

XPO Logistics

01975AC Houghton Main Carpark

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when local knowledge
intersects with
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Document Verification

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CONTENTS

1	INTRODUCTION	1
1.1	Scope	1
1.2	Sources of Information	1
2	SITE DESCRIPTION AND CONTEXT	2
2.1	Existing Site	2
2.2	Proposed Development	3
2.3	Site History	3
2.4	Adjacent and Surrounding Land Use	4
3	GEOLOGY	5
4	MINERAL EXTRACTION	5
4.1	Introduction	5
4.2	Coal Authority Mining Report	5
4.3	Coal Seams	6
4.4	Historical Boreholes	6
4.5	Shafts	7
4.6	Opencast Mining	7
5	GROUND INVESTIGATIONS	8
5.1	Previous Ground Investigations	8
5.2	Ground Investigation	8
6	MINING RISK AND TREATMENT	9
6.1	Introduction	9
6.2	Risk from Underground Coal Seams	9
6.3	Risk from Opencast Mine Workings	10
7	RECOMMENDATIONS	11

CONTENTS

8	CONCLUSION	11
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Figures

Figure 2-1 – Site Location	2
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Appendices

Drawings

Appendix A:	Historical Maps
Appendix B:	BGS Borehole Records
Appendix C:	Coal Authority Mining Report
Appendix D:	01975AB_R_001A_DAS - Foundation Assessment for Office Extension

1 INTRODUCTION

XPO Logistics are plan to construct a new carpark adjacent to an existing ASOS distribution warehouse development in at Grimethorpe in Barnsley as part of upgrading works to their existing facility. Coffey Geotechnics Ltd (Coffey) have been appointed by XPO Logistics to carry out an assessment of the extent of historical mining carried out on the proposed carpark site to determine mining related risk to the development and to provide recommendations for construction in the context of the proposed scheme.

1.1 Scope

The scope of works undertaken as part of this assessment is as follows:

- Review of current and historical uses of the site.
- Review of existing desk study information for the site.
- Review of existing Ground Investigation information.
- Quantify the risk to the development from mine workings.
- Provide recommendations for mitigation of mining related issues during development.

1.2 Sources of Information

In preparation of this document we have reviewed the following information;

- "RSA Geotechnics Ltd – *Ground Investigation Report*" (Ref – 9735), RSA, Dated August 2005
- "RSA Geotechnics Ltd – *Interpretive Geotechnical Report*" (Ref – 13378GI), RSA, Dated December 2012
- "RJB Mining (UK) Ltd Correspondence – *Houghton Main Site – Treatment to shafts*" (Ref – JNA/HS), Dated 18th September 2000.
- "The Coal Authority – Coal Mining Report - *Houghton Main Colliery Shafts, Darfield, South Yorkshire*" (Ref – 00007712-06) Dated 21st March 2006.
- "The Coal Authority – Non Residential Coal Mining Report - *Site at Houghton Main Barnsley*" (Ref – 710000290861002) Dated 30th October 2012.
- "The Coal Authority – Non Residential Coal Mining Report - *Site at Houghton Main Barnsley*" (Ref – 51001457843001) Dated 16th May 2017.
- "Conestoga-Rovers & Associates (Europe) Limited – *Bioremediation Works Review and Phase II Environmental Site Assessment*" (Ref - 033193) Dated October 2005.
- "Conestoga-Rovers & Associates (Europe) Limited – *Phase I Environmental Site Assessment*" (Ref – 033193 (1)) Dated October 2004.
- "RPS Group – *Mining Overlay*" (Drawing Number: NK014833A_0110) Dated 14 December 2012.

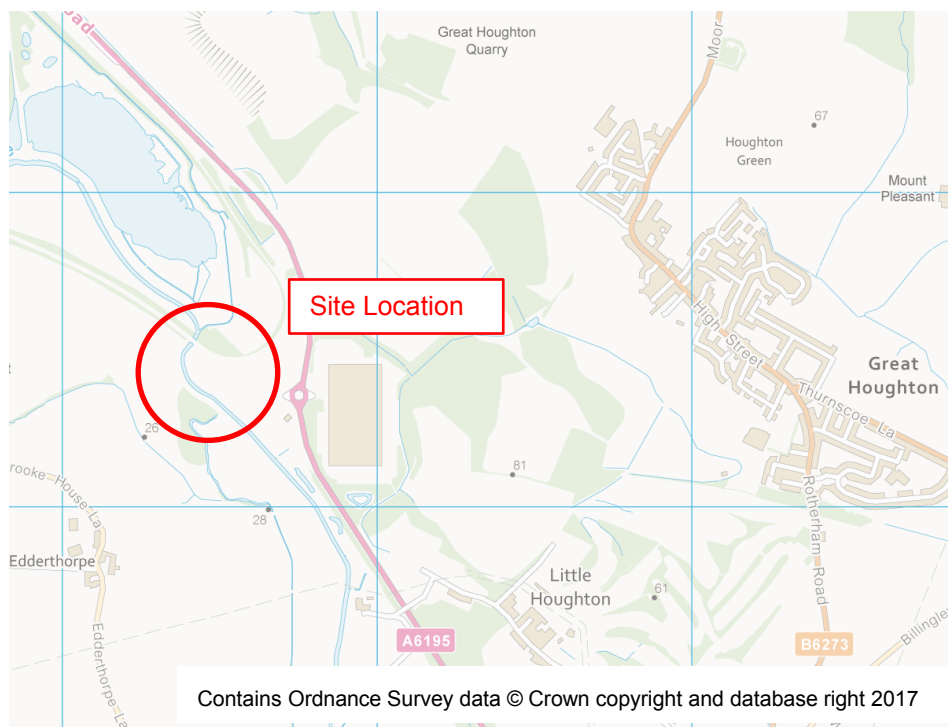
- “The UK Coal Mining Ltd - *Completion Plan*” (Drawing Number: 48/CP/1) Dated 21 March 2006.
- “aja architects LLP – *Proposed Car Park Land Coordinate Plan*” (Drawing Number: 6010 – 031) Dated 22 December 2016.
- “British Geological Survey - 1:10,000 Scale Geological Mapsheet SE40NW (Grimethorpe)” Dated 26 September 2005.

2 SITE DESCRIPTION AND CONTEXT

2.1 Existing Site

The site is located north west of Little Houghton, on Park Spring Road, Grimethorpe (A6195) at approximate national grid reference SE416063. The site is bounded by the A6195 link road to the east and a footpath and hedgerow to the west and south, beyond which lies the River Dearne. To the north the site is bounded by a dismantled railway line beyond which lies a body of water noted on ordnance survey mapping as a nature reserve. The site location is indicated in Figure 2-1.

Figure 2-1 – Site Location



The site is currently undeveloped, consisting of open grassland with occasional young trees and shrubs. The current Ordnance Survey 1:25,000 Scale mapping for the site shows the 40m contour to run close to the eastern boundary of the site, and the 30m contour to run close to the western boundary near the River Dearne. The Conestoga-Rovers & Associates (Europe) Limited – Phase I Environmental Site Assessment (2004) states that the site is not prone to flooding from the River Dearne and can be accessed via the A6196 roundabout.

2.2 Proposed Development

The proposed development comprises the construction of a new carpark to provide additional parking for the ASOS distribution warehouse located to the east of the site over Spring Bank Road. The proposed carpark will utilise approximately 2.9 acres of land. The proposed site layout is shown on the AJA Architects LLP – Proposed Car Park Land Coordinate Plan included in Appendix 1.

2.3 Site History

The proposed car park is within 100 m of the ASOS distribution warehouse development which was investigated from approximately 2004 to 2012. The history of the warehouse site was reviewed as part of the desk study undertaken by RSA Geotechnics Ltd (RSA) and reported in the Geotechnical Investigation Report (2005) which also included a review of previous reports on the site. The historical maps included in the RSA report also cover the site of the proposed carpark, and information relating to this is summarised in Table 1 below. The historical map extracts are included as Appendix A of this report.

Table 1: Summary of Historical Data

Year of map	Feature	Comments
1854	Midland Railway	Ordnance Survey maps indicated that there was no development on the site except the Midland Railway which runs northwest to southeast parallel to and outside the eastern boundary of the site.
	River Dearne	The River Dearne follows a meandering line alongside the railway to the south west of the railway line.
1892 -1893	Houghton Main Colliery	The colliery is present in this map edition to the south of the proposed carpark site. A small clay pit is also indicated immediately to the north of the colliery.
	Midland Railway	A branch line is present from the Midland Railway, connecting to Houghton Main Colliery.
1894	No major changes noted.	
1906-1907	Dearne Valley Railway	The 1906 map shows that the Dearne Valley Railway has been constructed approximately 200m to the north of the Houghton main colliery.
	Houghton Main Colliery	New branch lines have been constructed from the Dearne Valley Railway to service the colliery.
1930	Houghton Main Colliery	Houghton main Colliery has expanded with numerous spoil heaps now shown on the map. Additional branch lines are also indicated connecting the Dearne Valley Railway.
1948	Houghton Main Colliery	The map shows that the colliery has expanded to cover most of the area between the Dearne Valley Railway and Midland Railway.

Year of map	Feature	Comments
1956	Houghton Main Colliery	Further expansion of the colliery to the south is shown.
1962		No major changes noted.
1967	Houghton Main Colliery	The Colliery spoil heap is shown to have expanded towards the south east to Chapel Lane in Little Houghton.
1979		No major changes noted.
1980	River Dearne	The River Dearne has been realigned and now runs parallel to the midland railway and its former meandering path is shown as drained land.
	Dearne Valley Railway	The Dearne Valley railway and its branch lines to Houghton Main Colliery have now been dismantled.
	Houghton Main Colliery	Houghton Main Colliery seems to have fewer buildings and less infrastructure.
1981		No major changes noted.
1985		No major changes noted.
1989		No major changes noted.
1993		No major changes noted.
2000	Houghton Main Colliery.	The Colliery has been decommissioned. There is now a quarry in its place.
	Midland Railway	Midland Railway lines have been dismantled

A brief summary of the site history is also given in the Conestoga-Rovers & Associates (Europe) Limited – *Bioremediation Works Review and Phase II Environmental Site Assessment* as follows:

The site has been used for coal extraction, with a coke works operating from between 1900 until the early 1960's. All deep mining ceased at the site in the early 1990's. Opencast mining commenced at the site in 1997 and was completed in 2001. Following the closure of the opencast operations on the site, a restoration plan was implemented. This involved the backfilling of the opencast mine to the original ground levels. Since this time the site has been unoccupied.

2.4 Adjacent and Surrounding Land Use

The adjacent and surrounding land uses have been taken from the current Ordnance Survey 1:25,000 Scale mapping for the site and is summarised below.

To the north of site lies a body of water and grassland. To the north east, the land appears to comprise undeveloped agricultural land and there are two wind turbines. To the south east there is a golf course and the village of Little Houghton. To the east is past the distribution warehouse is agricultural land and open grassland, with the village of Great Houghton located approximately 1km beyond. To the west is the River Dearne and agricultural land beyond. To

the south there is an unknown steel clad building close to the proposed site and beyond this appears to be undeveloped grassland.

3 GEOLOGY

The geology below the site has been interpreted from the British Geological Survey (BGS) maps obtained as part of this assessment (England and Wales 1:50,000 Scale map sheet 87-1976 and 1:10,000 Scale map sheet SE40NW, Solid and Drift Edition-2005).

The geological maps indicate the presence of superficial alluvial deposits along the western extents of the proposed carpark associated with the River Dearne. The remainder of the proposed carpark overlies an area that has been historically mined using opencast methods. In this area therefore, there will be no natural superficial deposits on the site.

The maps shows that the bedrock geology beneath the site comprises of a series of sandstones, siltstones, mudstones and coal seams of the Pennine Middle Coal Measures of the Upper Carboniferous age. This overlies the Mexborough Rock which is a coarse grained sandstone, and iron stained gritstone, and also a minor aquifer in the area. The geological map also shows worked / made ground to be present across the site.

4 MINERAL EXTRACTION

4.1 Introduction

It is known that historical mining activities have been undertaken within the Coal Measures strata in this area from the nearby Houghton Main Colliery, which closed in 1991. Following on from this shallow mine workings were carried out from 1997 to 2001 and the opencast was subsequently backfilled. The extent of the opencast mine workings is shown in Coffey Proposed Carpark with Mining Overlay - Compaction drawing (01975AC_SK_002A_JWP).

In order to assess the likely extent of mineral extraction across the site Coffey have reviewed a number of sources of information including:

- A Coal Authority Mining Report
- England and Wales 1:50,000 Scale map sheet 87 (1976) and 1:10,000 Scale map sheet SE40NW, Solid and Drift Edition (2005)
- British Geological Survey borehole records
- The UK Coal Mining Ltd - *Completion Plan*
- RSA Geotechnics Ltd – *Ground Investigation Report* (2005)

A summary of the pertinent information is provided below.

4.2 Coal Authority Mining Report

A Coal Authority Mining Report (2017) was obtained for the proposed site as part of this assessment and is enclosed as Appendix C. A summary of the findings is outlined below:

- There are 10 seams of coal at 320m to 840m depth, last worked in 1991.

- Ground movement from the deep mining should by now have ceased.
- There is coal at or close to the surface that may have been worked in the past.
- It is unlikely that future underground coal mining will take place and the Coal Authority has no plans to grant a license.
- The property is within the boundary of an opencast site from which coal has been removed.
- The property has not been subject to remedial works due to any surface hazards occurring due to mining works.
- There are no known coal mine entries within, or within 20 metres of, the boundary of the property.

4.3 Coal Seams

The Coal Authority mining report stated that there are 10 coal seams present below the proposed site for the carpark. The seven coal seams listed below are seams which Coffey has positively identified as having been worked:

- Highgate (0.2 to 0.6 at a depth unknown)
- Shafton Rider (thickness unknown at a depth unknown)
- Shafton (1.3 to 1.8 at a depth unknown)
- Top Beamshaw (0.4 to 2.3* at approximately 410 mBGL)
- Low Beamshaw (0.9 to 1.0 at approximately 423 mBGL)
- Kent's Thin (0.4 to 0.7 at approximately 405 mBGL)
- Kent's Thick (0.5 to 2.1* and split at approximately 424 mBGL)

*include relatively thick argillaceous partings.

The remaining three worked coal seams have not been identified within the data obtained for the site. However based on the geological information these will lie at a level below the underlying Mexborough Rock.

4.4 Historical Boreholes

There are several historical borehole records around the proposed site available from BGS records. Only two boreholes, however, were close to the proposed development, being Borehole SE40NW22 and SE40NW20. Scans of these boreholes are enclosed as Appendix B

The commencement levels for these holes was significantly below ground level (commencing within the mine) at -362.7 and -364.5 mAOD respectively. These holes were carried out to prove the thickness and quality of coal seams during deep mining works.

A summary of the seams encountered in these holes is presented in Table 2.

Table 2: Summary of Coal Seams Encountered in BGS holes.

Borehole	Seam	Thickness	Level (mAOD)	Depth below Ground Level at site (mBGL)*
SE40NW20	Kent's Thin Coal	0.49	-377.28	410
	Kent's Thick Coal	0.84	-395.77	410
SE40NW22		0.66 m	-364.78	400
	Top Beamshaw	0.31	-381.77	420
	Low Beamshaw (floor)	No core recovered	-395.49	430

*based on ground level of 35 mAOD and rounded to the nearest 10m. No correction has been made for dip of strata.

Because of their significant depth the likelihood of potential workings in these coal seams affecting the site is remote. Therefore they are not discussed further.

4.5 Shafts

Three mine entries (shafts) were identified as part of the development of the ASOS warehouse which lies on the opposite side of the A6195 from the proposed carpark. These are shown on Coffey Proposed Carpark with Mining Overlay - Compaction drawing (01975AC_SK_002A_JWP). The shafts are located south east of the proposed carpark development to the south of the ASOS distribution warehouse. However, there are no known shafts situated within the proposed carpark footprint.

4.6 Opencast Mining

The geological maps indicate the upper three coal seams that were present above the Mexborough Rock comprised the Highgate Seam (200 to 600 mm thick), Shafton Rider Seam (thickness unknown) and the Shafton Seam (1.3 to 1.8 m thick). These are the likely materials exploited by opencast mining and this information is similar to that mentioned previously.

The RSA Geotechnics Ltd – *Ground Investigation Report* (2005) states that there are three seams of coal that were exploited by opencast mining in the carpark area. These are stated to be the Highgate Seam (75 to 500 mm thick), the Shafton Seam (1.5 m thick) and the Highgate Rider, which had a limited occurrence on site. No records were found to indicate that these shallow seams were worked underground outside the opencast area, but some evidence of old pillar and stall workings was observed during the opencast operations.

Although the Highgate Rider and Shafton Rider are named differently they are anticipated to be the same seam.

The seam thicknesses vary slightly from those indicated by RSA. However, these thicknesses were taken from geological maps rather than measured thicknesses taken during ground investigation works.

The UK Coal Mining Ltd - *Completion Plan* shows the perimeter of the batter from the opencast mine works and also the area of compacted backfill which extends into the proposed car park site. The RPS - *Mining Overlay* drawing shows the perimeter of the opencast mine workings with contours of the base of the excavation and location of the high walls. These drawings have been combined with the carpark layout to determine the location of high walls, extent of compacted fill and depth of excavation from opencast mining in relation to the proposed carpark.

It should be noted however that there is a discrepancy between the two plans as to the northern extent of the opencast workings. The UK Coal Mining Ltd - *Completion Plan* indicates the site to lie wholly within the backfilled area, while the RPS - *Mining Overlay* drawing indicates that the extent of the opencast within the northern boundary.

Drawing 01975AC_D_001A_JWP shows contours of the level of the base of the excavation relative to ordnance datum which show the floor to dip from southwest to northeast. Based on the current ground level as indicated on the Ordnance Survey map we estimate the base of the excavation to be 3 to 4m deep at the western boundary and about 22 to 24 m deep at the eastern boundary.

5 GROUND INVESTIGATIONS

5.1 Previous Ground Investigations

There are a number of historical boreholes drilled by others on site as indicated from the British Geological Survey records as discussed in section 4.4. This includes one within the proposed site and others to the east and south, mainly concentrated in and around the ASOS distribution warehouse site to the east of site. There were also three ground investigations carried out on the site of the ASOS distribution warehouse in 1995, 2005 and 2012 of which only some of the exploratory holes extended into the area of the proposed carpark.

The investigation in 1995 extended into the area of the proposed carpark. However, this investigation was carried out prior to the opencast mining operations and therefore does not assist in the determination of thickness of made ground from backfilling of the opencast mine. The investigations carried out in 2005 and 2012 did not extend into the area of the proposed carpark.

Although the boreholes were not directly in the area of the proposed carpark, the backfilling of the opencast mine was carried out at the same time and therefore the same material properties are likely to be present. Consequently, the testing information and design parameters obtained for the opencast backfill should be similar for the area of the proposed carpark. Estimated thicknesses of backfilled material are shown on Coffey drawing 01975AC_D_001A_JWP (enclosed) but this should be confirmed by additional ground investigation works.

5.2 Ground Investigation

Ground investigation has not been carried out on the specific carpark site. However, as part of the design works for the adjacent site (ASOS distribution warehouse), the ground conditions were assessed by Coffey based on the RSA Geotechnics Ltd – *Ground Investigation Report*

(2005). This assessment can be found in the Coffey Report - Foundation Assessment for Office Extension (01975AB_R_001A_DAS) dated 14 February 2017 attached in Appendix D.

The ground Conditions encountered on the warehouse site adjacent to the carpark comprised made ground to the base of all of the exploratory holes at 15 m depth. The made ground comprised firm to stiff friable very gravelly clay with gravel of weak to moderately strong mudstone, siltstone and sandstone or weak gravel and boulders of mudstone, siltstone and sandstone within a clay matrix.

Historical contour plans of the base of the opencast mine indicate that the thickness of the made ground on site is up to 24 m. The base of the made ground was described as being encountered in two holes, BH2 and BH7 at 12 m and 10 m depth respectively. The exploratory hole records show that the made ground is underlain by moderately weak mudstone. However, based on the historical extent of the mining it is likely that the mudstone encountered in BH7 is not the base of the made ground and could be a boulder in the backfill.

No coal seams were identified as part of the investigation into the adjacent site as the boreholes only extended to depths of up to 15 m, and any coal seams above this depth were removed during the opencast mining process.

Groundwater was encountered during the investigation on the adjacent site between 9.5 m and 12 m in the boreholes. Groundwater was not encountered in the trial pits undertaken on site.

6 MINING RISK AND TREATMENT

6.1 Introduction

Based on the information reviewed to date the proposed carpark construction is on a former UK Coal owned site which has been subject to opencast mining. The records reviewed indicate that the opencast site was excavated and backfilled between 1997 and 2001. Deep mine workings were also carried out within the vicinity of the site which ceased in the early 1990's.

In the following sections the level of risk to the development has been assessed taking into account not only the ground conditions and presence of workings but also the sensitivity of the proposed development to movements associated with mining.

6.2 Risk from Underground Coal Seams

When there is approximately eight times the thickness of the coal seam of rock above workings, the risk of surface settlement due to collapse is remote. As the thickness of cover increases the risk of crown holes forming at the site surface decreases. This is because the collapsed material tends to bulk and "chokes" the void. However, the collapse can result in surface depressions as the material settles.

Deep workings have been identified underneath the site but the mining report states that ground movement is likely to have ceased. Also, the workings are below the Mexborough Rock formation which is likely to provide more than adequate cover above the workings to

prevent them from affecting the proposed site. There are also no noted shafts within the site boundary.

Information contained in the Coffey Drawing 01975AC_D_001A_JWP – Proposed Carpark with Mining Overlays in Appendix 1 indicates the approximate depth of fill at the open cast site varies between 18 m and 24 m along the northern section of the carpark south of the high wall. It also shows that the buried high wall for the opencast site is within the boundary of the proposed carpark.

The high wall is indicated to be 18m in height in the north west corner of the site increasing to 24m at the north eastern extents.

The historical map shows the former highwall to be close to the northern boundary of the carpark. It is therefore possible that a small area near this boundary consists of natural ground. Although, there are no records of shallow mine workings in this area, the fact that evidence of pillar and stall working was observed during opencast operations indicates that coal seams below this area are likely to have been worked.

There is no risk of collapse of shallow coal seams identified on site in the desk study information for the majority of the carpark area where coal seams have been removed by opencast methods. However, there may be some risk near the northern boundary.

The geological map indicates the Mexborough Rock to have a thickness up to 30 m, and the shallowest seam thickness below to be up to 1.6 m thick (assuming the presence of Sharlston Top Coal). Therefore, the cover to the seam will be greater than eighteen times the seam thickness and unlikely to have any effects on the surface of the proposed carpark development.

6.3 Risk from Opencast Mine Workings

The UK Coal Mining Ltd - *Completion Plan* shows the extent of opencast mining works and the compaction within the area of the opencast mine fill material. This shows that all of the proposed carpark is within the area of compacted fill. However the RPS - *Mining Overlay* drawing plan showing the high wall is not consistent and shows the boundary slightly differently.

The shallow coal seams within the area of the proposed developments are believed to have been worked during opencast mining works. Therefore, the presence of voids from shallow mine workings is remote with the exception of the potentially undisturbed ground close to the northern boundary

The ground investigation and historical information indicate that the site has been backfilled to a compaction specification as outlined below:

- The lower 30 m of the fill (up to 10 mAOD) compaction must achieve not greater than 12 % air voids with a moisture content on placement between optimum moisture content +0.5 % and +2.5 %.
- The upper fill (lower of 10 mAOD to 38 mAOD or 5 m below ground level) compaction must achieve not greater than 10 % air voids. Moisture content as previous.

The percentage of air voids was generally calculated to be less than 12 %. Typical moisture content was found to be between 6.2 % and 10.5 %. Dry densities observed were in the order of 1.97 kg/m³ and 2.17 kg/m³. Therefore, it is likely that the majority of voids within the fill are likely to have already been removed.

However, ongoing creep settlement will occur as the fill self-settles (creep) in the deepest parts of the former opencast mine. This will be approximately 55 mm over the next 60 years based on a creep factor of 0.2% per log cycle of time. This is assuming that approximately 110 mm creep settlement has occurred over the past 15 years since the backfill was placed and compacted to a reasonable standard.

Outside the opencast mine workings, creep will not occur in the natural ground. Therefore, some differential settlement may occur near the northern boundary.

As the development is a carpark, any creep of the soils will not cause significant catastrophic issues to the site. However, creep may cause localised areas of differential settlement which will manifest at surface as undulations in the carpark surface and ponding water during rainfall events. Therefore, it is likely that regular maintenance of the carpark surface may be required.

These undulations may be reduced in severity by in situ ground improvement using at top down ground improvement method such as High Energy Impact Compaction (HEIC). But the risk of creep will not be mitigated.

7 RECOMMENDATIONS

As the extent and thicknesses of backfilled materials and the ground conditions outside the opencast mining area are based solely on historical data, we recommend that the assumptions made in this report are confirmed by site specific ground investigation. This is of particular importance at the northern boundary of the site to confirm the extents of the opencast mining operation and the presence or otherwise, of potentially worked coal seams at shallow depth.

In order to determine the extent of the workings we recommend that boreholes are formed by rotary core methods to identify the depth and condition of coal seams at the northern boundary if present and to confirm the thickness of fill across the remaining area of the carpark.

8 CONCLUSION

After reviewing all of the information, the risk of mining works affecting the proposed carpark construction within the former opencast has been deemed as very low. It is unlikely that any of the deep or shallow mine workings will have an effect on settlement of the carpark in this area.

However the boundary of the opencast workings lies within the area of the carpark. Within this area if shallow deposits of coal; are present they are expected to have been worked. The risk to the development from the presence of these potentially worked seams should be confirmed by ground investigation.

As a result of the opencast mining works there is a significant thickness of compacted fill across the site which is likely to be undergoing creep settlement. This settlement is unlikely to

affect the operation of the carpark. However, it will cause an ongoing issue in terms of visual appearance and ponding water which is likely to require regular maintenance. It may be possible to reduce the maintenance requirements by ground improvements of the upper fill material or the use of geotextiles. However, risk of creep settlement cannot be mitigated.

Also of concern is the position of the high wall. As the high wall crosses the carpark area there will be potential issues associated with differential settlement between the backfilled opencast and the adjoining natural ground. Based on our estimate of creep this is expected to be of the order of 50mm.