

A5.7.123. From where EL4 terminates the alignment continues on embankment at around 4m high. Historical borehole information at approximately Ch 800m indicates alluvium to a depth of 7m underlain by bedrock consisting of sandstone and mudstone.

A5.7.124. The ground conditions beyond this location will predominantly consist of river terrace deposits consisting of gravel underlain by bedrock. The founding stratum for the road along this section is more favourable than EL4 due to the granular deposits.

A5.7.125. The earthworks balance for this link indicates 278,000m3 of material would need to be imported.

Eastern Outer EL6

A5.7.126. EL6 is situated on the western boundary of the corridor and provides a link between the A465 Aylestone Hill Road at the Lugg Bridge to the A438 Ledbury Road in close proximity to the Lugwardine Bridge at Ch 1940m.

A5.7.127. The alignment extends entirely on embankments up to 4m high but generally between 1m and 2m. The ground conditions throughout the length of the proposed route are likely to consist of sands and gravels, with alluvium between Ch 750m and Ch 1000m and potentially over the last 200m of the scheme. Shallow bedrock will be located elsewhere throughout the route.

A5.7.128. A structure is required to carry the alignment over the River Lugg at approximate Ch 1895m. Piled foundations may therefore be required at this location due to the underlying soft alluvium. Three culverts are also proposed along this alignment.

A5.7.129. The earthworks balance for this link indicates 32,000m3 of material would need to be imported.

Eastern Outer EL7

A5.7.130. EL7 is situated on the eastern boundary of the corridor and extends from the A465 Aylestone Hill Road to the A438 Ledbury Road at Ch 1452m approximately 240m west of Lugwardine Bridge.

A5.7.131. The alignment extends almost entirely on embankments up 4m high, but generally less than 2m. The ground conditions throughout the length of the proposed route are likely to consist of river terrace deposits consisting of gravel over the first 200m and alluvium around Ch 650m with alluvium also being encountered over the last 200m of the scheme. Shallow bedrock will be located elsewhere throughout the route.

A5.7.132. A structure is required to carry the alignment over the River Lugg at approximate Ch 1380m. Piled foundations may therefore be required at this location due to the underlying soft alluvium. Two culverts are also proposed along this alignment.

A5.7.133. The earthworks balance for this link indicates approximately 35,000m3 of material would need to be imported.

Eastern Outer EL8

A5.7.134. EL8 is situated on the eastern boundary of this corridor and also provides a link between the A465 Aylestone Hill Road and the A438 Ledbury Road but will include realigning the existing A438 Ledbury Road via a new junction to be located on land approximately 180m south-west of the Lugwardine Bridge.

A5.7.135. This link follows the same alignment as EL7 up to approximately Ch 750m and terminates at Ch 1578m. Beyond Ch750 the alignment extends as a shallow cutting at less than 1m deep up to Ch 1100m before being carried on a low embankment up to 3m high before terminating on the A438 Ledbury Road.

A5.7.136. The ground conditions beyond Ch 750m are likely to consist of shallow bedrock with the remaining few hundred metres below the alignment around the banks of the River Lugg and associated floodplain consisting of alluvium.

A5.7.137. A structure is required to carry the alignment over the River Lugg at approximate Ch 1475m. Piled foundations will therefore be required at this location due to the underlying soft alluvium. Two culverts are also proposed along this alignment.

A5.7.138. The earthworks balance for this link indicates 40,000m3 of material would need to be imported.

Eastern Outer EL9

A5.7.139. EL9 is situated on the western boundary of the corridor and provides a link between the A438 Ledbury Road and the B4224 Hampton Park Road. The alignment commences at the termination point of EL7 and extends to Ch 1982m.

A5.7.140. The alignment predominantly extends on embankment up to 3.5m high but generally less than 2m up to Ch 1450m where it enters a small cutting, 1.5m deep over a distance of 200m before tying in with the B4224 Hampton Park Road on low embankment at a proposed roundabout.

A5.7.141. The ground conditions along this route will encounter alluvium, up to 1.5m deep consisting of silt, to approximately Ch 950m. From this location the alignment will extend across river terrace deposits consisting of sand and gravel to around Ch 1450m. The alignment will then encounter shallow bedrock towards the end of the route where alluvium will be encountered.

A5.7.142. A structure is required to carry the alignment over the Little Lugg River at approximate Ch 600m. Piled foundations may therefore be required at this location due to the underlying soft alluvium.

A5.7.143. The earthworks balance for this link indicates 60,000m3 of material needs to be imported.

Eastern Outer EL10

A5.7.144. EL10 is situated towards the eastern boundary of the corridor; similar to that of EL9 in so much as it provides a link between the A438 Ledbury Road and the B4224 Hampton Park Road. EL10 commences at the termination point of EL8 and extends to Ch 1887m.

A5.7.145. The alignment primarily extends on embankment up to a maximum height of 3.5m, but generally less than 2m. A small cutting extends from Ch 1350m, less than 2m deep, for an approximate distance of 200m.

A5.7.146. The ground conditions along this route are the same as EL9, similarly with a structure also being required, but at Ch 500m.

A5.7.147. The earthworks balance for this link indicates 69,000m3 of material needs to be imported.

Eastern Outer EL11

A5.7.148. EL11 is similar to EL9 commencing on the A438 Ledbury Road at the termination point of EL6 and extending to the same location on the B4224 Hampton Park Road at Ch 2011m.

A5.7.149. The alignment predominantly extends on embankment up to 3.5m high but generally less than 2m up to Ch 1550m where it enters a small cutting, 1.6m deep over a distance of 150m before tying in with the B4224 Hampton Park Road on low embankment at a proposed roundabout.

A5.7.150. The ground conditions along this route are the same as EL9, similarly with a structure also being required, but at Ch 630m.

A5.7.151. The earthworks balance for this link indicates 13,000m3 of material needs to be imported.

Eastern Outer EL12

A5.7.152. EL12 provides a link between the B4224 Hampton Park Road and The Straight Mile and commences at the termination point of WL9, WL10 and WL11 and extends to Ch 1381m. The tie in point on The Straight Mile is at the roundabout junction with the recently constructed Rotherwas Access Road.

A5.7.153. The alignment extends on embankment across the whole scheme with a structure required to cross the River Wye at Ch 450m. The embankments extend up to 5m high on the approach to the structure.

A5.7.154. The ground conditions along the alignment will be similar to EL3 and will consist of alluvium from the start of the link to approximately Ch 700m, where the route will then encounter river terrace deposits up to 7m deep consisting of sand and gravel. Areas of made ground will also be encountered where the link ends indicating a potential contamination risk. The proposed structure will require piled foundations.

A5.7.155. A narrow tract of alluvium may also be encountered at Ch 1200m.

A5.7.156. The earthworks balance for this link indicates 111,000m3 of material needs to be imported.

Preliminary Earthworks Summary for Eastern Outer Corridor

A5.7.157. The volume of material required for earthworks for each link within this corridor are shown in Table A5.11 below:

Table A5.11: Earthworks Volumes for Eastern Outer Corridor				
Route Link Chainages		Cut volume (m^3)	Fill volume (m^3)	Difference (m^3)
Link	Chainage (m)			
EL4	0 - 729	2,000	32,475	-30,475
EL5	0 – 1242	8,073	55,000	-46,927
EL6	0 – 1940	678	32,585	-31,907
EL7	0 - 1452	4,875	39,599	-34,724
EL8	0 – 1578	10,558	50,987	-40,429
EL9	0 – 1982	18,548	79,115	-60,567
EL10	0 - 1887	15,935	85,242	-69,307
EL11	0 – 2011	12,534	25,429	-12,895
EL12	0 – 1381	577	111,820	-111,243

A5.7.158. Based on the information available and considering the extent of soft deposits, earthworks balance, length of link, number of structures and potentially contaminated sites, EL7 would be the preferred alignment between the A465 Aylestone Hill Road and the A438 Ledbury Road.

A5.7.159. Regarding the three links, EL9, EL10 and EL11 between the A438 Ledbury Road and the B4224 Hampton Park Road, EL9 would be the preferred alignment based on the same issues mentioned above. EL9 also extends from EL7 which is the preferred link discussed above.

A5.7.160. Based on the information discussed above it would also be practical to upgrade the A465 Aylestone Hill Road and therefore EL5 should be incorporated into the overall alignment within this corridor.

A5.7.161. EL12 is the sole link under consideration within this corridor which provides a link between the B4224 Hampton Park Road and The Straight Mile Road.

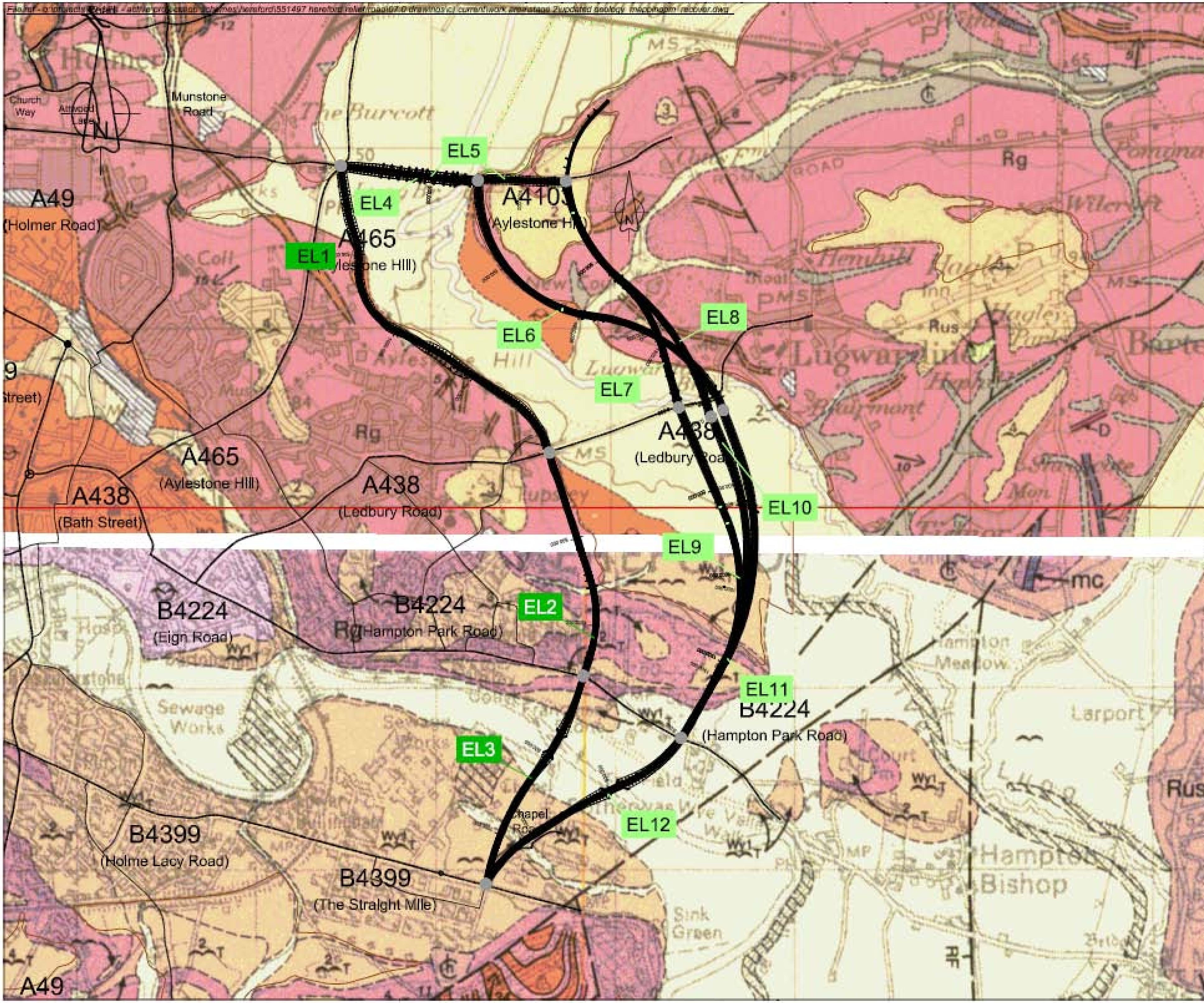
A5.7.162. A summary of the key geotechnical issues affecting each individual link is provided in Table A5.12 overleaf.

Table A5.12: Geotechnical Issues affecting the Eastern Outer Corridor									
Issue	Link								
	EL4	EL5	EL6	EL7	EL8	EL9	EL10	EL11	EL12
Volume of earthworks	xx	xxx	x	x	x	xx	xx	x	xx
Fill re-usability	xx	xxx	x	x	x	xx	xx	x	xx
Amount of Rock Excavation	-	-	x	x	x	x	x	x	x
Alluvium / Soft ground	xxx	xxx	x	x	x	x	x	x	x
Contaminated Sites	-	-	-	-	-	-	-	-	x
No. of Structures	1	2	1	1	1	1	1	1	1
Structure foundation problems	xx	xxx	xx	xx	xx	xx	xx	xx	xx

Key

✓✓✓ / ✓✓ / ✓ / - / x / xx / xxx

Positive neutral negative



LEGEND

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- Rg — Raglan Mudstone Formation
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Project Name: Hereford Relief Road

Drawing Title: Geological Mapping - Eastern Corridor

Original Drawing Size: A3 | Scale: 1:20000 | Dimensions: -

Figure No: A5.4 | Rev

A6. Hydrology, Hydrogeology and Drainage

A6.1. Flood Risk Management

Outline National Strategy

A6.1.1. As outlined in Stage 1 Engineering Assessment, the Government's future vision for surface water, as set out in Planning Policy Statement 25, is to develop:

- More adaptable drainage systems delivering reduced flood risk, improved water quality, and decreasing burdens on the sewer system
- Better management of surface water drainage, allowing for the increased capture and reuse of water; slow absorption through the ground and more above-ground storage and routing of surface water separate from the foul sewer system
- Better public appreciation of the causes and consequences of surface water run-off and the actions we can all take to minimise the risks.

Regional & Local Strategy

A6.1.2. Spatial planning has a vital role to play in managing flood risk and adapting to climate change. Sir Michael Pitt endorsed the PPS25 approach in light of findings from his enquiry into the summer 2007 floods and stipulated that it is to be rigorously applied at a local level.

A6.1.3. A comprehensive review of the lessons to be learned from the summer floods of 2007 was undertaken by Sir Michael Pitt and his report which was published in June 2008 contained a series of recommendations regarding Flood Risk Management. There are over 90 recommendations within the report including some of the key ones such as:

- Local authorities should lead on the management of local flood risk, with the support of the relevant organisations.
- Local authorities should positively tackle local problems of flooding by working with all relevant parties, establishing ownership and legal responsibility.
- Local authorities should collate and map the main flood risk management and drainage assets (over and underground), including a record of their ownership land condition.
- All relevant organisations should have a duty to share information and cooperate with local authorities and the Environment Agency to facilitate the management of flood risk.

- Local Surface Water Management Plans, as set out under PPS25 and coordinated by local authorities, should provide the basis for managing all local flood risk.

A6.1.4. With respect to local authorities, a number of key recommendations made within the West Midlands Regional Flood Risk Appraisal (RFRA) include the following:

- The Sequential Approach should be used to aim to locate all new development in Flood Zone 1.
- Only if insufficient suitable sites are available, should development be allocated to Flood Zone 2; and finally Flood Zone 3;
- Where the need to apply the Exception Test is identified, a Level 2 SFRA should be undertaken;
- Local Authorities should consider carrying out surface water mapping as part of a Surface Water Management Plan.

A6.1.5. PPS25 states that a development proposal within flood zones must take into account the likelihood of flooding from other sources as well as from rivers and the sea. A Flood Risk Assessment (FRA) following the Sequential Test approach will be required following the selection of a Preferred Corridor as the proposed highway will, as a completed development, comprise more than one hectare of additional hard surface as set out in the requirements for a Flood Risk Assessment in PPS25.

A6.1.6. The principle approach of locating the proposed corridor links in lower risk areas has been applied as feasibly as possible however, due to the nature of the topography and environmentally sensitive areas, significant impacts upon the existing rivers and streams and the major functional floodplain of the Lugg Meadow have been generated. The Strategic Flood Risk Assessment (SFRA) for Herefordshire sets out the local strategic approach to flood risk management in the County and provides much of the evidence base for proposals with which this assessment introduces for each corridor link. These include;

- Sub-catchment Standard Percentage Run-off rates
- Extent of Flood Zones 1,2 and 3
- Various evidence based statements and recommendations
- Sustainable drainage strategy and adoption of SUDS

A6.1.7. The above paragraphs illustrate pivotal activities within this assessment process. This will also include various consultations with relevant statutory bodies as identified and others considered to be a critical component of the flood risk analysis and surface water management arrangements. These consultations will ultimately involve more detailed statutory and non-statutory communications with, but not restricted to the following;

- Environment Agency
- Herefordshire Council
- Water Utilities (Welsh Water)
- Internal Drainage Board

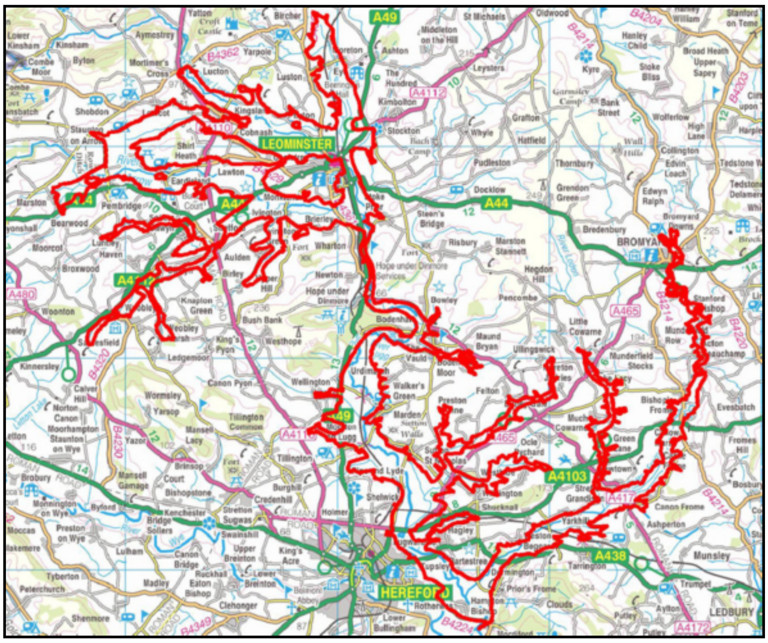

Fig A6.1 Internal Drainage Board Zone (Lower Lugg)

A6.1.8. Consultations with these statutory bodies will take place following the approval by Herefordshire Council of this Engineering Assessment so that each organisation can adequately comment on the approach to date and can advise on any issues. This report will form as part of a consultation process and inform the organisations of the study findings at this stage. This process will also inform the statutory bodies of the level of study evidence acquired to produce the proposals and recommendations contained herein. It is envisaged that the consultation will request their own recommendations and additional information for more site specific measures.

Flood Insight Report

A6.1.9. Amey utilised a 'Flood Insight Report', undertaken and provided by GroundSure, to gain an instant outline overview of the flood risks for the study area. The free report outturn provided an overview of the Environment Agency flood database for Hereford to inform this process of the significance of flooding in the area. The report supported the findings already summarised from the Stage 1 Engineering Assessment which concluded that;

- Flood Zones 2 and 3 are mostly due to the impact of catchment surface water run-off (fluvial) usually associated with high intensity rainfall events
- The National Flood Risk Assessment (NaFRA) Flood Rating for the study area is 'Significant'
- The study area is affected by Surface Water Flooding (pluvial)

A6.1.10. The report found that there were no 'Areas benefiting from flood defences'. This finding has not been brought forward on the basis that flood defences such as the Stank around Hampton Park and the flood defence at Belmont Roundabout have been implemented and as such are provided within Appendix A. The Flood Insight Report did provide a map overview of pluvial flooding within the study area. The map, as detailed below in Fig A6.2, has its limitations as the map is modelled on the basis of the topography only and does not account for various soil types and underlying hydrogeology.

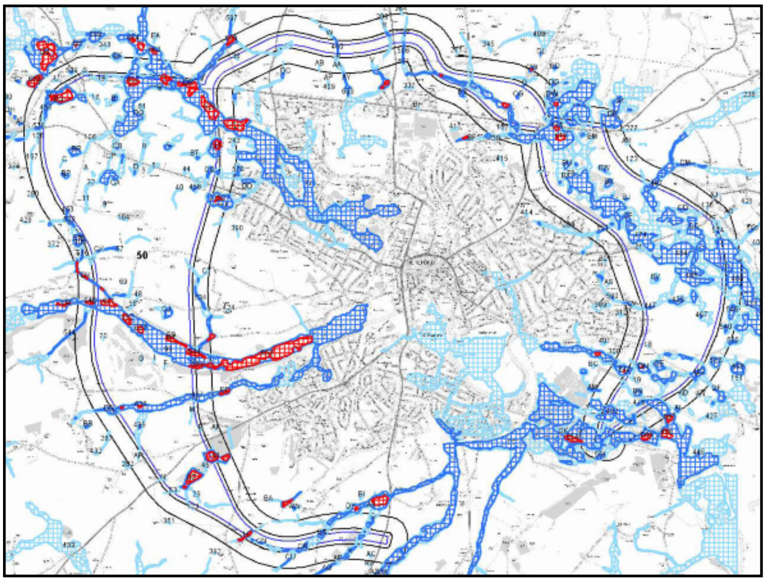

Fig A6.2 Pluvial Flood Map (Red – Significant / Blue - Moderate)

Fluvial and Pluvial Flooding

A6.1.11. The SFRA outlines the sub-catchment areas and assigns a Standard Percentage Rate for each individual sub-catchment. Predominantly, topography geology / soils and precipitation are the three most dominant influences in flood hydrology. These characteristics influence the timing and magnitude of fluvial flooding but also play a significant part in general surface flooding. The Flood Insight Report discussed in section A6.1.10 provides a simplistic representation of catchment 'hydrodynamics'. The mapping contained in Appendix A provides a more detailed overview of the fluvial aspect of the existing terrain. This chapter will aim to produce a breakdown of the impermeable, unmitigated surface water run-off (worst case) and assign a storage ranch to illustrate the necessary measures to be investigated further with respect to soil types and more detailed hydrogeology analysis.

A6.2. Hydrogeology Constraints Summary

A6.2.1. The Water Framework Directive requires the status of groundwater management units, or groundwater bodies, within each river basin to be determined as Good or Poor. The classification of groundwater bodies is based on chemical status as well as its relationship with surface water bodies and whether it influences a groundwater dependant terrestrial ecosystem such as a wetland area.

A6.2.2. The Groundwater Body in the Hereford area is classed as Wye Minor and currently has Good status under the WFD monitoring regime (EA website). The Hereford area is designated as a drinking water protected area, water abstraction management area and is also protected under the Nitrates Directive.

A6.2.3. A review of the Hydrogeological Map of England and Wales, scale 1:625 000, indicates that the aquifer underlying Hereford town centre is an aquifer in which flow is dominantly intergranular. The quaternary sands and gravels are a locally important aquifer with limited importance.

A6.2.4. The Devonian Old Red Sandstone around Hereford is classed as a concealed aquifer of limited potential in a region without significant groundwater. The sandstone is generally impermeable and is without groundwater except at shallow depth. Most of the western corridor options will overlie either the sands and gravels or the sandstone aquifers.

A6.2.5. There is a small area of quaternary alluvium to the east of Hereford along the banks of the River Wye and Lugg. This is classed as a concealed aquifer with limited or local potential.

A6.2.6. Groundwater vulnerability to pollution is assessed with respect to the distribution of aquifers, the physico-chemical properties of the overlying soils and the characteristics of the strata in the unsaturated zone. The aquifers are designated as principal or secondary aquifers.

A6.2.7. Principal aquifers are layers of rock or drift deposits that have high interangular and/or fracture permeability – meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

A6.2.8. Secondary aquifers include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types;

- **Secondary A -** permeable layers capable of supporting water supplies at local rather than strategic scale, and in some cases forming source of base flow to some rivers.
- **Secondary B –** predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.
- **Secondary Undifferentiated** – has been assigned in cases where it has not been possible to attribute either category A or B to a rock type, due to the variable characteristics of the rock type.

A6.2.9. Soils are divided into three general classes:

- **High leaching potential (H)** – soils with little ability to attenuate diffuse source pollutants and in which non-adsorbed diffuse source pollutants and liquid discharges have the potential to move rapidly to underlying strata or to shallow groundwater.
- **Intermediate leaching potential (I)** – soils which have a moderate ability to attenuate diffuse source pollutants or in which it is possible that some non-adsorbed diffuse source pollutants and liquid discharges could penetrate the soil layer.
- **Low leaching potential (L)** – soils in which pollutants are unlikely to penetrate the soil layer because either water movement is largely horizontal or they have the ability to attenuate diffuse pollutants. Lateral flow from these soils may contribute to groundwater recharge elsewhere in the catchment. They generally have a high clay content.

A6.2.10. The Groundwater Vulnerability Map of Worcestershire (sheet 29, 1:100 000) and Groundwater Vulnerability Map of Powys (sheet 28, 1:100 000) were reviewed to ascertain the groundwater vulnerability around Hereford. The urban area of Hereford and the lands around the River Lugg are underlain by a Secondary A aquifer with high leaching potential. The eastern alignments will cross these areas and any excavations will leave the groundwater susceptible to pollution. The urban fringe of Hereford, where most of the alignments would encroach, is a Secondary A aquifer with intermediate leaching potential. In these areas groundwater would be slightly susceptible to pollution. The area around King's Acre and Stretton Sugwas is shown as having low permeability drift deposits occurring at the surface and overlying a Secondary A aquifer with intermediate leaching potential. The presence of the low permeability drift deposits reduces the risk of any pollutants reaching groundwater sources.

A6.2.11. Groundwater provides a third of drinking water in England and Wales, and it also maintains flow in many rivers. It is crucial that we look after these groundwater sources to ensure that water is safe to drink. The Environment Agency have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. The maps show three main zones (inner, outer and total catchment). A source protection zone is located to the north west of Hereford.

A6.2.12. All Western Corridor options (WL1 to WL12) along with Northern Corridors 1 and 2 fall within the Source Protection Zone (SPZ) Total Catchment Area (Zone 3). Zone 3 is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

A6.2.13. Options WL1, WL3, WL4 and WL7 also fall within the Outer area (Zone 2) of the same SPZ. Zone 2 is defined by a 400 day travel time from a point below the water table and has a minimum radius of 250m or 500m around the source.

A6.2.14. These options are also within 50m of the inner catchment area (Zone 1). Zone 1 has a minimum radius of 50m and is defined as the 50 day travel time from any point below the water table to the source.

A6.3. Hydrology Overview

Watercourse Crossings

A6.3.1. As detailed in Map A0.05 and A0.06 in Appendix A, all proposed corridors and their associated corridor links cross numerous designated and undesignated watercourses which will require culverting and/or watercourse diversions / realignments. The southern and western corridors primarily cross watercourses at right angles with watercourses flowing from west to east, towards Hereford. The southern and western corridors can feasibly avoid direct impact of the floodplains where the local topography can be followed and mitigated adequately to ensure flood management measures can be provided without significantly impacting upon the Flood Zones 2 or 3.

A6.3.2. The Northern Corridor has the least impact upon major watercourses in terms of severance and this is evident by the elevated topography that this corridor navigates and the scarcity of major streams and watercourses. The eastern corridors represent the greatest impact of all the corridors and their respective corridor links. This is ultimately due to the network of watercourse and floodplain channel conveyances with the River Lugg & Rhea and the footprint impact on the surrounding functional floodplain of the Lugg Meadow leading to highly potential compensatory flood storage measures.

A6.3.3. Any proposed structure shall have soffit levels set at an approximate freeboard of 600mm above the 1% Flood Risk level (100 year return period) as provided by the Environment Agency and Herefordshire Council. Immediate supports within the watercourse channel and solid approaches (abutments) within the floodplain shall not be acceptable unless a flood risk assessment can prove that the effect upstream of the crossings can be mitigated.

Road Drainage

A6.3.4. The objective of the current assessment is to compare the proposed corridors in order to identify a Preferred Corridor/s. In order to undertake the hydrology and drainage assessment on a consistent and objective basis, several engineering assumptions are required. These assumptions and the proposed strategy for watercourse crossings, discharge locations, road drainage, and flood risk and site attenuation are to be provided in accordance with the following publications;

- CIRIA C624 Development and flood risk
- Herefordshire Strategic Flood Risk Assessment (SFRA)
- DMRB Volume 11 Section 3 Part 10 Road Drainage and the Water Environment
- Sustainable Urban Drainage Systems Manual