

Appendix 10A

Existing Track Geo-environmental Desk Study, Skelmersdale Rail Link

Existing Track Geo- Environmental Desk Study

Skelmersdale Rail Link

02 March 2020

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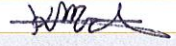
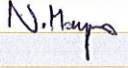
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Existing Track Geo- Environmental Desk Study

Skelmersdale Rail Link

02 March 2020

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Executive summary

Mott MacDonald Limited has been commissioned by Network Rail to develop the Skelmersdale Rail Link to GRIP 3A and Track AIP. The scheme comprises new rail tracks with junctions on WLK2 (Liverpool to Wigan Railway line) to the proposed station site at the former Glenburn Sports College site; a new station at Skelmersdale and at Headbolt Lane; modifications/platform extensions at the existing stations at Rainford and Kirby; and modifications along the existing WJK and WLK2 railway lines between Up Holland and the M57. This study focuses on proposed track bed renewal along the existing rail from Up Holland to the M57 and platform extensions at the existing Rainford and Kirkby Stations.

The purpose of this geo-environmental desk study is to provide information on the ground conditions likely to be encountered during the proposed work, and subsequently identify and reduce the risks to the project.

Mapping from the British Geological Survey shows that superficial and bedrock deposits vary along the study area but generally comprise the following: Blown Sand (Shirdley Hill Formation) and/or Glacial Till overlying Weathered Sandstone and Sandstone (Sherwood Sandstone Group) to the west; and Peat or Blown Sand, Glacial Till and Glaciofluvial Deposits overlying Mudstone, Siltstone and Sandstone of the Pennine Lower Coal Measures Formation to the east. Made Ground (Undivided) is also shown across the rail corridor at Kirkby Valley Golf Course and Simonswood Industrial Estate.

The full extent of the rail corridor is shown to have been built by 1850, which is the earliest OS map available. At this time the land around the corridor largely comprised undeveloped or farmed fields with some areas of woodland and minor urban developments. Many existing track crossings were already present. Holland Colliery and Rainford Collieries (and associated ponds) were also operational at the eastern half of the study area, as well as a corn mill and two sandstone delfs (quarries) around the crossings with Simonswood Brook. By 1893 industrial activity had increased. The main developments were around the collieries which encroached onto the rail corridor via sidings. There was also a pumping station to the east of County Road, and a sand washing works built on the track with connecting mineral railways. There were then few significant changes until 1956 where the collieries and associated infrastructure became disused and were shortly after infilled/remediated. Other types of works started to become prevalent at this time which resulted in new rail links joining the existing corridor. This includes the Kirkby Sorting Deposit near the centre of the study area. Following this, there was significant development of infrastructure, housing estates, schools and other buildings through the 1960's and 1970's. Areas of historic industries had either been redeveloped as unused woodland/fields, housing, or a more modern type of workings – as with Kirkby Sorting Depot which became a timber yard and then Simonswood Industrial Estate. The rail corridor matched present day by 1976 with the removal of the Rainford Junction and the construction of the M57 at its western edge. By 2005 the land surrounding the rail corridor matched present day after further residential developments.

A summary of key geotechnical and geo-environmental risks is given below:

- Features of historic coal mining, including shafts, and shallow and deep workings.
- Poor ground conditions associated with deposits of Made Ground, Peat and Blown Sand.
- Contamination from historic collieries, landfills, a munitions distribution depot and the railway.
- Obstructions from historic sidings and buildings, and foundations of existing bridges.

- Unexploded ordnance.
- Heat generation and spontaneous combustion within coal seams during drilling/construction.
- Services including high pressure gas mains, an ethylene pipeline and electrical cables.

A ground investigation is required in order to assess the existing ground conditions present beneath the site; validate the geotechnical and geo-environmental risks; and identify remedial requirements. Investigation works will also enable the collection of samples for chemical and geotechnical testing

1 Introduction

1.1 Scope of Work

Mott MacDonald Limited has been commissioned by Network Rail to develop the Skelmersdale Rail Link to GRIP 3A and Track AIP. This report is to inform the design as part of the GRIP 3A activities.

1.2 Proposed Scheme

The Skelmersdale Rail Link Project will create new transport hub within the town of Skelmersdale to provide a direct rail link between Skelmersdale, Wigan and Liverpool. A study commissioned by Lancashire County Council has found that improved transportation links to Wigan and Liverpool will provide job opportunities for Skelmersdale residents and this will create further employment in the area.

The scheme comprises the following: new rail tracks for about 3km over land from new junctions on WLK2 (Liverpool to Wigan Railway line) to the proposed station site at the former Glenburn Sports College site; a new station at Skelmersdale and at Headbolt Lane; modifications/platform extensions at the existing stations at Rainford and Kirby; and modifications along the existing WJK and WLK2 railway lines between Up Holland and the M57.

This report focuses on the existing rail corridor from Up Holland to the M57 and the proposed works at the existing Rainford and Kirkby Stations.

The proposed works will require geotechnical input related to but not limited to the following:

- Track bed foundations;
- Earthworks/Cuttings/retaining structures along the track alignment at the location of station platform extensions; and
- Station platform foundations

1.3 Report Objectives

The purpose of this geo-environmental desk study is to provide information on the ground conditions likely to be encountered during the proposed work along the rail corridor from Up Holland to the M57. This desk study reviews and summarises information obtained from several sources noted in Section 1.4 of this report. The report summarises potential geohazards associated with the site.

1.4 Sources of Information

The following sources of information were used in the preparation of this report:

- British Geological Survey, 1970. Geological Survey of England and Wales 1:63,360 Wigan Sheet 84, Drift (Keyworth, Nottingham: British Geological Survey).
- British Geological Survey, 1977. Geological Survey of England and Wales 1:50,000 Wigan Sheet 84, Solid (Keyworth, Nottingham: British Geological Survey).
- British Standards, 1997. Eurocode 7 – Geotechnical Design – Part 2: Ground Investigation and Testing. BS EN 1997-2:2007

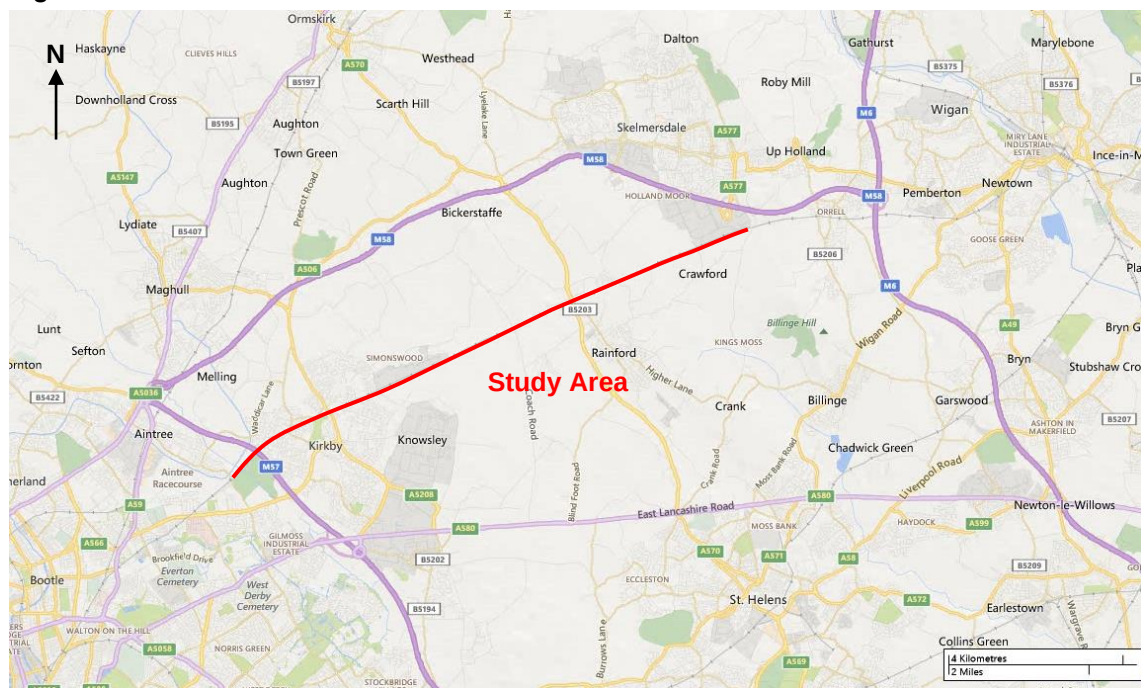
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- Zetica, 2018. Pre-Desk Study Assessments for Skelmersdale Rail Link

2 Geo-environmental Baseline

2.1 Study Location

The study area for this report follows a linear route along the Liverpool to Wigan rail line which spans Merseyside and West Lancashire. The start and end points are at Engineer's Line Reference (ELR) WJK and mileage 30m 308yds near the M57 south of Kirkby (National Grid Reference (NGR) 339437, 398704) and WKL2 22m 1378yds south of Up Holland (NGR 350185, 403577). The site location plan is shown in Figure 1 and the site layout plan in Figure 2 and Figure 3. These figures have been subdivided into three segments to ease description and have been annotated with details of the existing/proposed numbers of tracks.

Figure 1: Site Location Plan



Source: Microsoft product screenshot reprinted with permission from Microsoft Corporation, captured via Holebase SI

This aerial map illustrates the proposed rail route from WJK to the south. The route is divided into two segments:

- Segment 1:** This segment starts at WJK and runs southwards. It includes the following track details and distances:
 - Existing one track (30m)
 - One new track and one existing track (30m)
 - New double track (29m)
 - One new track and one existing track (28m)
 - New double track (28m)
 - One new track and one existing track (27m)
 - One new track and one existing track (+new turnback and terminal track) (26m)
- Segment 2:** This segment continues southwards from Segment 1, including:
 - New double track (27m)
 - One new track and one existing track (26m)

The map also shows a north arrow and a scale bar indicating 1 Kilometre and 1 Miles.

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Figure 3: Site Layout Plan B



Source: Microsoft product screenshot reprinted with permission from Microsoft Corporation, captured via Holebase SI

2.2 Site Description and Topography

The study area is subdivided into three segments in this section only for ease of description, starting at WJK 30m 308yds and travelling east to WKL2 22m 1378yds. The ELR changes from WJK to WKL2 at approximately 29m 900yds. The full study area is confined within the existing rail corridor of the Liverpool to Wigan line and currently comprises one track, although historically there were more tracks.

2.2.1 WJK/WKL2 28m 0yds to 30m 308yds – Segment 1

The route starts between Kirkby Vale Golf Course to the south and undefined woodland to the north of the rail corridor. It travels along the M57 overbridge to the northeast and continues alongside housing developments to the north and the south before reaching Kirkby Station where the B5192 and a footbridge cross the railway. Further housing developments and undefined woodland and fields are situated to the north and the south as the line passes over a pedestrian footpath, Simonswood Brook on a viaduct and County Road on a bridge. The bridge is single-track, however, the abutment on the western side looks as though it was constructed for two tracks. To the north of the track is the open grassed area of the proposed location of Headbolt Lane Station (approximately 28m 1350yds) and to the south is a narrow strip of rough open land before more residential housing. A freight train line runs northeast for approximately 700m, from just north of the proposed Headbolt Lane station before joining a spur into Knowsley Industrial Park. A footbridge crosses these two tracks opposite Hollinghurst Road to the housing

development to the south. There appears to be new house being built on a section of open land. Dale Lane overbridge crosses the railway line to the north of the spur into Knowsley Industrial Park and south of the Simonswood Industrial Estate to the north of the corridor. To the south of the Simonswood Industrial Estate is open land, farmland and woodland.

Elevation rises from 20m AOD to 22m AOD as the route travels to the east on an embankment and underbridge over the M57. Embankment height peaks in the region of 6m before the track enters a cutting on approach to Kirkby Station. Cutting height peaks at Kirkby Station in the region of 5m with track level around 23m AOD. This level rises slowly to the northeast as the earthworks transition again into embankment, reaching heights in the region of 6m and elevations of 28m AOD on approach and exit of the County Road underbridge. The track then continues at grade/short cutting as elevation continues to rise slowly for the remainder of the segment, reaching 33m AOD just past the Dale Lane overbridge where the track is on a 1-2m high embankment.

2.2.2 WKL2 28m 0yds to 25m 0yds – Segment 2

The segment travels to the northeast with farmed fields to the south and Simonswood Industrial Estate to the north. The industrial estate extends approximately 2km along the edge of the track. A un-named track passes over the railway at the eastern boundary of the industrial park, where it gives way to farm land and woodland areas on both sides of the rail corridor. On the north side of the railway line is a quarry which is now a construction waste recycling facility (W. Maher & Sons, 2018). At 500m to the northeast Simonswood Brook and an unnamed road pass back under the railway. A further 700m to the northeast Coach Road passes over the railway as the line continues to the northeast through similar land. To the north is Siding Lane Woodland Nature Reserve. The segment ends at the crossing over the Rainford By-Pass next to a small area of housing developments to the north.

The track starts on a 1-2m high embankment and changes between sections at grade and in cuttings, with maximum high around 6-7m at Simonswood Industrial Estate. Track elevation rises slowly through the area from 33m AOD at the start of the segment to 40-41m AOD at the edge of the quarry. This level remains as the track passes over approach embankments, a bridge over Simonswood Brook and an unnamed road, reaching a maximum height in the region of 5m. Along the remainder of the segment, the track travels at grade/on embankment that is less than 2m high until it reaches the Rainford By-Pass, where it crosses approach embankments and an bridge reaching 5-6m high. The rise in elevation along this section is still gradual, reaching 49-50m AOD on the eastern side of the by-pass where the track becomes at grade once more.

2.2.3 WKL2 25m 0yds to 22m 1378yds – Segment 3

The final section of the study area starts to the east of the Rainford By-Pass surrounded by farmed land and woodland. A track crosses over the railway halfway between the by-pass and a housing development to the north. At west of the houses there is a pedestrian level crossing and an allotment to the south. Rainford Station is at the eastern edge of the developed area where there is a pedestrian footway bridge between the platforms and where News Lane crosses over the railway. Beyond this the route continues largely through farmed fields and woodland, passing beneath two tracks leading to a farm at Maggots Nook Road. At Duke's Wood Lane there is a level crossing. The study area ends just past this point as land on the northern side of the rail corridor transitions into a Pimbo Industrial Estate

The track traverses the remainder of the study area at grade or in a 1-2m cutting. Elevation starts at 49-50m AOD and slowly climbs to 56m AOD at Rainford Station; 63m AOD at the two

bridges leading to a farm at Maggots Nook Road; 73m AOD at the level crossing of Duke's Wood Lane; and 78m AOD where the segment ends next to Pimbo Industrial Estate.

2.3 Site History

Historical OS maps at 1:10,560, 1:10,000 and 1:2,500 scales from between 1850 and 2018 have been reviewed to understand the historical development of the study area. A detailed review is provided in Appendix B and a summary given below.

The full extent of the rail corridor is shown to have been built by 1850, which is the earliest map available. At this time the land around the corridor largely comprised undeveloped or farmed fields with some areas of woodland and minor urban developments around Glovers Brow and County Road at the western end of the study area. Many existing track crossings are already present at this time, including those of County Road, Glovers Brow, Simonswood Brook (at the western and central parts of the study area), Coach Road, Rainford Road, New Lane, Maggots Nook Road and Duke's Wood Lane. Kirkby Station and Rainford Station are present (though Rainford Station moves 900m to the east by 1893 to its existing location) and the Lancashire and Yorkshire Railway connects to the corridor at the Rainford Junction, to the south of the current station. Concerning heavy industries, Holland Colliery and Rainford Collieries (and associated ponds) are operational at the eastern section of the study area. At the western section, there is Kirkby Mill (corn) on Simonswood Brook and two delfs (quarries) for sandstone.

By 1893 industrial activity had increased, with expansions at the collieries onto the study area – sidings in the case of Rainford Collieries and a mineral railway near Rainford Station. There was also a pumping station to the east of County Road and a sand washing works built on the track at this time.

There were few significant changes until 1956 where the collieries and associated infrastructure became disused and were infilled/remediated. Other types of works started to become prevalent at this time which resulted in new rail links joining the existing corridor. This includes the Kirkby Sorting Deposit (later the Simonswood Industrial Estate) near the centre of the study area and the Kirkby Industrial Estate to the south of the study area.

There was significant development of infrastructure, housing estates, schools and other buildings through the 1960's and 1970's. Areas of historic industries had either been redeveloped as housing, modern type of workings or left unused as woodland/fields. By 1976 the Rainford Junction had been removed and the M57 constructed northwest-southeast over the track at western edge of the site.

Additional residential developments occurred by 2005, after which there has been no further significant developments affecting the rail corridor or surrounding land.

2.4 Geology

2.4.1 Geological Summary

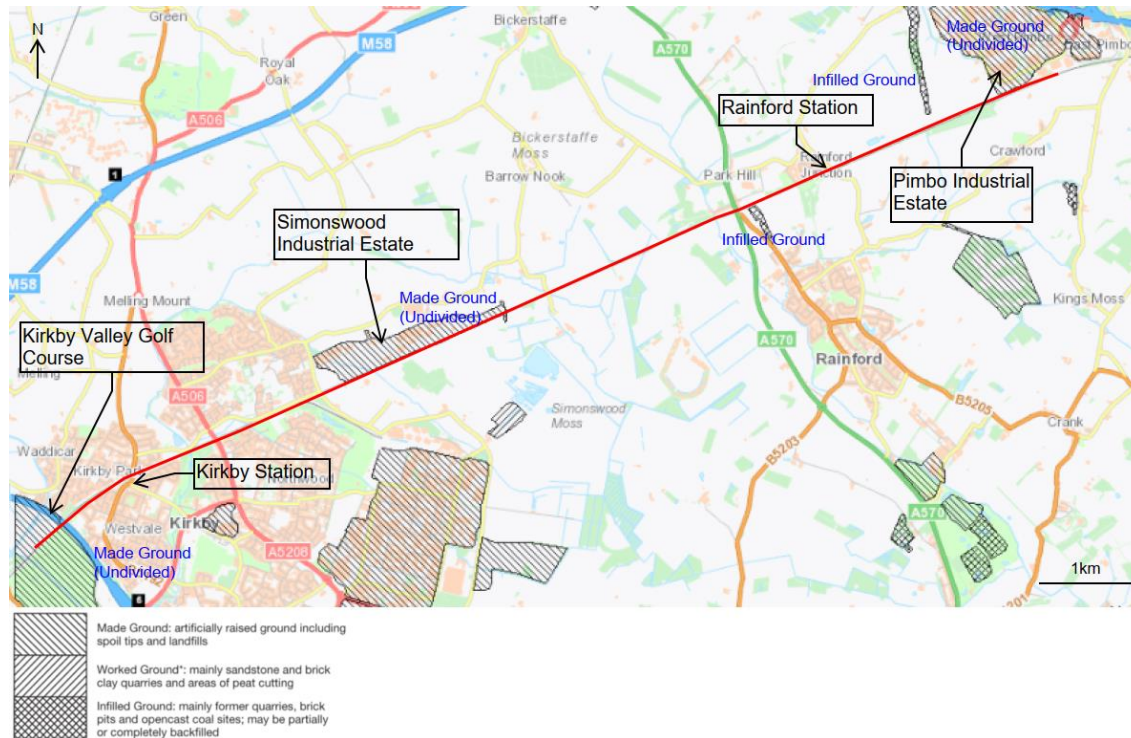
This section refers to information taken from British Geological Survey (BGS) 1:50,000 geological mapping for Wigan, Sheet 84, the BGS Onshore GeoIndex, and the Geological Memoir of Wigan District.

2.4.1.1 Artificial Deposits

Made Ground (Undivided) is shown across the rail corridor at Kirkby Valley Golf Course across the western end of the study area and at Simonswood Industrial Estate (previously Kirkby

Sorting Depot and a timber yard) across the centre of the study area. It is also shown on the edge of the corridor at the Pimbo Industrial Estate at the eastern edge of the study area. Further areas of Made Ground (infilled) are present within 100m of the corridor at the Rainford By-Pass and at Holland Moss. Figure 4 shows artificial deposits across the study area.

Figure 4: Artificial Deposits

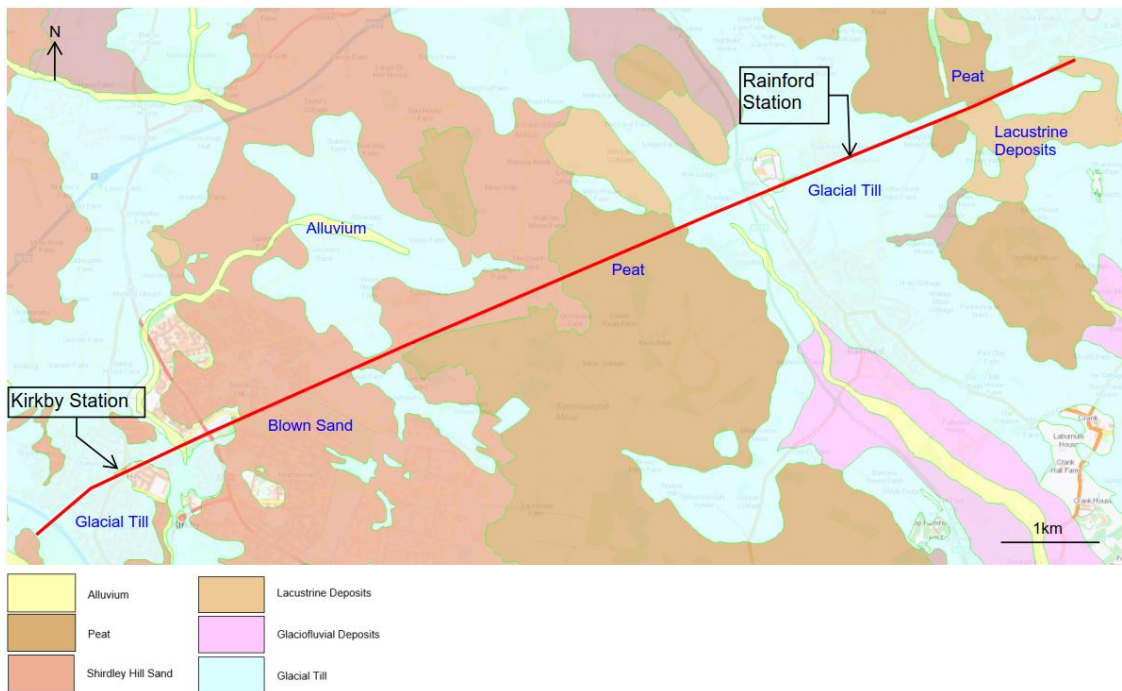


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2.4.1.2 Superficial Deposits

A variety of superficial deposits are mapped across the study area. Glacial Till predominates from the western end of the study area to Simonswood Brook (near County Road) and from the west of Rainford By-Pass to the eastern end of the study area. The BGS Memoir divides the stratum into Lower Boulder Clay (grey to red clay with erratics and boulders), Middle Sands (bedded sands interbedded with silts and silty sands) and Upper Boulder Clay (red to reddish brown clay which varies in thickness from 0.3m to 18m). Shirdley Hill Sand (blown sand) typically comprising well-sorted fine-grained sand with possible layers of Peat up to 5m thick is mapped from the east of County Road to the eastern crossing of Simonswood Brook. Deposits of Peat are mapped from the eastern crossing of Simonswood Brook to Siding Lane and to the west of Duke's Wood Lane crossing. Small deposits of Alluvium and Lacustrine deposits (typically silt and clay, and possibly organic) are also mapped where the corridor crosses Simonswood Brook and at the eastern tip of the study area respectively. Superficial deposits across the study area are shown in Figure 5.

Figure 5: Superficial Deposits



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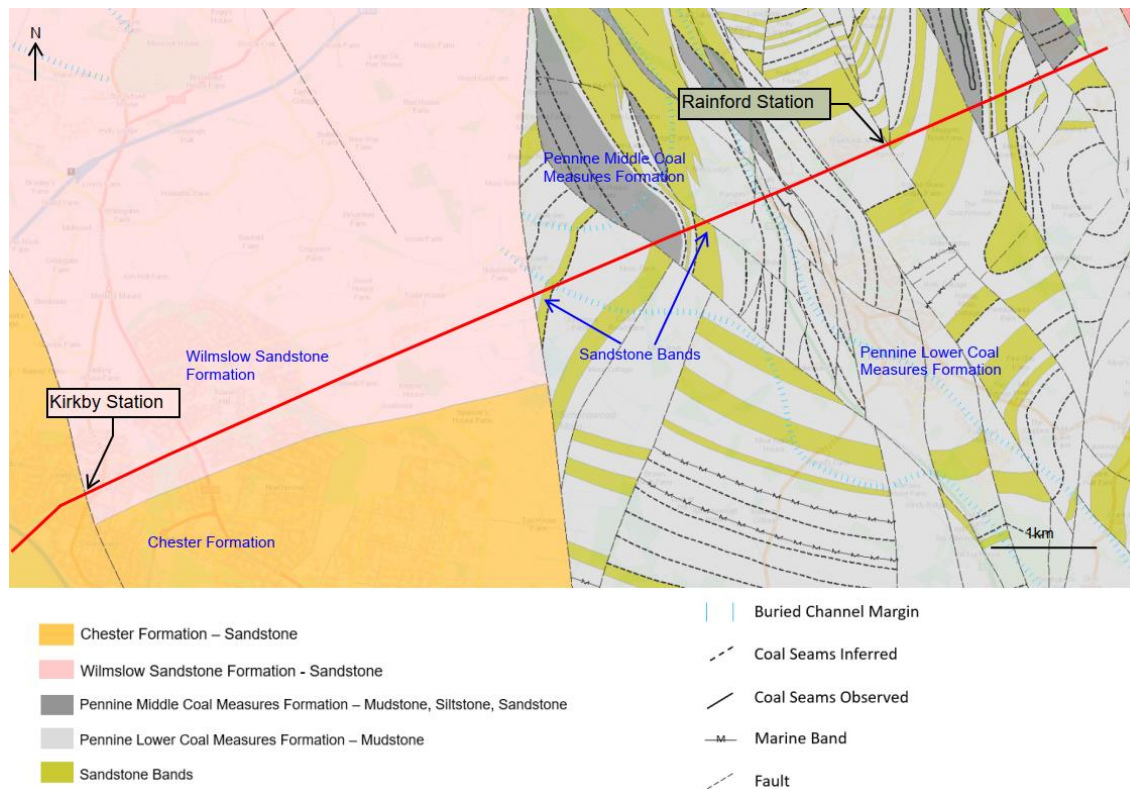
2.4.1.3 Bedrock Deposits

Bedrock deposits across the western half of the study area comprise Triassic sandstones of the Chester Formation and Wilmslow Sandstone Formation (Sherwood Sandstone Group - SSG), where the former transitions into the latter at Kirkby Station. Just to the west of the western Simonswood Brook crossing, these rocks are faulted against Carboniferous Mudstone and Sandstone bands of the Lower Pennine Coal Measures Formation (Pennine Coal Measures Group - PCMG). Small areas of Pennine Middle Coal Measures are also mapped beneath the corridor, typically comprising Siltstone and Sandstone as well as Mudstone. Bedrock deposits across the study are shown in Figure 6.

Rocks of the SSG dip 5-6° to the northwest and outcrop around Kirkby Station and County Road as the Wilmslow Sandstone Formation. Those of the PCMG are heavily faulted with fault strikes typically trending NW-SE and blocks dipping up to 11° to the west around Moss Farm and up to 7° to the north around Rainford and Up Holland. They outcrop to the east of the Rainford By-Pass as the Pennine Lower Coal Measures Formation.

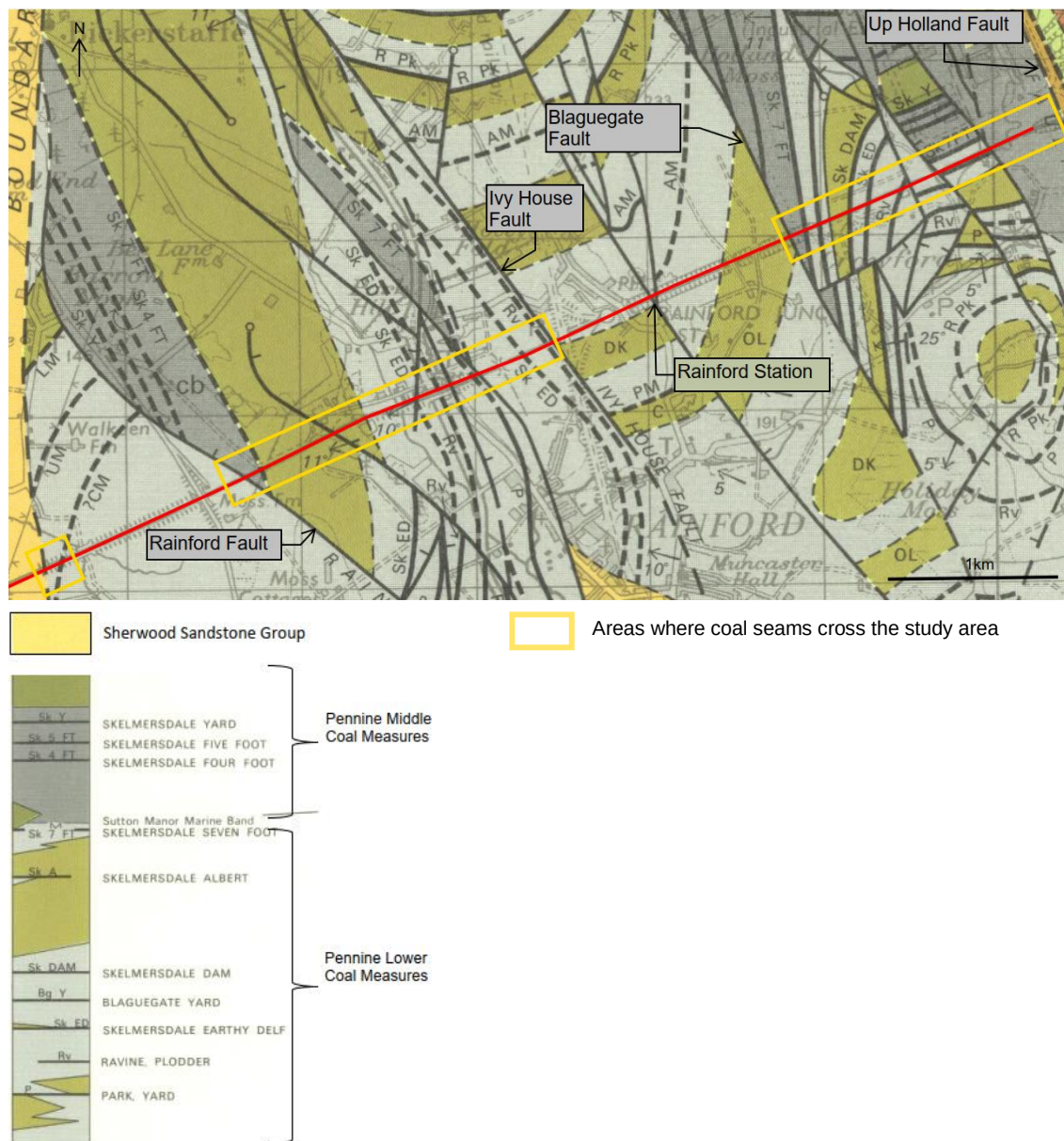
Mapping in Figure 7 shows the main areas where coal seams cross the study area, highlighted in yellow. The Ivy House Fault and Rainford Fault confines the Skelmersdale Earthy Delf, Ravine, Park and Skelmersdale Seven Foot coal seams around the Rainford By-Pass. The Blaguegate Fault and Up Holland Fault confines the Skelmersdale Seven Foot, Skelmersdale Dam, Skelmersdale Earthy Delf and Ravine coal seams.

Figure 6: Bedrock Deposits



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Figure 7: Bedrock Deposits in the Western area - Coal Seams and Faults

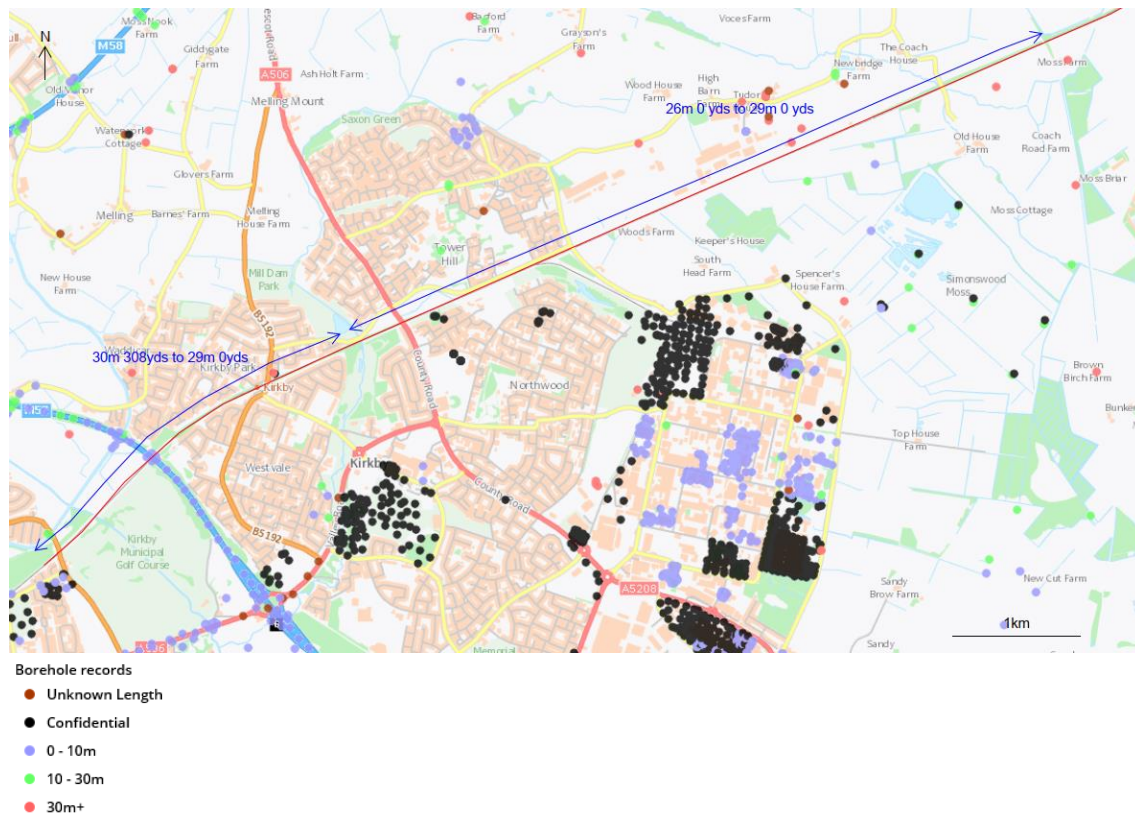


Extract from BGS Geological Mapping Sheet 84. Contains British Geological Survey Materials © NERC 2018

2.4.2 Historical Boreholes

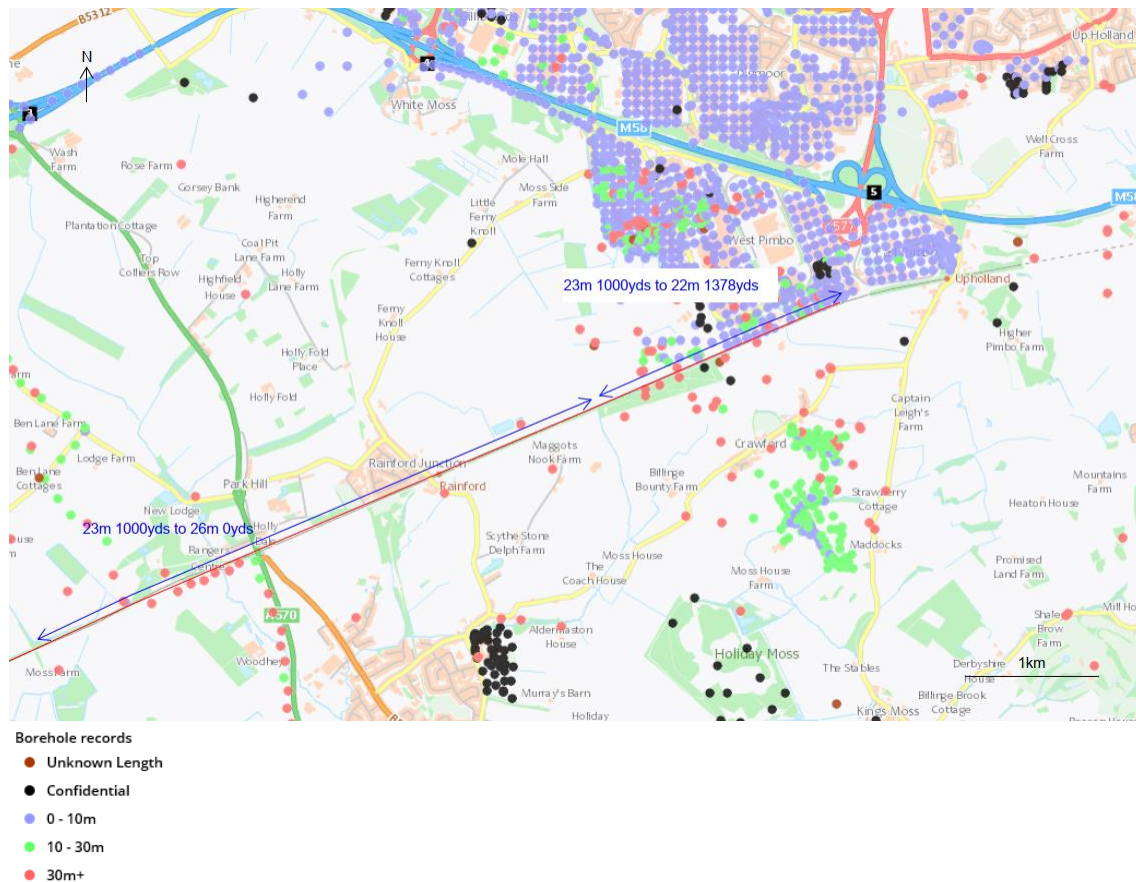
Historical boreholes have been accessed via the BGS Onshore GeoIndex (NERC, 2018). They are predominantly located around the M57 and Rainford By-Pass crossings, the eastern half of Simonswood Industrial Estate and Pimbo Industrial Estate. BGS borehole locations are shown in Figure 8 and Figure 9. Available borehole logs have been used to inform ground conditions along the route and are presented in the Table 1 to Table 3. However, it should be noted that the data is limited mainly to soil descriptions of ground away from the rail corridor, and the quality of the data available may vary depending on the age and purpose of the boreholes.

Figure 8: BGS Boreholes Plan A



Contains British Geological Survey Materials © NERC 2018

Figure 9: BGS Boreholes Plan B



Contains British Geological Survey Materials © NERC 2018

Table 1: Ground Model 30m 308yds to 29m 0yds

Strata	Typical Thickness (m) [Range, m]	Depth (mbgl)	Typical Description	Comments on Distribution
Glacial Till	2 [1.7 – 2.9]	1.7 – 2.9	Firm to very stiff red to brown sandy clay with cobbles (boulder clay)	All boreholes
Weathered Sandstone (Chester Formation SSG)	0.5 [0.2 – 0.5]	2.0 – 3.2	Red Sand	Discontinuous lens N and W of the M57 crossing
Sandstone (Chester Formation SSG)	>2.2*	>4.7*	Red Sandstone	*Base of stratum not proven All boreholes

Groundwater Level: Not Encountered

Source: NERC (2018). Boreholes sunk in 1967, focused along the M57

Table 2: Ground Model 26m 0yds to 29m 0yds

Strata	Typical Thickness (m) [Range, m]	Depth (mbgl)	Typical Description	Comments on Distribution
Blown Sand (Shirdley Hill Formation)	1.7 [1.7 – 2.0]	1.7 – 2.0	Grey brown clayey sand	Isolated occurrences to the north of Headbolt Lane and at Simonswood Industrial Estate
Glacial Till	5 [0.15 – 8.3]	1.8 – 10.3	Brown sandy gravelly clay	All boreholes
Weathered Sandstone (Wilmslow Sandstone Formation, SSG)	1 [1.0 – 1.2]	3.1 – 7.6	Red sand / soft rock	Isolated occurrences to the north of Headbolt Lane and at Simonswood Industrial Estate
Sandstone (Wilmslow Sandstone Formation, SSG)	>59*	>62.0*	Red sandstone	*Base of stratum not proven Only the deepest boreholes
Groundwater Level: Not Encountered				

Source: NERC (2018). Boreholes sunk in 1976, 1996 and 2001 to the north of Headbolt Lane (one borehole only) and around the eastern side of Simonswood Industrial Estate

Table 3: Ground Model 23m 1000yds to 26m 0yds

Strata	Typical Thickness (m) [Range, m]	Depth (mbgl)	Typical Description	Comments on Distribution
Peat	1.7*	3.7*	Very soft reddish brown clayey fibrous Peat	*Base of stratum not proven Only in one borehole on the northern edge of the corridor at 19m 900yds
Blown Sand (Shirdley Hill Formation)	3.3 [2.6 – 5]	3.0 – 5.4	Sand	Most boreholes
Glacial Till	6 [0.5 – 18.9]	7.7 – 37.3	Firm sandy clay with bands of sand and cobbles (boulder clay)	Most boreholes
Glaciofluvial Deposits	0.8 [0.4 – 1.2]	7.7 – 21.7	Sand and gravel / gravel	Thin bands within Glacial Till
Pennine Lower Coal Measures Formation	>105*	>115*	Mudstone/Siltstone, Sandstone	*Base of stratum not proven
Groundwater Level: Not Encountered				

Source: NERC (2018). Boreholes sunk in 1990 for the North Western Ethylene Pipeline and in 2008 at Maggots Nook Farm (one borehole)

Table 4: Ground Model 23m 1000yds to 22m 1378yds

Strata	Typical Thickness (m) [Range, m]	Depth (mbgl)	Typical Description	Comments on Distribution
Peat	3.2 [2.7 – 4.9]	2.7 – 4.9	'Bog'	Boreholes in fields to the west of Pimbo Industrial Estate
Glaciolacustrine Deposits	1.0 [0.6 – 1.5]	0.9 – 3.4	Sandy yellow or mottled brown clay Clayey sand	Boreholes at Pimbo Industrial Estate
Glacial Till	3.0 [1.7 – 4.9]	3.7 – 5.3	Firm to stiff brown sandy clay with cobbles	All boreholes
Glaciofluvial Deposits	1.0 [0.3* – 2.1]	2.0 – 3.7*	Sand and gravel	*Base of stratum not proven Often thin bands within Glacial Till
Pennine Lower Coal Measures Formation	>1.5*	>21*	Grey shale with coal	*Base of stratum not proven

Groundwater Level: 18m bgl, with perched water in granular lenses above clay

Source: NERC (2018). Boreholes mainly sunk in 1965 for Pimbo Industrial Estate and an unrecorded date for Holland Colliery

2.5 Hydrology

There are a number of controlled water features which have the potential to affect the proposed works, the main one being Simonswood Brook. Simonswood Brook is an Environment Agency (EA) main river which flows to the north from Rainsford to Simonswood and then South through Kirkby, and crosses the rail corridor at the following locations:

- to the west and east of Coach Road at WKL2 26m 813yds and WKL2 25m 1325yds respectively;
- as a tributary through Simonswood Industrial Estate at WKL2 27m 1290yds; and,
- as a tributary near Headbolt Lane at WKL2 28m 1148yds which then joins the main path of the brook on the north side before the brook passes beneath the railway at WKL2 29m 136yds.

Rainford Brook flows to the north across the track to the west of Rainsford By-Pass at WKL2 25m 369yds.

Off-site features include the River Alt (EA main river) and the Leeds & Liverpool Canal located 400m and 220m to the west of the start of the study area, flowing to the northwest and south and west respectively. There are also a number of small water bodies/ponds within 100m of the study area near Bowes Brow, Woods Farm, Siding Lane Woodland Nature Reserve, the allotments at Rainford, and Maggots Nook Farm/Red House Farm.

2.6 Flooding

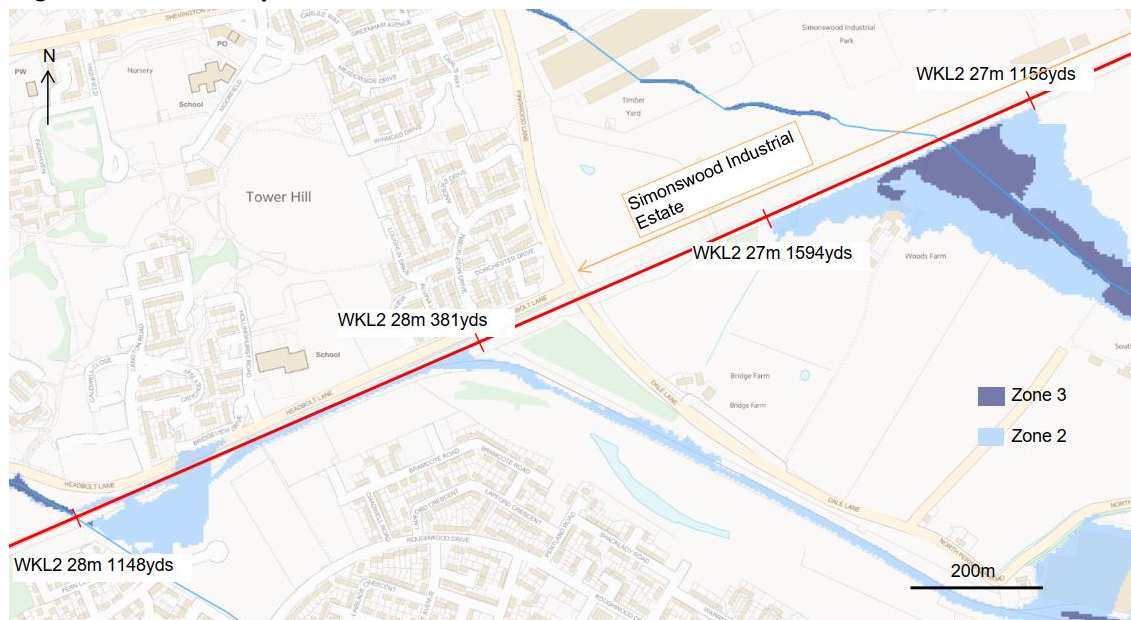
EA flood zones define the probability of flooding from rivers and seas and are split into the following:

- Zone 1 – Low Probability (<1 in 1000 annual probability of flooding. All undesignated land)

- Zone 2 – Medium Probability (between 1 in 100 and 1 in 1,000 annual probability of river flooding; or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding)
- Zone 3a – High Probability (≥ 1 in 100 annual probability of river flooding; or (≥ 1 in 200 annual probability of sea flooding)
- Zone 3b – Functional Floodplain (land where water has to flow or be stored during times of flooding)

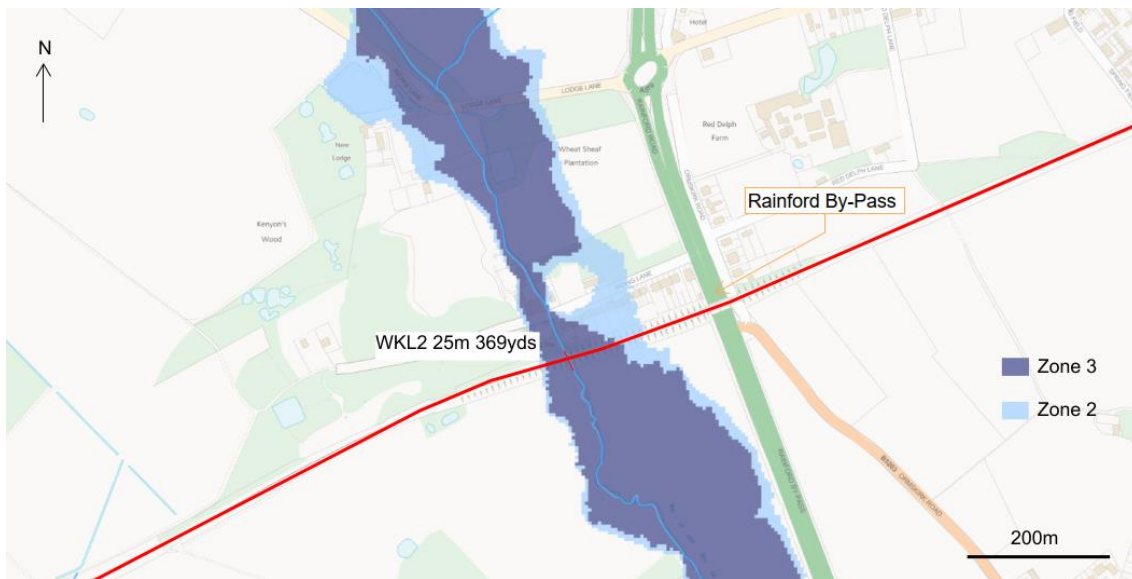
There are only two areas of the study area which are within a designated Flood Zone: a section of the corridor within Zone 2 which runs parallel to Headbolt Lane (WKL2 28m 1148yds to 28m 381yds) and within Zone 2-3 at the crossing of Rainford Brook (WKL2 25m 369yds). There is also an area of Zone 2-3 at Woods Farm (WKL2 27m 1158yds to WKL2 27m 1594yds) along the southern boundary of the corridor which follows Simonswood Brook. These areas are shown below in Figure 10 and Figure 11 whilst the full maps are provided in Appendix H. There are also no recorded areas of historic flooding across the study area.

Figure 10: Flood Map Extract A



Source: Environment Agency Flood Map for Planning

Figure 11: Flood Map Extract B



Source: Environment Agency Flood Map for Planning

2.7 Hydrogeology

Peat is classified as an Unproductive Strata, which means it has a low permeability and have negligible significance for water supply or river base flow. Glacial Till is classified as a Secondary Undifferentiated Aquifer, given to layers which may be permeable and capable of supporting water supplies at a local scale, or less permeable and capable of storing and yielding limited amounts of groundwater due to localised features. Glaciolacustrine Deposits, Glaciofluvial Deposits, Alluvium and deposits of Shirdley Hill Formation blown sand are classified as Secondary A Aquifers, defined as permeable layers capable of supporting water supplies at a local scale and in some cases forming an important source of base flow to rivers.

Sandstones of the SSG are classified as Principal Aquifers, which are defined as strata with a high intergranular and/or fracture permeability, usually providing a high level of water storage that may support water supply/river base flow on a strategic scale. Rocks of the PCMG are classified as Secondary A Aquifers, which defined as above.

Source Protection Zones (SPZs) are zones around wells, boreholes and springs used for public drinking supply which show the risk of contamination from activities that might cause pollution. In the area. The EA (via Groundsure.io) shows an active well at the northern side of Simonswood Industrial Estate and two wells 1.8km and 2.4km to the north of Kirkby near Melling Mount. As a result the western half of the site, up to the quarry at Simonswood Industrial Estate is within Zone 3 of these sources (2250m radius), and from WKL2 27m 620yds to 26m 1606yds within Zone 2 of the source at Simonswood Industrial Estate (500m radius).

2.8 Mining

2.8.1 Coal Mines

Mining across the study area has been assessed using Historical OS maps, Coal Authority mining plans and a Network Rail Mining Report. They reveal two distinct areas of coal mining within the Lancashire Coal Field which affect the eastern half of the study area: Rainford Collieries on the northern side of the rail corridor to the west of the Rainford By-Pass (between WKL2 24m 1010yds and 25m 1340yds) and Holland Colliery (between WKL2 22m 1627yds to

Figure 12: Summary of Shallow Coal Mine Workings

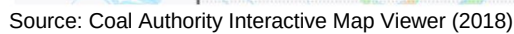


Figure 13: Map Extract from Network Rail Mining Report

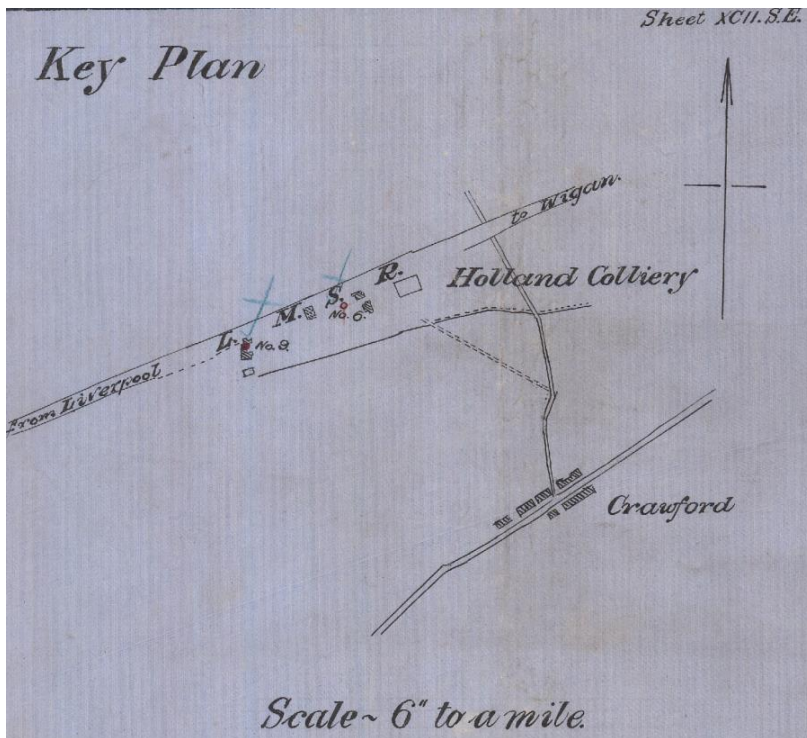


Source: Network Rail Mining Report LM-MISC-2448 (2018)

One of the sets of mining plans are for Holland Colliery, which appears to be operational until the late 1930s. They show there to have been two pits (No. 6 and No. 9) on the southern side of the railway and another two No. 8 and Day-Eye. All of the pits are connected to tunnels and/or workings directly beneath the rail corridor which work a range of coal seams including the Arley, Park, Rushy and Earthy seams. A plan and cross section is shown in Figure 14 and Figure 15 which show the succession of coal seams and depths from the surface at No. 6 and No. 9 pits. Whilst only shown to be partly worked by 1920, the Earthy seam is the shallowest and was worked at a depth of 59m at No. 9 Pit. The seam could have been further worked since the plan was produced, with potential shallow workings from No. 9 Pit to the east of No. 6 Pit where the seam outcrops. Underlying seams in the Park Mine, Rushy Park Mine and Arley Mine are shown to be completely worked to the east of No. 6 Pit by 1920, with workings becoming increasingly shallow to the east. Workings or tunnels to the west of No. 9 Pit are also shown to be as shallow as 35m, and Albert Mine to the west of Duke's Wood Lane appear to indicate workings as shallow as 15m from the surface beneath the track.

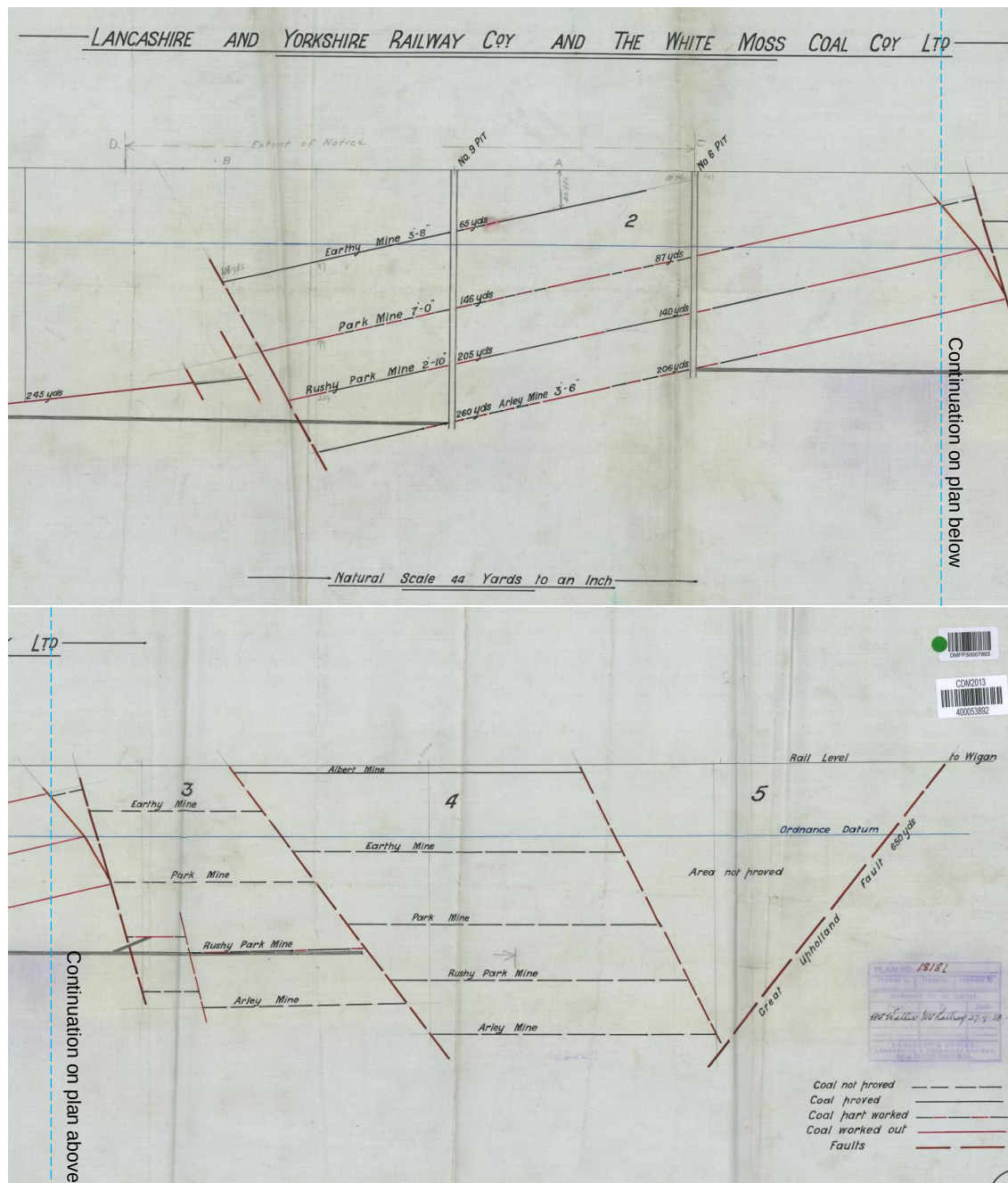
Further evidence of shallow tunnels is given in Figure 16 in the form of access roads which connect the King Coal Mine (Earthy Mine) to Day-Eye Pit and No. 9 Pit beneath the rail corridor. The end of the road section which directly joins to No. 9 Pit (surface level) is at 23m bgl, with an estimated depth beneath the rail track of around 10m bgl.

Figure 14: Plan showing No. 6 and No. 9 Pits at Holland Colliery



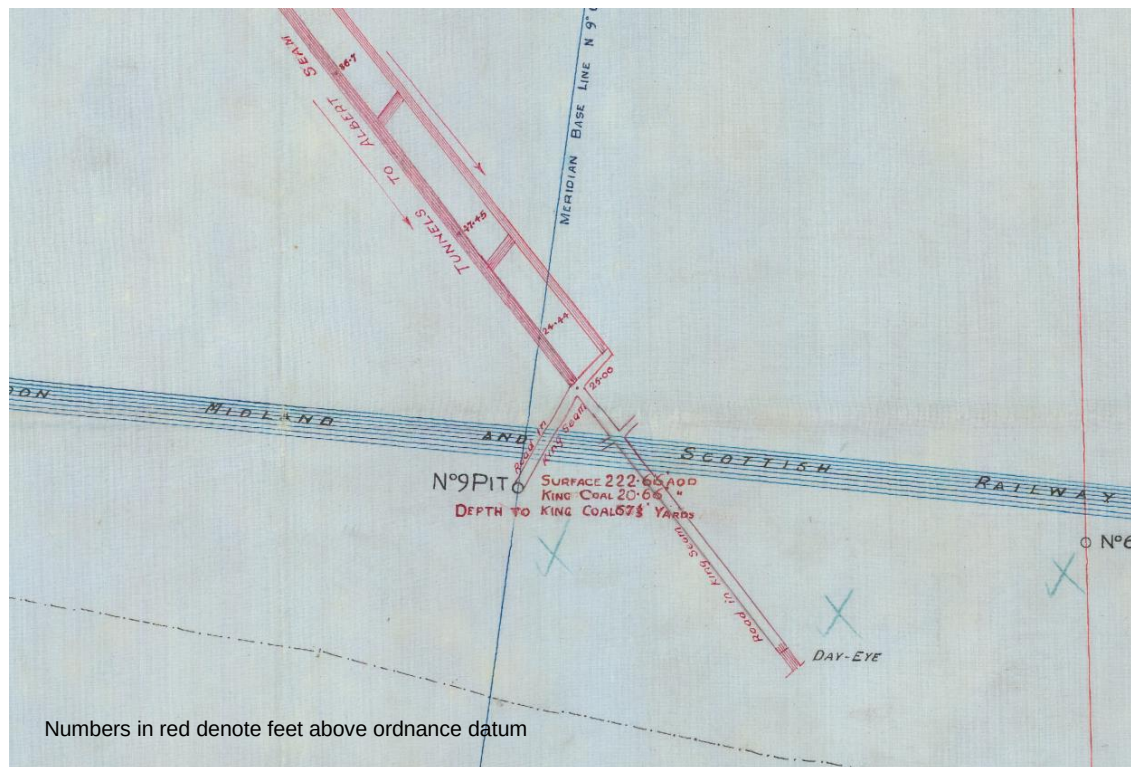
Source: CA Mine Plan 10207

Figure 15: Cross Section of Coal Seams at Holland Colliery



Source: CA Mine Plan 400053892 (1920)

Figure 16: Shallow Access Tunnels at Holland Colliery



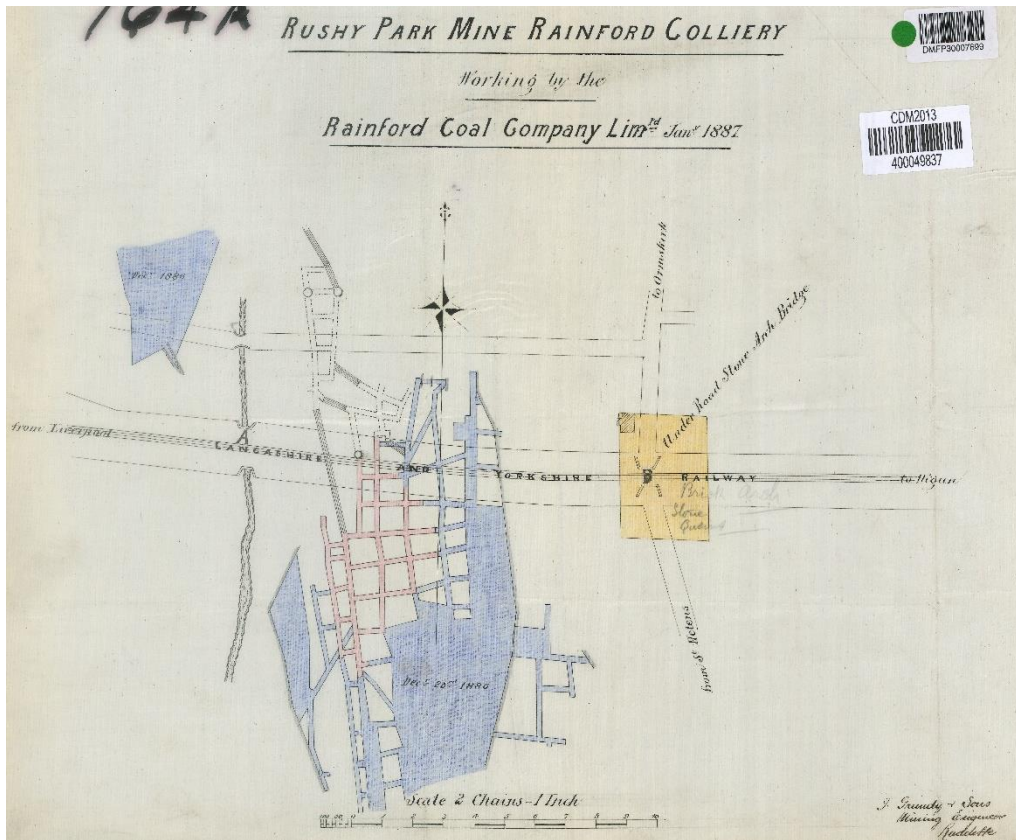
Source: CA Mine Plan 12484 5 of 5.

Rainford Collieries were operational until around the same time as Holland Colliery. Mining plans show No. 1, No. 2 and No. 4 pits on the northern side of the rail corridor, with No. 4 located between Rainford Brook and the present-day Rainford By-Pass, and No. 1 and No. 2 approximately 300m to the west of Rainford Brook. Workings and access tunnels are shown across the area and beneath the rail corridor as shown in Figure 17. Figure 18 shows a cross section (1887) from Rainford Brook (A) to what is now the Rainford By-Pass (B). The Five Feet Mine is recorded to be 23m below the surface at Rainford By-Pass and the corresponding plans indicate where coal has been removed. The available plans it indicates that coal was not completely removed from the shallowest Five Feet Mine.

A second cross section (date unknown), shown in Figure 19, illustrates the seams/mines along the study area in more detail. Seams dip to the west and the shallowest workings are those within the Seven Feet seam (Five Feet seam on previous plan), shown as being 146m deep at No. 2 Pit and 30m deep at No. 4 Pit, becoming increasingly shallower to the east until the seam outcrops just to the east of what is now the Rainford By-Pass (labelled Arch Bridge in the Figure 19).

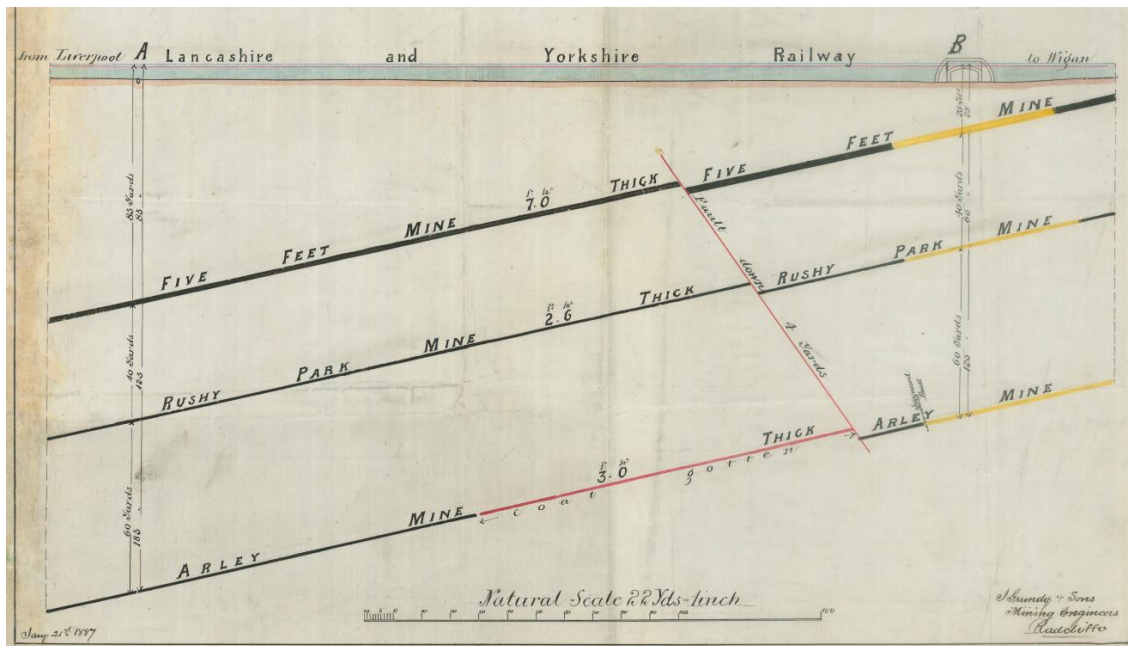
It should be noted that the information given on the plans is variable, referenced to historic roads/features and in some cases very limited. It should also be remembered that typically their purpose was quantity measurements rather than survey accuracy and could be inaccurate due to deliberate intent (e.g. avoidance of royalties) (CIRIA C758). However, they do indicate that mining has been undertaken around two localities beneath the railway line.

Figure 17: Pits Proximal to The Rail Corridor at Rainford Collieries



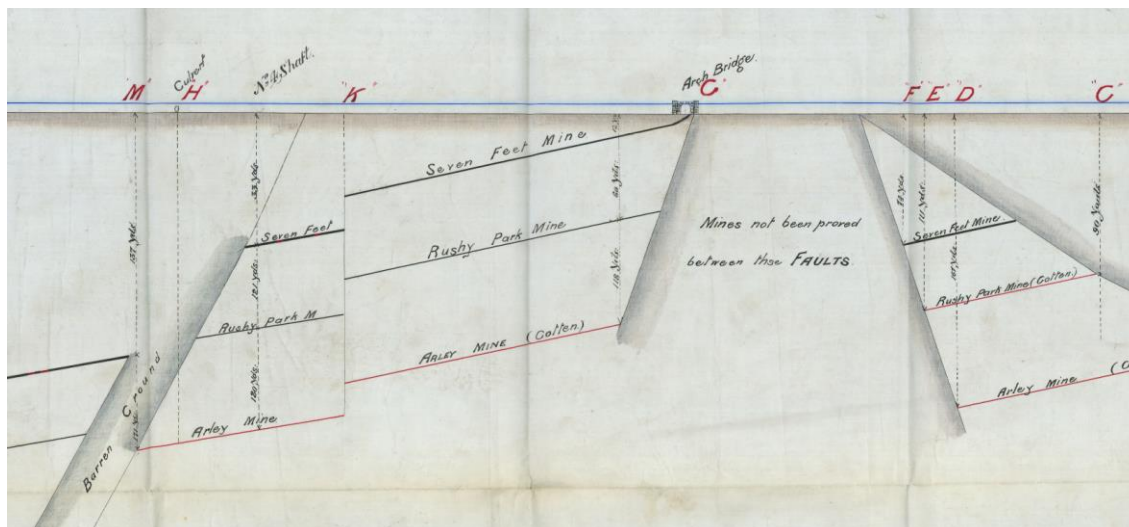
Source: CA Mine Plan 40009837

Figure 18: Cross Section Extract of Coal Seams at Rainford Collieries



Source: CA Mine Plan 400053186

Figure 19: Cross Section Extract of Coal Seams at Rainford Collieries



Source: CA Mine Plan 400049838

2.8.2 Mining Summary

There are significant areas of coal mine workings beneath the rail corridor. Records suggest that workings rarely come within distance of the ground surface to affect the proposed works ($\leq 25\text{m bgl}$) but there are at least two examples at Holland Colliery of tunnels which appear to directly underlie the corridor at depths of up to 15m bgl . There are also a number of shafts proximal to the corridor. The remedial status of all shafts, tunnels and workings is currently unknown. The proposed works mainly take the form of track bed renewal, which is not expected to cause significant loading or disturbance of the ground surface such that subsidence or ground collapse would occur where shallow voids are present. Where more intrusive/disturbing construction methods are required, such as at Rainford Station where platform extension is proposed, there are not shown to be any potential shallow workings or shafts in the area. Nonetheless, the overall risk to the proposed works is considered to be high due to the potential impact of collapsing ground. Once the final proposals are known a mining risk assessment should be carried out to further define the risk.

2.9 Railway Earthwork Records

Table 5 below summarises earthwork sections along the study area based on records from the JBA-Network Rail Earthwork Record Database (the full report of which is provided in Appendix E). The records separate earthworks into 110yd (100m) sections and include the earthwork type, Earthwork Hazard Category (EHC) and Risk Category. Network Rail does not classify cutting/embankment which are less than 3m high. These are defined as being at grade. EHC relates to the statistical likelihood of failure (A – E, where E is most likely) and Risk Category defines the risk posed to the track for a variety of failure types. All earthwork sections along the study area have an EHC A - C. Approximately 86% of sections have a Risk Category of Low Risk, 8% have a Medium Risk and a further 6% are noted to be 'not applicable', referring to at grade/no earthworks. Date of inspection for the records range from 2012 to 2019, so it is possible there has been some degradation in earthworks quality during recent time. A summary of all 100m sections for up and down sides of the corridor is given in Appendix E.

During a typographic survey carried out in 2018 along the railway line the presence of potential sandstone blocks (used as pitching) was noted along the track next to Simonswood Industrial

estate. However, there is no information available to confirm the whether the blocks are pitching and the extent that they cover.

Table 5: Earthworks Summary

ELR	Start Mileage	End Mileage	Earthwork type	EHC	Risk Category
WKL2	22.1320	24.1650	No Earthwork		
WKL2	24.1650	25.0660	Soil Embankment	A	Low Risk
WKL2	25.0660	26.0440	No Earthwork		
WKL2	26.0440	26.0990	Soil Embankment	A	Low Risk
WKL2	26.0990	26.1430	No Earthwork		
WKL2	26.1430	26.1760	Soil Cutting	A	Low Risk
WKL2	26.1760	27.0440	No Earthwork		
WKL2	27.0440	27.1100	Soil Cutting	A	Low Risk
WKL2	27.1100	27.1540	Soil Embankment	A	Low Risk
WKL2	27.1540	28.0220	No Earthwork		
WKL2	28.0220	28.0330	Soil Cutting	A-C	Low-Average Risk
WKL2	28.0330	28.1430	No Earthwork		
WKL2	28.1430	29.0440	Soil Embankment	A	Low-Average Risk
WKL2	29.0440	29.0550	No Earthwork		
WKL2/WJK	29.0550	29.1320	Soil Cutting	A-C	Low-Average Risk
WJK	29.1320	30.0330	Soil Embankment	A-C	Low-Average Risk

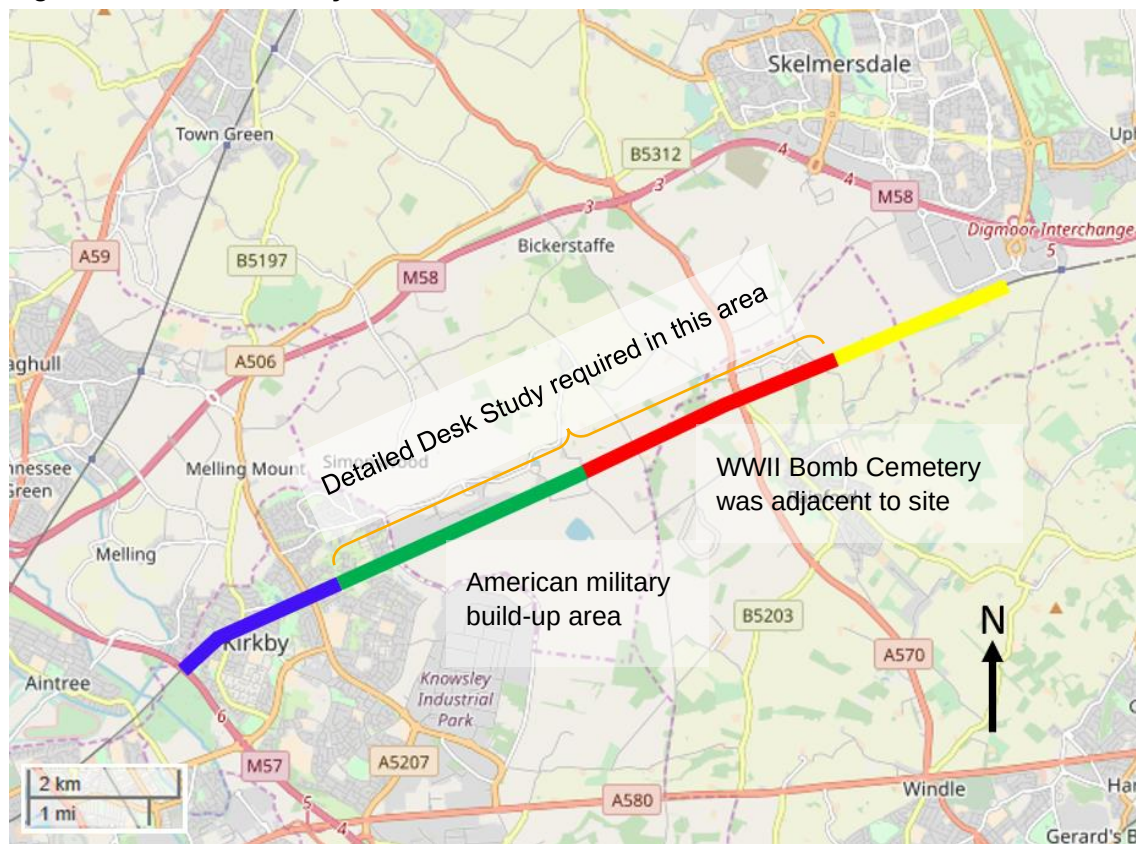
Source: JBA-Network Rail Earthwork Asset Database

2.10 Unexploded Ordnance (UXO)

Four Pre-Desk Study Assessments (PDSA) for unexploded ordnance (UXO) were obtained from Zetica for separate segments of the study area. The PDSAs state that a number of strategic WWII targets were located within 5km of the site including infrastructure, industries important to the war effort, and military barracks and depots. One of these was the Kirkby Inland Sorting Depot (at the existing location of Simonswood Industrial Estate) which was used by the American military to store and distribute imported war materials. A bomb cemetery is also recorded adjacent to the eastern part of the study area, although no further detail on this is known at this time.

The PDSA recommend that a detailed desk study is commissioned to assess, and potentially zone, the UXO hazard level across the central section of the study area. A summary is shown below in Figure 20 and the PDSAs in Appendix F.

Figure 20: PDSA Summary Plan



Source: © OpenStreetMap contributors. Available under Open Database Licence (Zetica, 2018)

2.11 Landfill

There are a number of landfills within range to affect the ground conditions along the study area. Historic landfills within 1km are summarised in Table 6 and active landfills in Table 7 below.

Table 6: Historic Landfills

Site Name	Location (NGR)	Distance from Study Area	Dates of Operation	Recorded Waste
Ingoe Lane	Ingoe Lane 339900, 398000	660m S	Unknown	Unknown
Nico Trading Limited	Bank Lane 340500, 400100	430m N	1992 – 1993	Inert
Simonswood Industrial Estate	Simonswood Industrial Estate 342600, 400400	<5m N	Unknown	Unknown
Stopgate Lane North and South	Stopgate Lane 342300, 400700	460m N	Unknown	Unknown
Siding Lane Tip	Siding Lane 346300, 402200	70m N	1952 – unknown	Commercial
Holland Colliery	Duke's Wood Lane 349200, 403100	<5m S	1939 - 1986	Inert, Industrial, Commercial

Site Name	Location (NGR)	Distance from Study Area	Dates of Operation	Recorded Waste
Pimbo Landfill Site	Chequer Lane 351300, 403900	1000m E	1960 – 1996	Inert, Industrial, Commercial, Household, Special, Liquid/Sludge

Source: Environment Agency

Table 7: Active Landfills

Site Name	Location (NGR)	Distance from Study Area	Date of License Issue	Recorded Waste
Holland Colliery	Duke's Wood Lane 349200, 403100	5m S	1992	Other Wastes
Marl Road/Woodward Road Inert Landfill	Woodward Road 343326, 399466	700m S	1992	Non-Biodegradable Wastes

Source: Environment Agency

2.12 Services/Utilities

The rail corridor crosses a number of active services/utilities which have been identified from the 5-Mile Plans provided by Network Rail. A summary, including material type and dimensions where known, is provided below in Table 8. Most of these are culverts but also included are water mains, gas mains, sewer pipes and electrical cables.

Table 8: Summary of Utilities

ELR	Miles	Yards	Service/ Utility
WKL2	22	1340	24" stone culvert
WKL2	22	1612	12" stone culvert
WKL2	23	443	3ft stone arch culvert
WKL2	23	882	NM 9"EW pipe
WKL2	24	000	NM 3ft brick arch culvert
WKL2	24	444	NM water main (LA Maint)
WKL2	24	449	NM 13" X7 Drain pipe
WKL2	24	884	NM 24" Brick barrel culvert
WKL2	24	887	NM Elec cable assumed
WKL2	24	968	Four concrete pipes
WKL2	24	1105	3Ft Stone culvert
WKL2	25	2	Elec Cable Assumed
WKL2	25	4	NM Water Main (LA Maint)
WKL2	25	7	NM Gas Main (LA Maint)
WKL2	25	9	NM 18" Timber Truck culvert
WKL2	25	882	NM 24" Trunk culvert
WKL2	25	400	Sankey Brook Culvert
WKL2	25	1342	M 30" Timber trunk culvert
WKL2	26	1160	24" Stone Culvert
WKL2	27	882	NM 18" stone culvert
WKL2	27	883	NM3FT 6" Stone culvert
WKL2	27	1315	3FT 10" stone arch culvert
WKL2	27	1452	NW 30" stone culvert

ELR	Miles	Yards	Service/ Utility
WKL2	27	1572	30" stone arch culvert
WKL2	27	1716	24" stone culvert
WKL2	28	882	NM 18" stone arch culvert
WKL2	28	1160	4Ft 2" stone arch culvert
WKL2	28	1322	NM 18" stone pipe
WKL2	29	195	3FT 10" stone arch culvert (Millstream)
WJK	29	1323	18" stone culvert
WJK	29	1324	18" stone culvert
WJK	29	1725	12" sewer pipe
WJK	30	2	Elec cable
WJK	30	4	Elec cable
WJK	30	74	18" stone culvert
WJK	30	203	18" stone culvert
WJK	30	409	18" stone culvert
WJK	30	442	3' culvert
WJK	30	556	18" stone culvert
WJK	30	882	24" Brick culvert
WJK	30	1105	Elec Cable (Manweb)

Source: Network Rail

2.13 Network Rail Hazard Directory

A hazard directory has been provided by Network Rail for the extents of the study area. The most commonly listed hazards refer to mine workings/shafts, buried services, overhead cables and landfill gases. Summarised below are items from the hazard directory which relate to shallow coal mine workings or shafts and landfill gases. The full hazard directory is provided in Appendix G.

Table 9: Extract from Network Rail Hazard Directory

ELR	Start	End	Type	Name	Comments
WKL2	22.165	23.1496	Landfill Gases	Holland Colliery	At risk from the migration of landfill gasses. Appropriate precautions should be taken.
WKL2	23.0066	23.0066	Mineworking - Pitshaft	Shaft	Mineshaft
WKL2	23.0374	23.0506	Mineworking - Mine	Culvert at 23M 20C	Shallow Mineworking
WKL2	23.0484	23.0484	Mineworking - Pitshaft	Shaft	Mineshaft
WKL2	23.0627	23.0627	Mineworking - Pitshaft	Shaft	Mineshaft
WKL2	23.0814	23.0869	Mineworking - Mine	Holland Colliery	Shallow Mineworking
WKL2	23.0869	23.0869	Mineworking - Pitshaft	Shaft	Mineshaft
WKL2	23.1078	23.1166	Mineworking - Mine	Holland Colliery	Shallow Mineworking
WKL2	23.1188	23.1243	Mineworking - Mine	Holland Colliery	Shallow Mineworking
WKL2	24.1100	24.1100	Mineworking - Pitshaft	Shaft	Mineshaft

ELR	Start	End	Type	Name	Comments
WKL2	24.1188	24.1364	Mineworking - Mine	Rainford Colliery	Shallow Mineworking
WKL2	25.0286	25.033	Mineworking - Mine	Rainford Colliery	Shallow Mineworking
WKL2	25.0308	25.0308	Mineworking - Pitshaft	Shaft	Mineshaft
WKL2	25.0308	25.0924	Landfill Gases	Sidings Lane. Rainford	At risk from the migration of landfill gasses. Appropriate precautions should be taken.
WKL2	25.0781	25.0781	Mineworking - Pitshaft	Shaft	Mineshaft
WKL2	27.0704	28.0462	Landfill Gases	Stopgate Lane. Simonswood	At risk from the migration of landfill gasses. Appropriate precautions should be taken.

Source: Network Rail Hazard Directory. For all items shown above, additional comments of 'contact NST Mining for advice – 01332 262716'.

3 Ballast Contamination Assessment

A large part of the proposed works will involve excavating, handling and potentially disposing of track bed material off-site. It is important to identify potential areas of contaminated ground that can be targeted as part of the ground investigation (GI) so that the contamination status of the excavated ballast can be determined, and potential hotspots can be identified which may pose an increased risk to construction workers. A summary of potential areas of contamination affecting the track bed is provided below in Table 10.

Table 10: Areas of Potential Contamination

Start (mi.yds)	End (mi.yds)	Source	Comments
26.1376	28.0000	Historic Kirkby Inland Sorting Depot	Located in the existing footprint of Simonswood Industrial Estate, the sorting depot was established in 1941 and is known to have been used to store and distribute imported war materials. It was directly connected to the rail corridor via private sidings and therefore the possibility of track bed contamination exists. Although war materials were not manufactured on site, potential contaminants may include those associated with munitions factories, including a variety of propellants (organic and inorganic solvents and compounds), metals and fuels.
25.0290	25.1086	Rainford Collieries	Holland Colliery and Rainford Collieries were located on the borders of the rail corridor connected via sidings and were both disused by 1956. Given the age of closure, it is likely that the sites were infilled with colliery spoil with no formal remediation undertaken.
23.330	23.1190	Holland Colliery	Historic landfills are recorded at both colliery sites, with Sidings Lane Tip (Rainford Collieries) reporting commercial waste and Holland Colliery Landfill reporting commercial, industrial and inert waste. Contaminated material may be buried within the track bed from when the collieries were operational or from the leachate of landfill waste in more recent times.
Entire Site		Rail Corridor	The rail corridor of the study area pre-dates the earliest historic map available (1850). Whilst the track bed is likely to have been maintained and possibly replaced in part since this time, the original track bed (and any contamination within it) may still be present beneath the upper layer of ballast. By nature, even modern railways are considered to be contaminative. Potential sources of contamination are likely to include the following: - Ash ballast (containing metals, phenols, sulphates and polycyclic aromatic hydrocarbons (PAHs)) which may be buried below modern ballast layers. - Fuel oils, lubricating oils and greases in areas of historic sidings (Kirkby Inland Sorting Depot, Holland Colliery and Rainford Collieries) - Herbicides from trackside farmland - Spillages and leakages of fuels - General contamination through the wind dispersal of airborne contaminations, including coal dust and asbestos fibres. - Buried asbestos from trackside buildings, such as the historic sand washing works (Simonswood Industrial Estate). The presence of contaminated material within the track bed is considered to be very likely.

4 Potential Ground Related Constraints and Risks

The potential ground related constraints for the proposed railway line and associated buildings have been summarised into a risk register provided in. Table 11 and Table 12 show the impact index and likelihood index respectively for assessing a hazard. Table 13 presents the Risk Matrix, which shows the actual risk level, rated from 'Severe' (max. risk level) to 'Negligible' (min. risk level). These constraints and risks require further investigation or consideration as the scheme progresses to reduce and minimise the impacts of these on the scheme.

Table 11: Negative Consequence Score Table

	Impact	Health and Safety	Time	Cost	Reputation	Environment
Very Low	negligible	negligible	negligible effect on programme	negligible	negligible	negligible
Low	minor	minor injury	5% effect on programme	1% budget	minor effect on local company image/ business relationship mildly affected	minor environmental incident
Medium	serious	major injury	12% effect on programme	10% budget	local media exposure/ business relationship affected	environmental incident requiring management input
High	threat to future work and client relations	fatality	25% effect on programme	20% budget	nationwide media exposure / business relationship greatly affected	environmental incident leading to prosecution or protestor action
Very High	threat to business survival and credibility	multiple fatalities	50% effect on programme	50% budget	permanent nationwide effect on company image/ significant impact on business relationship	major environmental incident with irreversible effects and threat to public health or protected natural resource

Table 12: Likelihood Score Table

	Likelihood	Probability
Very Low	negligible / improbable	<1%
Low	unlikely / remote	>1%
Medium	likely / possible	>10%
High	probable	>50%
Very High	very likely / almost certain	>90%

Table 13: Risk Matrix

		Likelihood				
		Very Low	Low	Medium	High	Very High
Negative Consequence	Very Low	N	N	N	N	T
	Low	N	N	T	T	S
	Medium	N	T	T	S	S
	High	N	T	S	S	I
	Very High	T	S	S	I	I

Risk Key

intolerable

RED

significant

AMBER

tolerable

YELLOW

negligible / trivial

GREEN

I
S
T
N

GEOTECHNICAL RISK REGISTER

Date:24/02/2020Project Phase: GRIP 3AProject:Skelmersdale Rail Link

Risk Assessment carried out by:Scott Myles

Ref No.	Affected area (station/ track)	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)
1	Eastern half of the study area near Holland and Rainford Collieries	Presence of mine shafts along the rail alignment.	* Potential for gradual or sudden collapse of capping above mine shaft. * Leading to damage to railway line and potential derailment of the train.	VH	L	S	HSCR	1) Consult Coal Authority/Network Rail records and historical maps for the presence of shafts. 2) Review risk as part of Mining Risk Assessment. 3) Where deemed necessary, GI to target shafts through intrusive and/or geophysical techniques and inform remediation methods prior to construction	VH	VL	T	Designer/Client	Designer prior to detailed design. Client to enable access for additional surveys and works required to mitigate this risk.
2	Eastern half of the study area	Construction over known historical shallow coal mine workings	* Potential for gradual or sudden collapse of ground beneath the railway line. * Leading to damage to railway line and potential derailment of the train. Low likelihood if track bed loading is unchanged after the works are completed	VH	L	S	HSCR	1) Carry out a desk study and consult with Coal Authority and Network rail mining engineers for coal abandonment plans 2) Ground investigation to relevant depths for track bed renewal and platform extensions, and to probe for voids along the route 3) Ground improvement works may be required to stabilise abandoned workings. Mitigation measures need to be carefully designed not to interfere with services or alter local transmissivity of near surface mine gas and water.	VH	VL	T	Designer/Client	Designer prior to detailed design. Client to enable access for additional surveys and works post-GI to mitigate this risk if required
3	Eastern half of the study area	Construction over unknown historical shallow coal mine workings	* Potential for gradual or sudden collapse of ground beneath the railway line. * Leading to damage to railway line and potential derailment of the train. Low likelihood if track bed loading is unchanged after the works are completed	VH	L	S	HSCR	1) Carry out a desk study and consult historical mapping, Coal Authority and Network rail mining engineers for coal abandonment plans and any ancillary information about possible unknown/unrecorded workings. 2) Ground investigation to relevant depths for track bed renewal and platform extensions, and to probe for voids along the route 3) Ground improvement works may be required to stabilise abandoned workings. Mitigation measures need to be carefully designed not to interfere with services or alter local transmissivity of near surface mine gas and water.	VH	VL	T	Designer/Client	Designer prior to detailed design. Client to enable access for additional surveys and works post-GI to mitigate this risk if required
4	Entire Route	Contamination within the rail corridor	* Harm to site staff. * Mobilisation of pollutant into local environmental receptors. * Additional costs for the ground investigation. * Additional costs for treatment and disposal of excavated soil and groundwater.	H	M	S	HSE	1) Consult with historical mapping and industrial records to identify potential sources of contamination. 2) Site staff to wear appropriate PPE. Vigilance by site staff during Ground Investigation/ Construction. 3) Adequate GI to include contamination testing for ballast contamination assessment. 4) Material to be screened by appropriately trained/competent sub-contractor if the material is being removed and replaced. 5) Findings of the ground investigation to be incorporated into the detailed design and construction planning.	H	L	T	Construction contractor/Designer/Client	Construction contractor prior to and during construction works. Designer to do desk study and design GI. Client to enable access for ground investigation.
8	Entire Route	Obstructions encountered during construction. Potential obstructions at locations of historic sidings and buildings within the corridor (sand washing works), as well as existing bridge foundations	* Delays in the construction progress. * Damage to the existing infrastructure. * Leading to delays and extra costs.	M	M	T	TCR	1) Carry out ground investigation to identify the nature and depth of the track bed and deeper at locations of platform extensions, and the possibility of encountering obstructions. 2) Risk mitigation strategy for obstructions to be developed based on proposed construction methodology and technology to be deployed.	M	L	T	Designer/Client/ Construction contractor	Designer prior to detailed design. Client to enable access for additional surveys and works required to mitigate this risk. Contractor to monitor during constructions
9	Entire Route	Unforeseen ground conditions.	* Inappropriate design and construction methodologies. * Impact on suitability and stability of design. * Impact on cost and project programme.	VH	M	S	HSTCR	1) Carry out ground investigation to further understand the ground conditions of the track bed and beneath it 2) Construction Control - logging of excavation and pile arisings during works, where required.	VH	VL	T	Designer Construction contractor	Designer prior to detail design. Construction contractor during planning of works and construction.
10	Kirkby and Rainford Stations	Incomplete knowledge of groundwater conditions at the site.	* Inaccurate assumptions for design of platform extensions * Leading to damage and instability issues for structures.	VH	M	S	HSTCR	1) Install groundwater monitoring installations. 2) Long term monitoring of standpipes. 3) Design to make conservative groundwater assumptions.	VH	VL	T	Designer	Designer to make appropriate assumptions in detailed design.

GEOTECHNICAL RISK REGISTER

Date:24/02/2020Project Phase: GRIP 3A

Project:Skelmersdale Rail Link

Risk Assessment carried out by:Scott Myles

Ref No.	Affected area (station/ track)	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)
11	Central part of route	Construction on peat and other soft/loose deposits beneath the track bed	* Excessive differential settlement * Leading to damage and instability issues for the track and proposed structures	M	H	S	HSTC	1) Ground investigation to identify the nature and depth of the track bed material and the ground beneath it 2) Appropriate construction methodologies to be adopted if required, which may include: - dig and replace - ground improvement - to be considered in foundation design in case of platform extensions	M	L	T	Designer/Client	Designer prior to detailed design. Client to enable access for additional surveys and works required to mitigate this risk.
12	Entire Route	Encountering services including culverts, high pressure gas mains, ethylene pipeline, and electrical cables	* Damage to services/culvert. * Possible damage to rig/construction equipment * Delay to construction programme. * Human helath risk to construction workers	H	M	S	HSTCRE	1) All available services information/drawings for the site area to be passed to the GI Contractor and Construction Contractor by designer in pre-construction information. 2) Service diversion to be designed where required. 3) Construction Contractor to satisfy himself as to the adequacy of available information and make additional enquires as necessary. 4) Appropriate methods to be utilised whist constructing the diversion and the main proposed works.	H	L	T	Designer/Construction Contractor	Designer prior to construction. Construction Contractor prior to and during construction works.
13	Kirkby and Rainford Stations	During construction process contaminants and/or grout/cement can be pushed down into the groundwater table.	* Groundwater contamination from piling for platforms or retaining walls (where required)	H	M	S	TCRE	1) Review the results of the ground investigation for contamination risk 2) Appropriate construction methodologies to be adopted 3) Construction contractor to use appropriate temporary works design. 4) Consultation with the Environment Agency/Coal Authority may be required regarding the proposed construction method and mitigation strategies to be put in place.	H	L	T	Construction Contractor	Construction contractor prior to and during construction.
14	Kirkby and Rainford Stations	Aggressive ground conditions	* Degradation of foundations and pile caps, leading to long term repairs and maintenance.	M	M	T	TCR	1) Results of chemical test suites to be reviewed to determine appropriate concrete class to use.	M	VL	N	Designer	Designer at detailed design stage.
16	Rainford Station	Heat generation and spontaneous combustion within coal seams during drilling/construction.	* Fire * Generation of CO which migrates via pathways to receptors, leading to injury or death. * Damage to equipment and inury to personnel.	VH	M	S	HSTCRE	1) Use only approved construction methods which minimise this risk such as water flush 2) Install monitoring wells and monitoring points near to receptors.	VH	VL	T	Designer/Construction Contractor	Designer prior to construction. Construction Contractor prior to and during construction works.
17	Entire Route	Ground gases encountered near historical mine shafts/workings, coal measures or landfill deposits	* Ground gas (methane, oxygen deficent, radon etc) could cause an explosive or asphyxiation hazard. * Risk to site workers	VH	VL	T	HSTCR	1) No action to be taken at this stage 2) Risk to be re-assessed following a change in scope of the proposed works	VH	VL	T	Designer/Client	To be re-assessed following a change in scope
18	Entire Route	Slope instability associated with track bed excavation and cutting into slopes as part of platform extensions or track realignment.	* Damage to equipment and existing or partially constructed elements of the proposed work. * Risk to of injury to the site workers.	M	M	T	HSTCR	1) GI to establish ground conditions 2) Stability analysis should be carried out to assess the temporary and permanent case for the slopes at locations of platform extensions 3) Suitable retaining structures to be adopted if required	M	VL	N	Designer/Client	Designer to design GI. Client to enable additional study/assessment to be carried out.
20	Central part of route	Encountering UXO	* Damage to equipment and existing or partially constructed elements of the proposed work. * Risk to of injury or death to the site workers.	VH	M	S	HSTCR	1) Desk study to consult with UXO risk maps and PDSA. 2) Review assessments and use additional mitigation measures if necessary, including a detailed UXO risk assessment	H	L	T	Designer	Designer to carry out desk study prior to design.

NOTES: RISK TYPES; HS = Health & Safety, T = Time, C = Cost, R = Reputation, E = Environment
Risk level: I = Intolerable, S = Significant, T = Tolerable, N = Negligible

		Likelihood				
		Very Low	Low	Medium	High	Very High
Impact	Very Low	N	N	N	N	T
	Low	N	N	T	T	S
	Medium	N	T	T	S	S
	High	N	T	S	S	I
	Very High	T	S	S	I	I

5 Conclusions and Recommendations

5.1 Geotechnical

Ground models have been produced in Section 2 based on a review of available information. Superficial and bedrock deposits vary along the study area but generally comprise the following: Blown Sand (Shirdley Hill Formation) and/or Glacial Till overlying Weathered Sandstone and Sandstone (Sherwood Sandstone Group) to the west; and Peat or Blown Sand, Glacial Till and Glaciofluvial Deposits overlying Mudstone, Siltstone and Sandstone of the Pennine Lower Coal Measures Formation to the east.

The review has highlighted a number of geotechnical hazards (detailed in Section 4) that require further investigation to reduce the risks. A summary of key risks is given below:

- Recorded and unrecorded features associated with historic coal mining, including shafts, and shallow and deep workings.
- Poor ground conditions associated with deposits of Made Ground, Peat and Blown Sand, particularly over the eastern half of the study area.
- Contamination associated with historic collieries and works, landfills, railways (including historical tramways and present day) and a munitions distribution depot.
- Obstructions at locations of historic sidings and buildings, and foundations of existing bridges within the corridor.
- Unexploded ordnance.
- Heat generation and spontaneous combustion within coal seams during drilling/construction.
- Recorded and unrecorded services and utilities, including culverts, high pressure gas mains, ethylene pipeline, and electrical cables.

The main risk to the proposed works stems from historic coal mining activities, as discussed in Section 2.8. There are two distinct areas of coal mining which affect the eastern half of the study area: on the northern side of the rail corridor to the west of the Rainford By-Pass and to the south of Pimbo industrial estate. Within both areas are a significant number of past and probable, shallow and deep coal mine workings and shafts which are proximal to the rail corridor. Records suggest that workings rarely come within distance of the ground surface to affect the proposed work but there are examples of tunnels which directly underlie the corridor at shallower than 15m bgl. The proposed works mainly take the form of track bed renewal, which is not expected to cause significant loading or disturbance of the ground surface. Deeper proposed construction works are not within areas of historic coal mining. As such, the likelihood of subsidence or collapse is considered to be low but the impact high. Regardless, approval will need to be sought from the Coal Authority prior to the ground investigation and construction where the works are expected to encroach onto Coal Authority mining interests, and to ensure that the risks are appropriately managed. In addition, shaft locations will need to be confirmed prior to construction and mine workings should be considered as potentially susceptible to collapse due to natural degradation over time.

There is a risk of potentially compressible ground from soft or loose deposits of Peat, Blown Sand and Made Ground, which are unsuitable as subgrade materials. However, it is anticipated that many of these would have been excavated as part of the historic corridor construction/maintenance. Once the ground conditions are known following the ground investigation, actions can be taken to minimise this risk where needed.

Another significant risk is posed from buried obstructions, utilities and services, which can have impacts on construction costs and delays. The risk can be mitigated by in part by an intrusive ground investigation and by considering the existing location of services and utilities in construction and design.

5.2 Geo-environmental

A ballast contamination assessment has been undertaken in Section 4 which identifies and reviews areas of potential contamination affecting the rail corridor. They are summarised as follows:

- Simonswood Industrial Estate (historic Kirkby Inland Sorting Depot) – possible contamination associated with the distribution of munitions, as well as more recent contamination from activities at the existing industrial estate.
- Collieries – Rainford Collieries and Holland Colliery on the corridor borders were likely infilled with spoil with no remediation strategies in place. They are now classified as landfill sites and may pose a source of contamination following the leaching of landfill material.
- Rail Corridor – the rail corridor pre-dates the earliest historic map available (1850). Rail corridors are contaminated environments by nature. This is particularly true for older railways, which were not controlled by modern regulations and which have had time to accumulate potentially large amounts of contamination.

The main risk is to construction workers, who will need to excavate into the ground as part of the proposed works. It is also important to identify the contamination status of the ground for material being removed and disposed of off-site. There may be a requirement for treatment prior to disposal where contaminated ground is identified, resulting in increased costs and programme time.

The ecological constraints of the study area are currently unknown and will be assessed during a subsequent phase of the project.

5.3 Recommendations

5.3.1 Walkover Survey

A physical walkover was not undertaken during the desk study phase. A virtual walkover has been undertaken during the course of this desk study through the review of aerial imagery and the Network Rail Route viewer website. A walkover would primarily serve two purposes:

1. Field reconnaissance to record any visible evidence of features that are not present from maps and aerial photographs such as recent construction, suspicious depressions, colour, odour and condition of standing water, vegetation die-back, fly-tipping etc.
2. Assist in scoping of the ground investigation.

5.3.2 Ground Investigation

A ground investigation is required in order to assess the existing ground conditions present beneath the site; validate the geotechnical and geo-environmental risks; and identify remedial requirements. Investigation works will also enable the collection of samples for chemical and geotechnical testing, which are all required to inform a Track Bed Investigation Report/Ground Investigation Report for the study area.

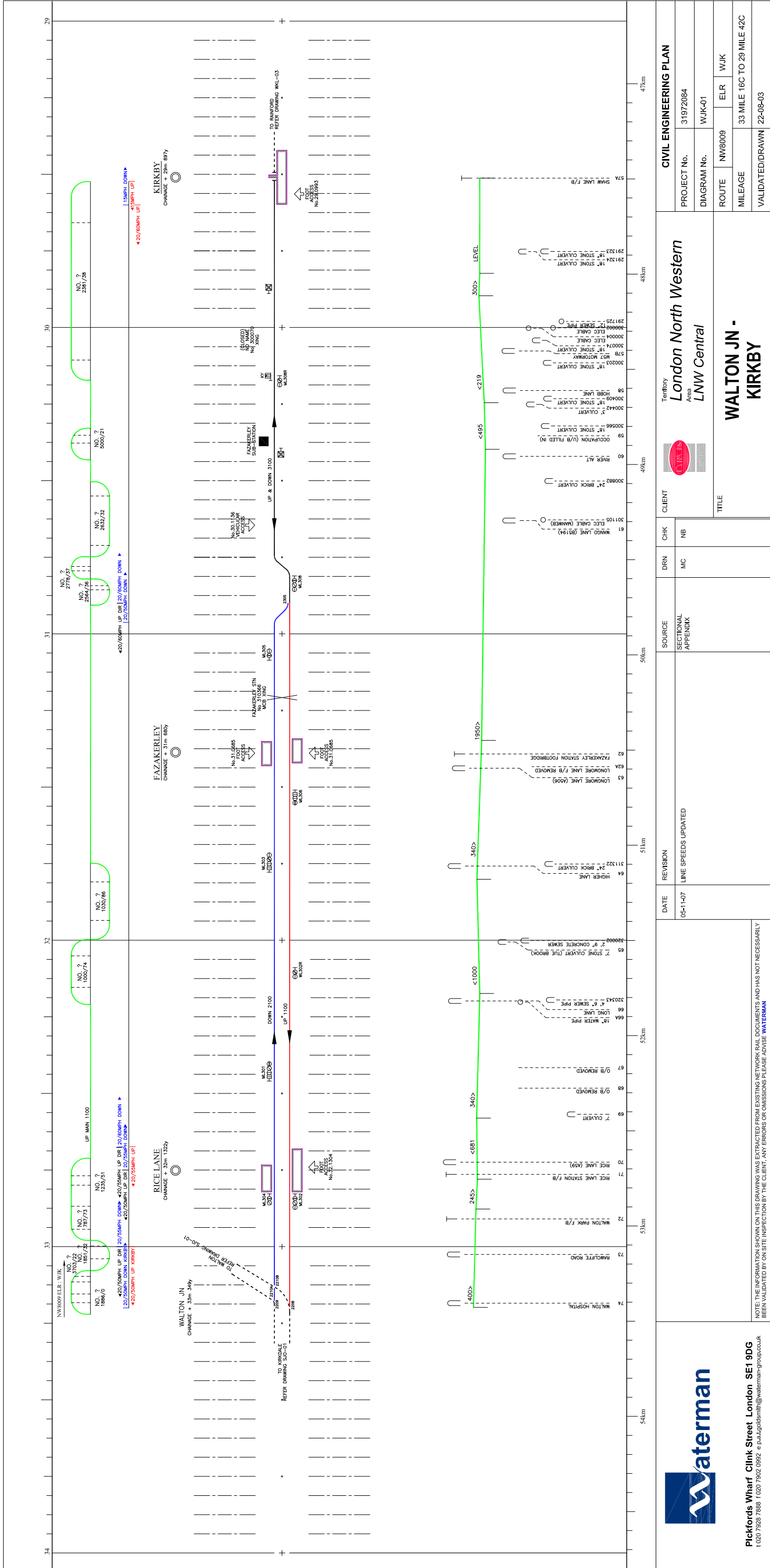
5.3.3 Mining Risk Assessment

Whilst this desk study details the potential risks from the historic mine workings in the area it does not constitute a detailed Mining Risk Assessment. It is recommended that this risk assessment is produced at the next GRIP stage. Depending on the outcome of the risk assessment and if voids are encountered during the ground investigation voids are encountered, ground treatment (e.g. drilling and grouting) may be required to reduce the risks.

Appendices

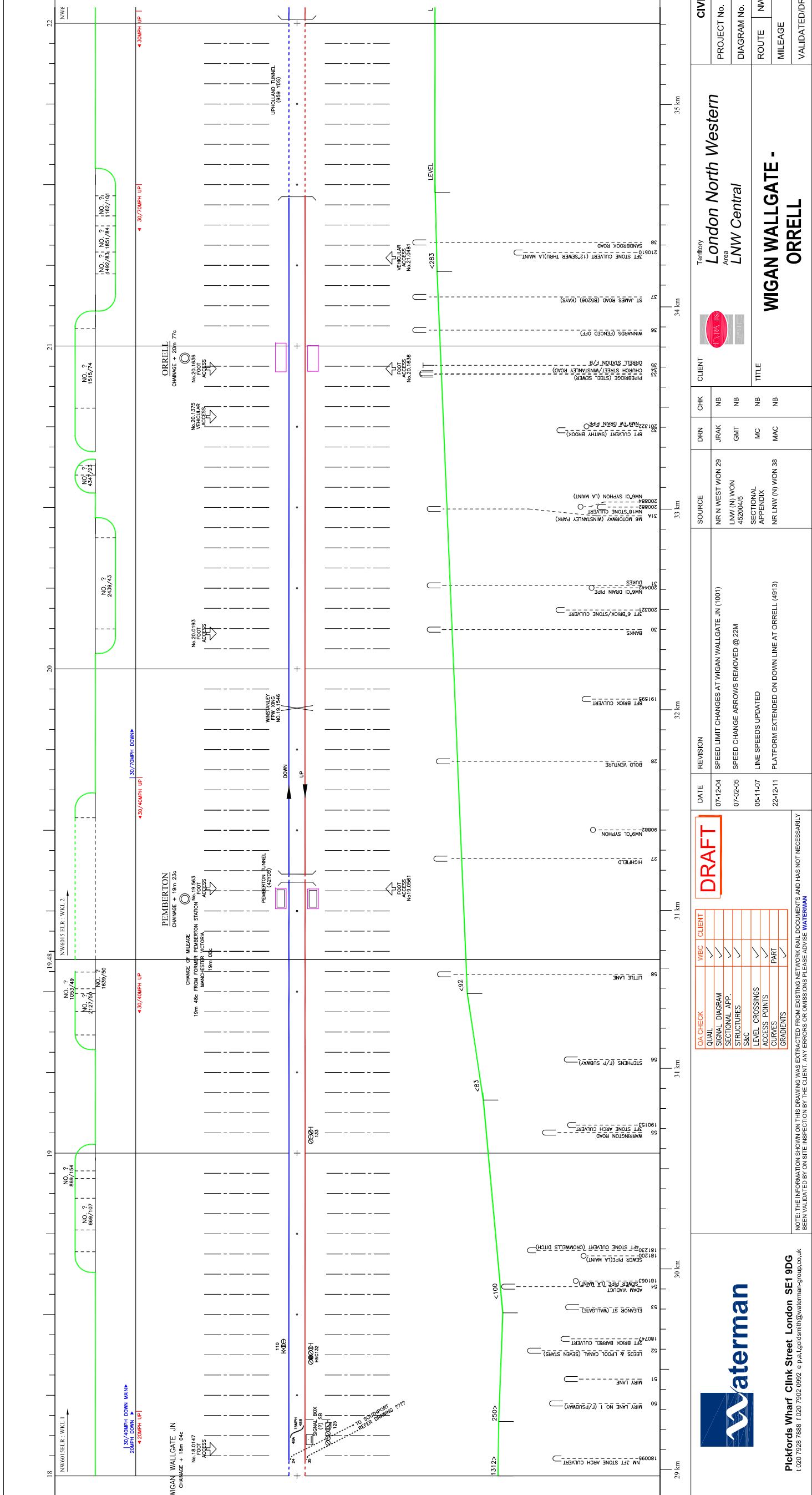
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A. Drawings and Plans



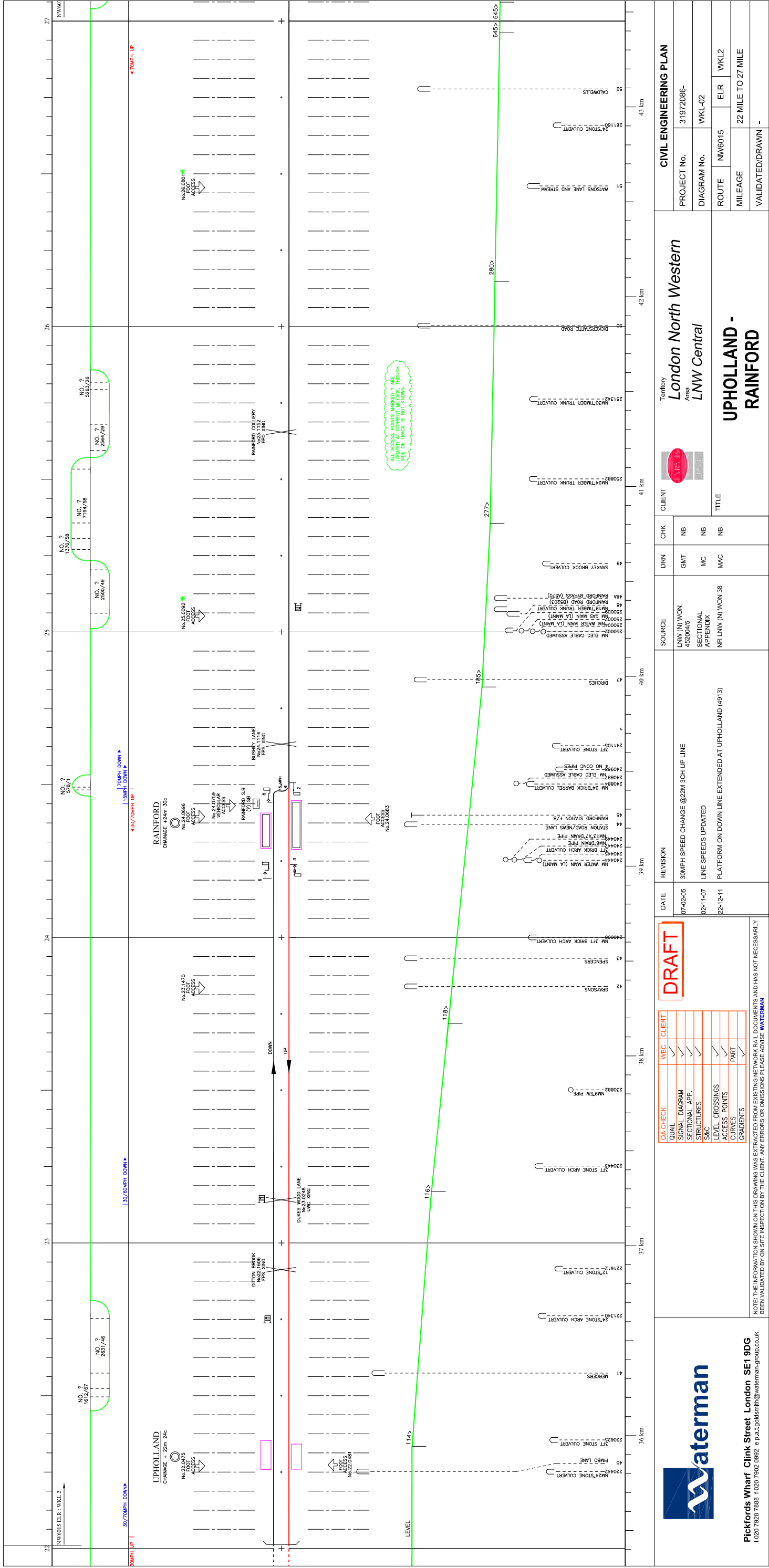
LIST OF ROUTES	TO UK MAP	CIVIL ENGINEERING PLAN	SIGNALLING PLAN	ELECTRICAL PLAN	HAZARD PLAN	TRACK QUALITY	POSSESSION PLANNING
SIGNALLING DIAGRAM NOT AVAILABLE							

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LIST OF ROUTES	TO UK MAP	CIVIL ENGINEERING PLAN	SIGNALLING PLAN	ELECTRICAL PLAN	HAZARD PLAN	TRACK QUALITY	POSSESSION PLANNING
SIGNALLING DIAGRAM NOT AVAILABLE							
 Waterman Burrow Crocker Civil & Transportation Consulting Engineers Pickfords Wharf Clink Street London SE1 9DG t 020 7928 7888 f 020 7902 0992 e p.a.goldsmit@watermar-group.co.uk NOTE: THE INFORMATION SHOWN ON THIS DRAWING WAS EXTRACTED FROM EXISTING NETWORK RAIL DOCUMENTS AND HAS NOT NECESSARILY BEEN VALIDATED BY ON SITE INSPECTION BY THE CLIENT. ANY ERRORS OR OMISSIONS PLEASE ADVISE WATERMAN BURROW CROCKER DATE REVISION SOURCE DRN CHK CLIENT SIGNALLING PLAN DRAWING No. - DIAGRAM No. - BRS - ELR - MILEAGE - LAST VALIDATED - C S E MAP							
SEARCH		MAIN MENU					

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LIST OF ROUTES	TO UK MAP	CIVIL ENGINEERING PLAN	SIGNALLING PLAN	ELECTRICAL PLAN	HAZARD PLAN	TRACK QUALITY	POSSESSION PLANNING							
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						MILEAGE -								
						LAST VALIDATED -								

SEARCH

MAIN MENU

	LIST OF ROUTES	TO UK MAP	CIVIL ENGINEERING PLAN	SIGNALLING PLAN	ELECTRICAL PLAN	HAZARD PLAN	TRACK QUALITY	POSSESSION PLANNING
	ELECTRICAL DIAGRAM NOT AVAILABLE							

Waterman Burrow Crocker Civil & Transportation Consulting Engineers Pickfords Wharf Clink Street London SE1 9DG t 020 7926 7888 f 020 7902 0992 e p.a.j.godsmill@watermar-group.co.uk	DATE - REVISION .	SOURCE -	DRN -	CHK -	CLIENT	ELECTRICAL PLAN DRAWING No. - DIAGRAM No. -BRS -ELR -MILEAGE-LAST VALIDATED -	CSEMAP
NOTE: THE INFORMATION SHOWN ON THIS DRAWING WAS EXTRACTED FROM EXISTING NETWORK RAIL DOCUMENTS AND HAS NOT NECESSARILY BEEN VALIDATED BY ON SITE INSPECTION BY THE CLIENT. ANY ERRORS OR OMISSIONS PLEASE ADVISE WATERMAN BURROW CROCKER							

SEARCH

MAIN MENU

B. Detailed Review of Historical Mapping

Table 15: Summary of Historical Mapping WJK/WKL2 28m 0yds to 30m 308yds

Year	Map Scale	Significant development along the rail corridor	Significant development around the rail corridor
1850	1:10,560	- Rail corridor in existing footprint - Kirkby Station present - Simonswood Brook present flowing beneath the track - Crossing of County Road and Glovers Brow present in existing footprint - Crossing of Dale Road present in historic footprint (NW-SE)	- Undeveloped or farmed fields with urban developments around Glovers Brow and County Road. - Mawdsley's Farm at side of corridor near Dale Lane and - Row Farm at southern side of Kirkby Station - Kirkby Mill (corn) and a mill pond to the north of the corridor on Simonswood Brook - Dearbolt Delf (quarry) for sandstone to the north of the rail corridor on Glovers Brow - Mercer's Delf for sandstone off County Road to the north of the rail corridor
1893	1:2,500	Crossing which joins to existing position of Bramcote Walk	- Pumping Station at side of corridor to the east of County Road - Small pond on northern side of the corridor near the start of the segment - Dearbolt Delf disused
1894	1:10,560	No significant changes	No significant changes
1908	1:2,500	No significant changes	- Bridge Farm on Dale Lane on southern side of the rail corridor - Well to south of the corridor at existing position of Bramcote Walk
1909	1:10,560	No significant changes	No significant changes
1927	1:2,500	No significant changes	No significant changes
1928	1:10,560	No significant changes	No significant changes
1955-1956	1:10,560	Additional rail lines joining and crossing the track at the eastern edge of the segment – connecting the track with Kirkby Industrial Estate (approx. 1km to the south) and Kirkby Inland Sorting Depot	Development of Kirkby on the northern side of the rail corridor

Year	Map Scale	Significant development along the rail corridor	Significant development around the rail corridor
		(approx. 500m to the west).	
1961-1962	1:1,250	• Crossing which joined to existing position of Bramcote Walk no longer shown.	• Significant housing and school developments around Kirkby both sides of the Rail Corridor. • Undefined works on northern side of the rail corridor near the segment start • Redevelopment of Kirkby Mill, Row Farm • Significant development (mainly housing and schools) to the south of the rail corridor between County Road and Dale Lane
1962-1975	1:1,250	• No significant changes	• No significant changes
1966 (partial)	1:10,560	• No significant changes	• No significant changes
1974 (Russian)	1:10,000	• No significant changes	• Further housing developments to the south of the corridor at Kirkby
1976	1:2,500	• M57 present crossing the start of the segment in its existing footprint. • Dale Lane rebuilt into existing footprint	• Significant housing developments to the north of the rail corridor at the eastern edge of the segment
1976-1978	1:10,000	• Track connecting to Kirkby Inland Sorting Depot no longer shown	• Areas of development in line with existing footprints
1989-1999	1:10,000	• No significant changes	• No significant changes
2000 (aerial imagery)	-	• No significant changes	• Works to straighten out the track which joins the eastern edge of the segment to Kirkby Industrial Estate • Mercer's Delf filled in • Pumping station no longer shown
2005 (aerial imagery)	-	• No significant changes	• Housing developments over school fields on southern side of the rail corridor, east of County Road
2018 (aerial imagery)	-	• No significant changes	• No significant changes

Table 16: Summary of Historical Mapping WKL2 25m Oyds to 28m Oyds

Year	Map Scale	Significant development along the rail corridor	Significant development around the rail corridor
1850	1:10,560	- Rail corridor in existing footprint - Track crossing of an unnamed road (at eastern edge of the existing quarry); Simonswood Brook; Coach Road; and Rainford Road in existing footprints - Two track crossings at western end of the segment - Two track crossing to the east of Coach Road. - Rainford Brook flowing beneath the track in its existing footprint	- Undeveloped or farmed fields with several woodlands/"wood plantations" at the western end of the segment - Woods Farm to the south of the rail corridor at the western edge of the segment - Moore's Farm to the north of the rail corridor at the eastern edge of the segment
1893	1:2,500	- Rainford Collieries at the eastern edge of the segment with tracks and sidings joined to the northern side of the rail corridor. Includes reservoirs, clay pits and houses on the eastern side - Sand Washing Works shown near the crossing at the western edge of the segment (only one crossing now shown) - Two track crossings at the western edge of the segment no longer shown	No significant changes
1894	1:10,560	No significant changes	No significant changes
1908	1:2,500	No significant changes	Brickworks and reservoir included at Rainford Collieries
1909	1:10,560	No significant changes	No significant changes
1927	1:2,500	No significant changes	Bridge Farm at northern side of the corridor at Coach Road
1955-1956	1:10,560	Kirkby Inland Sorting Depot shown at western edge of the segment with sidings/tracks joining the rail corridor. Built over the woods plantation	Rainford Collieries shown as disused

Year	Map Scale	Significant development along the rail corridor	Significant development around the rail corridor
		● Rainford By-Pass built in existing footprint	
1961-1962	1:1,250	● No significant changes	● Two ponds shown on the southern side of the sorting depot near Woods Farm ● Rainford Collieries shown to partially redeveloped with woodland. Still ponds/reservoirs and disused shafts shown.
1962-1975	1:1,250	● No significant changes	● No significant changes
1976	1:2,500	● No significant changes	● Refuse tip and Wood Yard at location of historic collieries
1976-1978	1:10,000	● Kirkby Sorting Depot no longer shown. Replaced with a timber yard and works (to be Simonswood Industrial Estate)	● No significant changes
1989-1999	1:10,000	● No significant changes	● Bridge Farm now a cottage ● Rainford Collieries now fully remediated with trees with ponds remaining
2000 (aerial imagery)	-	● No significant changes	● No significant changes
2005 (aerial imagery)	-	● Further expansion of Simonswood Industrial Estate into woodland	● No significant changes
2018 (aerial imagery)	-	● No significant changes	● No significant changes

Table 17: Summary of Historical mapping WKL2 22m 1378yds to 25m 0yds

Year	Map Scale	Significant development along the rail corridor	Significant development around the rail corridor
1850	1:10,560	● Rail corridor in existing footprint ● Rainford Station present 900m to the west of existing location ● Track crossing of New Lane (Rainford Station); Maggots Nook Road to Maggots Nook Farm; and Duke's Wood Lane in existing footprints ● Track crossing to Maggots Nook Farm ● Track crossing to Long Lane	● Undeveloped or farmed fields ● News Lane Farm and Maggots Nook Farm at the southern side of the corridor near the centre of the segment ● Holland Colliery at the southern side of the corridor at the eastern section of the segment ● Rainford Collieries at the northern side of the corridor near Rainford Station

Year	Map Scale	Significant development along the rail corridor	Significant development around the rail corridor
		Lancashire and Yorkshire Railway running N-S across the western edge of the segment with chords joining the track near the location of the existing Rainford Station (named Rainford Junction)	
1893	1:2,500	- Track leading to Maggots Nook Farm rebuilt into existing footprint - Mineral railway joining the track at the western end of the segment - Rainford Station appears to have moved to Rainford Junction (existing footprint)	- Holly Farm to the north of the corridor at Rainford Junction - Expansion of Holland Colliery - Minor development around the eastern end of the segment (houses and bowling green) - Old shaft at edge of the corridor where the mineral railway meets the western edge of the segment - Multiple ponds near Maggots Nook Farm - Red Delf Farm to north of the corridor at the western end of the segment
1894	1:10,560	No significant change	No significant change
1908	1:2,500	- Mineral railway no longer shown at the western end of the segment - Sidings joining the track at Holland Colliery	Reservoir at Holland Colliery
1927	1:2,500	No significant change	- News Lane Farm now Bridge Farm - Expansion westward of Holland Colliery - Bowling green at eastern end of the segment now Balcarres Farm
1955-1956	1:10,560	No significant change	Holland Colliery now disused
1961-1962	1:1,250	No significant change	Holland Colliery appears to be infilled/remediated
1976	1:2,500	Rainford Junction removed and developed into housing	Works/business park (Pimbo Industrial Estate) and a gas distribution station now to the north of the eastern end of the segment

Year	Map Scale	Significant development along the rail corridor	Significant development around the rail corridor
			Significant development around Rainford to the south
1976-1978	1:10,000	No significant change	No significant change
1989-1999	1:10,000	No significant change	No significant change
2000 (aerial imagery)	-	No significant change	No significant change
2005 (aerial imagery)	-	No significant change	No significant change
2018 (aerial imagery)	-	No significant change	No significant change

C. Historical Borehole Records

LANCASHIRE COUNTY COUNCIL

BOREHOLE DATA SHEET

British Geological Survey

DATE 21st MARCH, 1967

JOB NO. 247/B

ST 39 NE/454
SE 39491 98736
BOREHOLE NO. 576674

JOB LIVERPOOL OUTER RING ROAD (A59 to A580)

DEPTH 15'4"

LOCATION HOBBS RAILWAY BRIDGE

GROUND LEVEL 52.03 A.O.D.

Description	Depth	Symbol	M.C.	L.L.	P.L.	P.I.	Class.	Sign.	Remarks
SANDY TOPSOIL	2'-0" (0.61)		19.2				TS		
STIFF BROWN SANDY BOULDER CLAY with GREY SAND-FILLED FISSURES	9'-6" (2.90)		19.1	32	14	18	CL		5'-0" to 6'-6"
RED BUNTER SANDSTONE	15'-4" (4.67)		14.2				S		9'-6" to 10'-9" N = 64 for 3"
			14.1						12'-6" to 13'-2" N = 50 for 2"
BOREHOLE DRY									BOREHOLE CASSED to 14'-0"

Undisturbed Sample
Bulk Sample
Water EntryRaymond Penetration Test
Kilner Jar Sample
Final Water Level
☐ R.
☐ KJ.
☐ FWL.

N = No. of Blows

Depth of Sample	5'-0" / 6'-6"							
Bulk Density	lb/ft ³	128						
Dry Density	lb/ft ³	107						
Moisture Content	%	19.1						
Compressive Stress	lbs / ft ² / lb/in ²							
Shear—Cohesion	lbs / ft ² / lb/in ²	2870						
Shear—Angle of Friction	°	0°						
B.S. COMPACTION								
Maximum Dry Density	lb/ft ³							
Optimum Moisture Content	%							
Remoulded Dry Density	lb/ft ³							
Field Moisture Content	%							
B.S. (HEAVY) COMPACTION								
Maximum Dry Density	lb/ft ³							
Optimum Moisture Content	%							
Remoulded Dry Density	lb/ft ³							
Field Moisture Content	%							
Specific Gravity								
Air Voids at MC	%							
CBR at MC	%							
Consolidation Test								

LANCASHIRE COUNTY COUNCIL

BOREHOLE DATA SHEET

5 J 39 NE / 452

British Geological Survey

British Geological Survey

5 J 39 NE / 452

DATE 20th MARCH, 1967

JOB NO. 247/B

BOREHOLE NO. 5766/2

JOB LIVERPOOL OUTER RING ROAD (A59 to A580)

DEPTH 14' 1 1/2"

LOCATION HOBBS RAILWAY BRIDGE

GROUND LEVEL 52.98' AOD

Description	Depth (metres)	Symbol	M.C.	L.L.	P.L.	P.I.	Class.	Sign.	Remarks
SANDY TOPSOIL	2'-0" (0.61)		17.3						
FIRM BROWN SANDY BOULDER CLAY with GREY SAND-FILLED FISSURES			18.0				CL		3'-0" to 4'-0"
			20.8						5'-0" to 6'-6"
	8'-9" (2.71)		18.2	33	14	19			8'-9" to 9'-6" N=75 for 9"
RED BUNTER SANDSTONE							S		HR 11'-9" to 11'-10 1/2" N=50 for 1 1/2"
	14'-1 1/2" (4.31)								
BOREHOLE DRY									BOREHOLE NOT CASED

Undisturbed Sample
Bulk Sample
Water Entry

WE.

Raymond Penetration Test
Kilner Jar Sample
Final Water Level

□ R.
KJ.
FWL.

N=No. of Blows

Depth of Sample	3'-0"	4'-0"	5'-0"	6'-6"
Bulk Density lb/ft ³	127	127		
Dry Density lb/ft ³	107	105		
Moisture Content %	18.0	20.8		
Compressive Stress lb _s /ft ² lb/in ²				
Shear—Cohesion lb _s /ft ² lb/in ²	1490	910		
Shear—Angle of Friction	0°	0°		
B.S. COMPACTION				
Maximum Dry Density lb/ft ³				
Optimum Moisture Content %				
Remoulded Dry Density lb/ft ³				
Field Moisture Content %				
B.S. (HEAVY) COMPACTION				
Maximum Dry Density lb/ft ³				
Optimum Moisture Content %				
Remoulded Dry Density lb/ft ³				
Field Moisture Content %				
Specific Gravity				
Air Voids at MC %				
CBR at MC %				
Consolidation Test				

LANCASHIRE COUNTY COUNCIL

BOREHOLE DATA SHEET

ST 39 NE/453

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British Geological Survey

British Geological Survey

BOREHOLE NO. 5766/3

DATE 20th and 21st MARCH, 1967 JOB NO. 247/B

JOB LIVERPOOL OUTER RING ROAD (A59 to A580)

DEPTH 13'9"

LOCATION HOBBS RAILWAY BRIDGE

GROUND LEVEL 52.08 A.O.D.

Description	(metres) Depth	Symbol	M.C.	L.L.	P.L.	P.I.	Class.	Sign.	Remarks
SANDY TOPSOIL	2'0" (0.61)		22.7				TS		
VERY STIFF BROWN SANDY BOULDER CLAY	6'6" (1.98)		14.2				CL		5'0" to 6'6"
RED BUNTER SANDSTONE	13'9" (4.19)								7'6" to 8'3" N = 100 ft x 9"
BOREHOLE DRY									BOREHOLE CAVED To 5'0"

Undisturbed Sample
Bulk Sample
Water Entry

WE.

Raymond Penetration Test
Kilner Jar Sample
Final Water Level

OR.
KJ.
FWL.

N = No. of Blows

Depth of Sample	5'0" 6'6"								
Bulk Density	lb/ft ³	133							
Dry Density	lb/ft ³	116							
Moisture Content	%	14.2							
Compressive Stress	lbs/ft ² lb/in ²								
Shear—Cohesion	lb/ft ² lb/in ²	7800							
Shear—Angle of Friction	°	0°							
B.S. COMPACTION									
Maximum Dry Density	lb/ft ³								
Optimum Moisture Content	%								
Remoulded Dry Density	lb/ft ³								
Field Moisture Content	%								
B.S. (HEAVY) COMPACTION									
Maximum Dry Density	lb/ft ³								
Optimum Moisture Content	%								
Remoulded Dry Density	lb/ft ³								
Field Moisture Content	%								
Specific Gravity									
Air Voids at MC	%								
CBR at MC	%								
Consolidation Test									

LANCASHIRE COUNTY COUNCIL

BOREHOLE DATA SHEET

British Geological Survey

DATE 16th MARCH 1967

JOB NO. 247/B

BOREHOLE NO. 5766/6

JOB LIVERPOOL OUTER RING ROAD (A59 to A580)

DEPTH 12'0"

LOCATION HOBBS RAILWAY BRIDGE

GROUND LEVEL 50.43' A.O.D.

Description	(metre) Depth	Symbol	M.C.	L.L.	P.L.	P.I.	Class.	Sign.	Remarks
SANDY TOPSOIL	2'0"						TS		
FIRM BROWN SANDY BOULDER CLAY	5'5"		17.1						
RED SAND or WEATHERED SANDSTONE	6'6"		15.8	44	19	25	CI	■	5'0" to 5'6"
RED BUNTER SANDSTONE	12'0"								
BOREHOLE DRY									BOREHOLE CLOSED TO 11'6"

Undisturbed Sample
Bulk Sample
Water Entry

WE.

Raymond Penetration Test
Kilner Jar Sample
Final Water Level

□ R.
KJ.
FWL.

N = No. of Blows

Depth of Sample	5'0"	5'6"						
Bulk Density lb/ft ³	131							
Dry Density lb/ft ³	113							
Moisture Content %	15.8							
Compressive Stress lbs/ft ² lb/in ²								
Shear—Cohesion lbs/ft ² lb/in ²	1080							
Shear—Angle of Friction °	0°							
B.S. COMPACTION								
Maximum Dry Density lb/ft ³								
Optimum Moisture Content %								
Remoulded Dry Density lb/ft ³								
Field Moisture Content %								
B.S. (HEAVY) COMPACTION								
Maximum Dry Density lb/ft ³								
Optimum Moisture Content %								
Remoulded Dry Density lb/ft ³								
Field Moisture Content %								
Specific Gravity								
Air Voids at MC %								
CBR at MC %								
Consolidation Test								

LANCASHIRE COUNTY COUNCIL

BOREHOLE DATA SHEET

SJ 39 NE/451

British Geological Survey

DATE 16th MARCH 1967

British Geological Survey

JOB NO. 247/B

S 39492 98790

BOREHOLE NO. 5766/1

JOB LIVERPOOL OUTER RING ROAD (A59 to A580)

DEPTH 12'2"

LOCATION 10 HOBBS RAILWAY BRIDGE

GROUND LEVEL 51.40 AOD

Description	(metres) Depth	Symbol	M.C.	L.L.	P.L.	P.I.	Class.	Sign.	Remarks
SANDY TOP SOIL	2'0" (0.61)		20.5						
FIRM BROWN SANDY, STONY BOULDER CLAY	(1.98) 6'6" 7'0" (2.13)		15.5	28	10	18	CL		5'0" to 6'6"
WEATHERED BUNTER SANDSTONE									7'0" to 8'0" N = 60 for 6"
RED BUNTER SANDSTONE									
BOREHOLE DRY.	12'2" (3.71)								BOREHOLE CLOSED To 12'0"

Undisturbed Sample
Bulk Sample
Water Entry

■
●
WE.

Raymond Penetration Test
Kilner Jar Sample
Final Water Level

□ R.
KJ.
FWL.

N = No. of Blows

Depth of Sample	6'0"	6'6"						
Bulk Density	lb/ft ³	131						
Dry Density	lb/ft ³	113						
Moisture Content	%	15.5						
Compressive Stress	lbs/ft ² lb/in ²							
Shear—Cohesion	lbs/ft ² lb/in ²	1,100						
Shear—Angle of Friction	°	0°						
B.S. COMPACTION								
Maximum Dry Density	lb/ft ³							
Optimum Moisture Content	%							
Remoulded Dry Density	lb/ft ³							
Field Moisture Content	%							
B.S. (HEAVY) COMPACTION								
Maximum Dry Density	lb/ft ³							
Optimum Moisture Content	%							
Remoulded Dry Density	lb/ft ³							
Field Moisture Content	%							
Specific Gravity								
Air Voids at MC	%							
CBR at MC	%							
Consolidation Test								

LANCASHIRE COUNTY COUNCIL 53 39522 98738

BOREHOLE DATA SHEET

THERE IS NO NO. 17

SJ 39 NE 1457

British Geological Survey

DATE 13th FEBRUARY, 1967

JOB NO. 247/R

BOREHOLE NO. 38

JOB LIVERPOOL OUTER RING ROAD (A59 to A580)

DEPTH 10' 6"

LOCATION CH 96+80 - 4

GROUND LEVEL 52.95 FEET A.O.D.

Description	Depth (feet)	Symbol	M.C.	L.L.	P.L.	P.I.	Class.	Sign.	Remarks
TOP SOIL	1' 0" (0.31)		22.6				C1		
STIFF MOTTLED BOULDER CLAY	5' 0" (1.52)		18.6					■	3' 0" to 3' 6"
FIRM BOULDER CLAY			18.8				C1		
			13.7						
			12.3					■	8' 0" to 8' 6"
WEATHERED BUNTER SANDSTONE	9' 0" (2.74)		5.5					●	9' 0" to 9' 6"
	10' 6" (3.20)								
BOREHOLE DRY									

Undisturbed Sample
Bulk Sample
Water Entry



Raymond Penetration Test
Kilner Jar Sample
Final Water Level

□ R.
KJ.
FWL.

N = No. of Blows

Depth of Sample	3' 0"	3' 6"	8' 0"	8' 6"	9' 0"	10' 6"		
Bulk Density lb/ft ³	132	141						
Dry Density lb/ft ³	111	125						
Moisture Content %	18.6	12.3						
Compressive Stress lbs ft ⁻² lb/in ²	482.0	367.0						
Shear—Cohesion lbs ft ⁻² lb/in ²	241.0	183.5						
Shear—Angle of Friction								
B.S. COMPACTION								
Maximum Dry Density lb/ft ³								
Optimum Moisture Content %								
Remoulded Dry Density lb/ft ³					106.8			
Field Moisture Content %					5.2			
B.S. (HEAVY) COMPACTION								
Maximum Dry Density lb/ft ³								
Optimum Moisture Content %								
Remoulded Dry Density lb/ft ³								
Field Moisture Content %								
Specific Gravity								
Air Voids at MC %								
CBR at FIELD MC %					3.9			
Consolidation Test								

LANCASHIRE COUNTY COUNCIL

BOREHOLE DATA SHEET

British Geological Survey

DATE 17th MARCH 1967

British Geological Survey

JOB NO. 247/B

5539NE/455
5539461 98760
BOREHOLE NO. 5766/5

JOB LIVERPOOL OUTER RING ROAD (A59 to A580)

DEPTH 12'11"

LOCATION HOBBS RAILWAY BRIDGE

GROUND LEVEL 49.21 A.O.D.

Description	Depth (meters)	Symbol	M.C.	L.L.	P.L.	P.I.	Class.	Sign.	Remarks
SANDY TOP SOIL	2'0" (0.61)		20-3				TS		
FIRM REDDISH BROWN SANDY STONY CLAY	(1.78) 5'10"		18.5	29	13	16	CL		
WEATHERED BUNTER SANDSTONE	7'6" (2.29)								5'10" to 6'6"
REDDISH BROWN BUNTER SANDSTONE	12'11" (3.44)								R 7'0" to 8'0" N = 90
									R 10'6 1/2" to 10'8 1/2" N = 50 for 2 1/2"
BOREHOLE DRY									BOREHOLE CASSED TO 12'6"

Undisturbed Sample
Bulk Sample
Water Entry

■
●
WE.

Raymond Penetration Test
Kilner Jar Sample
Final Water Level

□ R.
KJ.
FWL.

N = No. of Blows

Depth of Sample	5'10" to 6'6"								
Bulk Density	lb/ft ³	128							
Dry Density	lb/ft ³	108							
Moisture Content	%	18.5							
Compressive Stress	lbs/ft ² lb/in ²								
Shear—Cohesion	lbs/ft ² lb/in ²	850							
Shear—Angle of Friction	°	0°							
B.S. COMPACTION									
Maximum Dry Density	lb/ft ³								
Optimum Moisture Content	%								
Remoulded Dry Density	lb/ft ³								
Field Moisture Content	%								
B.S. (HEAVY) COMPACTION									
Maximum Dry Density	lb/ft ³								
Optimum Moisture Content	%								
Remoulded Dry Density	lb/ft ³								
Field Moisture Content	%								
Specific Gravity									
Air Voids at MC	%								
CBR at MC	%								
Consolidation Test									