

Geo-Environmental and Geo-Technical Baseline Assessment

Halsnead Masterplan SPD

January 2017

Knowsley Metropolitan Borough Council

Knowsley Metropolitan Borough Council
Municipal Buildings
Huyton
L36 9UX

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	18/09/16	N. Spofforth	N. Haynes	N. Haynes	FIRST ISSUE
B	10/10/16	L. McGovern	C. Williams	A. Smith	REVISED FOLLOWING CLIENT COMMENTS
C	11/01/17	N. Spofforth	C. Williams	A. Smith	FINAL

Information class: Standard

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

Contents

Chapter	Title	Page
Executive Summary		i
1	Introduction	1
1.1	Background _____	1
1.2	Site Location _____	1
1.3	Scope of Report _____	2
1.4	Limitations _____	3
1.5	Sources of Information _____	4
2	Geo-Environmental Baseline	5
2.1	Site Description _____	5
2.2	Site History _____	8
2.3	Topography _____	16
2.4	Published Geology _____	16
2.5	Mining _____	20
2.6	Hydrogeology _____	25
2.7	Hydrology and Flood Risk _____	26
2.8	Sensitive Land Uses and Designations _____	28
2.9	Other Records _____	28
3	Previous Applications	30
3.1	Location of Information _____	30
3.2	Previous Relevant Applications _____	30
3.3	Planning ref: 93/00231 – Removal of Colliery Spoil (600,000m ³) and associated re-modelling and other ancillary works (with reference to planning ref: APP/8955) _____	31
3.4	Planning ref: 99/00682 – Drilling of up to two coal bed methane ‘GOB’ gas wells for investigation and extraction purposes _____	32
3.5	Planning ref: 03/01148/OUT – Proposed Business Park _____	33
3.6	Planning ref: 07/00929/COU and 15/00191/FUL – Change of use of site to informal country park _____	43
4	Qualitative Contaminated Land Assessment	47
4.1	Regulatory Context _____	47
4.2	Planning Context _____	48
4.3	Qualitative Contaminated land Risk Assessment _____	50
4.4	Preliminary Qualitative Risk Assessment including Initial Conceptual Model _____	56
5	Preliminary Geo-technical Assessment	68
5.1	General _____	68
5.2	Geological Hazards _____	69
5.3	Geo-technical Risk Register _____	70

6	Conclusions and Recommendations	72
6.1	Conclusions _____	72
6.2	Recommendations _____	72
Appendices		78
A.	Figures _____	79
B.	Site Photos _____	80
B.1	South Whiston Site (all photos taken 01/08/16) _____	80
B.2	Land South of M62 Site (all photos taken 01/08/16) _____	88
C.	Disclaimer _____	95
D.	Contaminated Land Risk Assessment Methodology _____	97
E.	References _____	103

Executive Summary

Mott MacDonald Ltd is supporting the preparation of a masterplan and Supplementary Planning Document (SPD) for the Sustainable Urban Extension (SUE) on behalf of Knowsley Metropolitan Borough Council, comprising new homes, employment land and a new country park covering two sites formerly known as “Land south of Whiston” located to the north of the M62 as well as “Land south of the M62”. These two sites have collectively been termed ‘Halsnead’.

This report has been produced in support of the masterplan preparation, to identify the geo-environmental and geo-technical constraints. A variety of sources have been used to determine the site baseline including a review of supporting documents from relevant previous applications on site.

The South of Whiston site (north of the M62) is located at Halsnead Park, formerly a stately home (now a mobile home park) surrounded by farmland and wooded areas. The Land South of the M62 site is located across the southern portion of the former Halsnead Estate, dominated by the former Cronton Colliery with associated colliery spoil plateaux. Surrounding land uses are predominantly residential, community and agricultural. Site boundaries primarily comprise roads.

Bedrock geology is divided by the Eccleston West Fault, with Pennine Middle Coal Measures (Secondary A Aquifer) to the west and Permo-Triassic Sandstone (Primary Aquifer and groundwater Source Protection Zone) to the east. To the very south of the Land South of M62 site, the Etruria Formation (mudstone, sandstone and conglomerate) is present. Numerous additional faults cross the SUE area. Varying thicknesses of superficial deposits comprising Glacial Till and localised Alluvium are present (Secondary A/undifferentiated Aquifers), although some of the Till deposits may have been extracted in the past. Historic and authorised landfills are present to the immediate south and north-west of the SUE. The Zetica Bomb Risk Maps for Merseyside indicate that the SUE is within a zone of moderate bomb risk.

The SUE and wider area has an extensive coal mining history with historic mine entries present on both sides of the M62. The SUE is partially within a Coal Authority Surface Coal Resource Area. A Coal Authority Development High Risk Area (DHRA) coincides with an area of probable shallow coal workings

and coal outcrops – present across the north-west of the South Whiston site and the south-west to central area of the South Whiston site. The DHRA includes three former Cronton Colliery Shafts, which are also classed by the Coal Authority as a Mine Gas Site. In addition, 1-3% of homes in the area are at or above the action level for radon.

Numerous surface water bodies and watercourses are present across the SUE. Chapel Brook crosses both sites and Fox's Bank Brook historically diverted around colliery spoil on the Land South of M62 site (joined by overflows, drains and ponds). Sections of Fox's Bank Brook are located within EA Flood Zones 2 and 3. Surface water flood risk areas are present across the SUE site.

A qualitative geo-environmental risk assessment was undertaken for the SUE in accordance with current guidance. A key element of this was the development of a conceptual model and completion of a source-pathway-receptor linkage analysis. For each potential linkage identified, the potential risk has been evaluated for receptors, based on the probability of the linkage occurring, and its relative severity. A summary of the risks identified are as follows:

- Moderate potential risks to final end users from potential contamination in site soils and ground/mine gases, with High potential risks to construction workers (given the nature of their work) from the same;
- Low potential risks to users of adjacent sites from wind-blown dusts and migration of ground/mine gases off-site;
- Moderate to High potential risks to the underlying Principal and Secondary Aquifers given the sensitivity of the receptors, likelihood of leachate generation and the creation of engineered pathways;
- Low to Moderate risks to surface watercourses and features across the SUE given that groundwater within the superficial deposits and shallow bedrock is likely to be in continuity with surface waters and mine water discharges are likely to be impacting surface water quality at certain locations;
- Low to Moderate risk to buried and surface structures (including historic buildings) arising from likely sulphate attack on buried concrete, migration and accumulation of potentially explosive gases and the soil transmission of potentially destructive invasive species; and
- Low to Moderate risks to the establishment of potential future vegetation from contaminants in site soils.

A geo-technical risk register has been produced for the site qualitatively summarising potential geotechnical risks identified at this desk-top study stage. Identified risks include:

- Made Ground (including Colliery Spoil): Variations in composition, thickness and strength, potential presence of perched water, variable pore water pressure, presence of previously unrecorded in-filled land/structures, obstructions, high loss on ignition (LOI) and high sulphate content;
- Superficial Deposits (Devensian Till and Alluvium): Piling obstructions, variable thickness and variable composition; and
- Pennine Middle Coal Measures: Variable rockhead level, presence of pyrite, shallow coal workings, extensively worked lower seams, mine entries and potential for coal resource sterilisation.

Quantification of risk will require further investigation.

Any proposed SUE development will have to address the geo-environmental source-pathway-receptor linkages and associated risks along with the identified geo-technical risks. The former and current SUE uses have the potential to warrant remedial action. It is recommended that further data be sourced and additional desk-based assessment be undertaken in order to inform and refine the existing geo-environmental and geo-technical risk assessment and subsequent design of an intrusive site-wide ground investigation (GI), including:

- Source data from the 2004 GI on the Land South of M62 site and re-assessing both this data and 1999 GI data against current standards appropriate to the proposed end-use of the SUE;
- Obtain a Coal Authority Report and mine abandonment plans as part of a Coal Mining Risk Assessment to cover the whole of the SUE;
- Seek advice from a certified Unexploded Ordnance Consultant to determine the site-specific risk with regard to UXO; and
- Request former Cronton Colliery mine shaft methane gas emission data from the Coal Authority.

The subsequent GI will be used to obtain contamination data required to progress a Generic Quantitative Risk Assessment (GQRA) sufficient to assess the source-pathway-receptor linkages and risks for the re-development of the SUE. Geo-technically, ground conditions across the Land South of Whiston require further investigation to determine the ground model and parameters for geo-technical design.

Recommendations for the GI objectives and scope have been provided within this report. While it would not be appropriate to undertake a remediation strategy at the current stage, the aforementioned GQRA and quantitative geo-technical risk assessment would allow the approximate scope of mitigation and/or remediation to be determined for costing purposes.

1 Introduction

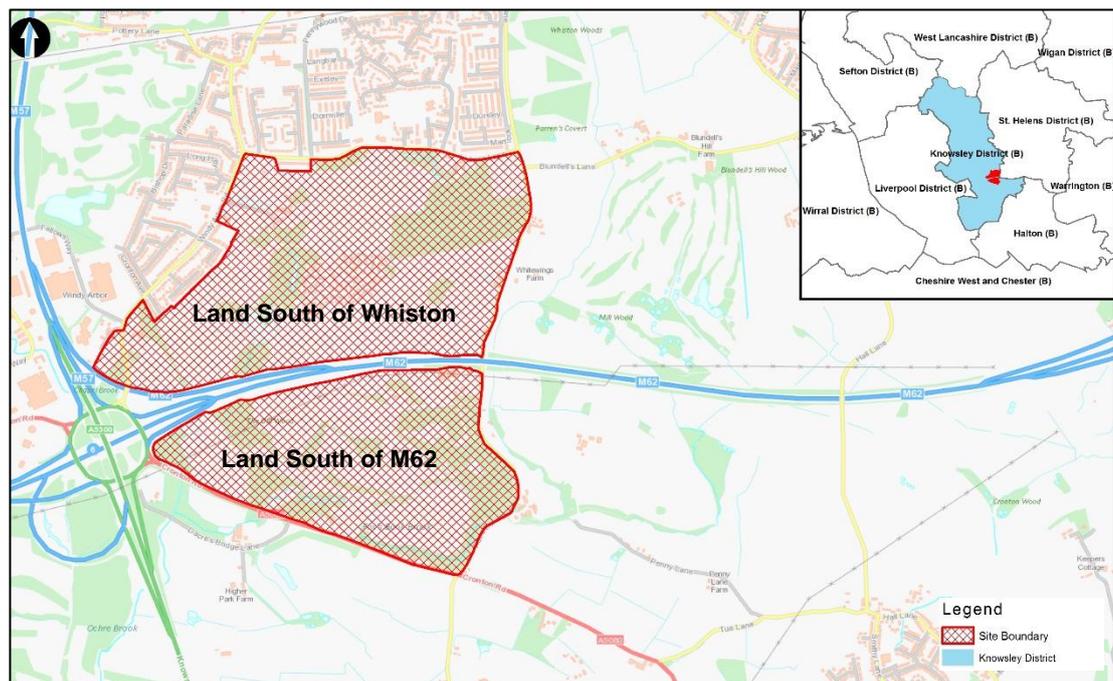
1.1 Background

- 1.1.1 Mott MacDonald Ltd is supporting the preparation of a masterplan and Supplementary Planning Document (SPD) for the Sustainable Urban Extension (SUE) on behalf of Knowsley Metropolitan Borough Council, comprising new homes, employment land and a new country park covering two sites formerly known as “Land south of Whiston” located to the north of the M62 as well as “Land south of the M62”. These two sites have collectively been termed ‘Halsnead’.
- 1.1.2 The SUE was until recently designated as Green Belt land however on adoption of the Local Plan Core Strategy (2016) it was allocated for development. The Local Plan Core Strategy (SUE2) identifies the largest SUE locations as needing additional planning guidance and the site under consideration in this report forms the largest and most complex SUE. The Local Plan identifies that this SUE has the capacity to accommodate upwards of 1,500 new homes, at least 22.5 hectares of employment land, and a new country park.
- 1.1.3 The preparation of the masterplan is currently at baseline stage and a range of evidence has been collected from a number of different disciplines to inform an up to date evidence base for the study area. This evidence is presented within a series of coordinated studies which ensure the constraints and opportunities are fully understood to inform the development of a deliverable masterplan.

1.2 Site Location

- 1.2.1 The site consists of two parts, a northern part and a southern part, with the two separated by the M62. There are multiple land ownerships across the SUE making a comprehensive masterplan important to ensure that development expectations are managed and there is a common design framework to make best use of the site. The final masterplan will practically function as a planning instrument, both as a guide to developers and as a material planning consideration to help bring development proposals into conformity. Together the two parts of the site total 176 hectares of development land. The site can be seen in Figure 1.1 overleaf.

Figure 1.1: Site Location



© Crown Copyright Knowsley MBC 100017655

- 1.2.2 The site is bounded by existing residential development to the west and north and by Fox's Bank Lane to the east, a rural road which provides an underpass under the M62. The south of the site is bordered by the A5080 Cronton Road, with the south eastern corner of the site being bounded by the former Cronton Colliery. Currently in the centre of the northern part of the site is Halsnead Park, a mobile home park. Adjacent to this is a medium sized lake and surrounding woodland.

1.3 Scope of Report

- 1.3.1 This report has been produced to identify the likely geo-environmental and geo-technical constraints across the SUE which may affect future development.

- 1.3.2 The objectives of this Geo-environmental Desk Study are to:
- Evaluate the geo-environmental and geo-technical setting of the SUE, including the geology, mining, hydrology, hydrogeology, site history and likely ground conditions based on published available sources and a site walkover completed on Monday 1st August 2016;
 - Review existing information provided with previous planning applications across the SUE;
 - Produce a conceptual contamination source-pathway-receptor model which forms the basis of a qualitative contamination risk assessment;
 - Complete an initial geo-technical assessment to identify potential ground risks;
 - Determine the outline requirements for further assessment and investigation across the SUE in order to fully understand the contamination and geo-technical engineering risks of future SUE development; and
 - Identify, where applicable, any special procedures and precautions that will be necessary during subsequent sampling and examination of the SUE.

1.4 Limitations

- 1.4.1 A Coal Authority Report has not been provided for the South of Whiston site or the western section of the Land South of the M62 site at this time.
- 1.4.2 Much of the background information on the SUE is in the form of reporting for previous development applications. While this data provides very useful baseline information, interpretative reporting was produced for specific projects and cannot be relied upon going forward with a different end use/site design.
- 1.4.3 An unexploded ordnance survey (UXO) has not been carried out across the SUE.
- 1.4.4 A site walkover was completed by representatives of Mott MacDonald on 1st August 2016, however due to the size of the SUE along with access, weather and time constraints, not all areas were observed on this occasion.
- 1.4.5 The Geo-technical Review of this site has been undertaken based on limited, publicly available data which has been reviewed at the time of reporting. Any

assumptions drawn from this report must be verified by project specific intrusive ground investigation before being used in design\construction.

1.4.6 Mott MacDonald Ltd are not insured to advise on risks from asbestos, toxic mould or radioactive substances.

1.4.7 Please refer to the Disclaimer presented in Appendix C.

1.5 Sources of Information

1.5.1 A detailed list of all reference materials can be found in Appendix E, referenced throughout the report.

2 Geo-Environmental Baseline

2.1 Site Description

2.1.1 The SUE description has been based on a combination of current OS mappingⁱ for the SUE and observations made during a site walkover, which was completed by representatives of Mott MacDonald on 1st August 2016. Site walkover photographs can be found within Appendix B. However it should be noted that due to the size of the SUE along with access, weather and time constraints, not all areas were observed on this occasion.

South of Whiston

2.1.2 The South of Whiston site is located at Halsnead Park, formerly a stately home (now demolished) and parkland. It is roughly a parallelogram in shape, bounded by Windy Arbor Road to the west, Lickers Lane to the north, Fox's Bank Lane to the east and the M62 motorway to the south. The Land South of the M62 site lies to the south.

2.1.3 Surrounding land uses are predominantly residential and community to the west and north, with Whiston Enterprise Park to the south-west. To the east, farm land predominates with some isolated residential housing. A golf course is located to the far-east.

2.1.4 The South of Whiston site mostly comprises open farmland interspersed with heavily wooded areas. The centre of the site is occupied by a mobile home park located on the area of the former Halsnead House and gardens of which only a couple of outbuildings and walls remain. A pump house and electricity sub-station are present within the mobile home park. The road 'Main Drive' to the mobile home park is located off Windy Arbor Road next to Church Lodge and runs parallel to an elongated (west-east) fishing lake before turning southwards and south-east into the centre of the site. To the north of the fishing lake is a recreation ground with a rough track 'Cock Glades' running north-south adjacent to its eastern boundary. To the east of the fishing lake is Prince's House Farm – a collection of historic and recent buildings in varying states of repair with a small pond to the east.

2.1.5 To the south of the Main Drive where it enters the site is the disused site of a former nursery (a large area of poor quality black top was observed through

security fencing) with a children's play area beyond. Crossing the Main Drive, west of the mobile home park is a small drain which flows into a north-south elongated pond. From here the water flows southward via a small stream into 'Big Water' a relatively large lake (formerly the boating lake for Halsnead House) which outflows to the south via a small stream. The area surrounding the surface water features is heavily wooded with 'Round Clump' to the west of Big Water and 'The Old Wood' to the south. During the site walkover fly tipping was noted to be prevalent throughout The Old Wood and adjacent to Big Water with evidence of rubbish being burned.

- 2.1.6 At the eastern boundary of the mobile home park is an additional small pond. Along the eastern boundary of the site are several residential properties: (from north to south) The North East Lodge to Halsnead Park, Cherry Tree Farm and Snape Gate Farm. To the west and south of Cherry Tree Farm are several small ponds. A small wooded area 'Fox Clump' is present between Cherry Tree Farm and the mobile home park. Along the northern site boundary additional wooded areas are present with some residential properties including Sandfield Cottage along the north-eastern boundary with an associated L-shaped pond. In the north-eastern corner of the site, a cemetery is present.
- 2.1.7 In the south-western corner of the site is the line of a disused mineral railway relating to the former Cronton Colliery (located south of the M62) which runs approximately north-west to south-east. It is understood to pass beneath Windy Arbour Road in a cutting approximately 5m deep, although this cutting was not observed during the site walkover. A communications mast is present just to the east of Windy Arbor Road to the west of the dismantled railway.

Land South of the M62

- 2.1.8 The Land South of the M62 site is located across the southern portion of the former Halsnead Estate, with the majority of the site dominated by the former Cronton Colliery which closed in the early 1980s.
- 2.1.9 The site is roughly triangular in shape bounded by the M62 to the north, Fox's Bank Lane to the east and the A5080 (Cronton Road) to the south. Adjacent to the western corner of the site is the roundabout at Junction 6 of the M62.

- 2.1.10 Surrounding land uses are predominantly farmland to the east with a mobile home park, Bluebell Farm and some residential properties. To the south, more farm land is present with a disused quarry to the central south along with a riding school. A couple of residential properties (including Park Villas) are present along the southern site boundary.
- 2.1.11 The central area just south of the M62 comprises open farmland with Old Halsnead (residential property) and Halsnead Farm (to the east), accessed off Fox's Bank Lane. To the west is a continuation of The Old Wood from the northern half of the site beyond the M62. Overhead power lines traverse the northern part of the site from east to south-west.
- 2.1.12 The south-western two thirds of the Site comprise the former Cronton Colliery, currently comprising open space, a number of watercourses, local ponding, some dispersed tree coverage, hardstanding areas, informal pathways, colliery spoil heaps, mine shafts, earthworks and legacy colliery features. Currently the land at the Site is secured and fenced. According to KMBC the Site is regularly used for horse riding (with permission) although there is evidence that the site is used without permission as recreational space by walkers, dog walkers, falconers and motorcycle riders.
- 2.1.13 Fox's Bank Brook enters the site via the eastern boundary and then flows westward along the southern boundary of the site joined by the other site surface water features which generally flow to the west and south. The Brook crosses the A5080 and passes adjacent to Strettles Bog. Issues and drains are also present within The Old Wood. Three capped former mine entry shafts are present in a fenced compound in the centre of the site. Chapel Brook flows southward through the eastern-most corner of the site before passing beneath the A5080, this is the receiving water for Fox's Bank Brook to the south-east of Strettles Bog. The line of the dismantled Mineral Railway mentioned previously crosses the central western portion of the site and crosses the M62 at the north-western corner.
- 2.1.14 The site was accessed off the A5080 to the east of Park Villas (residential properties on the southern boundary) and west of Fox's Bank Cottages (also on the southern boundary). An extensive area of overgrown hardstanding was present just north of the entrance, assumed to relate to former colliery

administrative buildings and parking. To the north of Park Villas in a fenced compound is a small package sewerage treatment plant serving the adjacent propertiesⁱⁱ. Brick structures containing water (with deep water warning signs) were observed assumed to be overflows, along with canalised sections of Fox’s Bank Brook. Across the plateau areas coal fragments were present at the surface.

- 2.1.15 Fox’s Bank Brook passes through ‘Cronton Road Debris Screen’ when passing under the A5080. To the north-west of this, widespread Himalayan Balsam was noted.

2.2 Site History

- 2.2.1 The SUE development history has been summarised from historic large scale mapping included within publicly available reporting supporting previous planning applications on the Land South of M62 site (specifically Parkman Environment – Former Cronton Colliery site, Site Investigation Interpretative Report Volume 1, Report No. 19399/OR/02B August 1999ⁱⁱⁱ). The history of the SUE and surroundings, along with mapping references can be found in Table 2.1 and Table 2.2.

South of Whiston

Table 2.1: Site History of South of Whiston

Map Ref	Site	Surroundings
Lancashire and Furness County Series 1:10,560 1850	The site is already bounded by lanes to the west, north and south (named Lickers Lane to the north, Fox’s Bank Lane to the east). This site is located on the historic Halsnead estate and parkland. Halsnead Hall and gardens is present in the centre of the site, accessed by the Main Drive to the west. An access road is also indicated to the east of the house. Prince’s House (and presumed	The predominant surrounding land use is as farmland. North: A Sandstone Quarry and ‘Stone Quarry Plantation’ are shown beyond the central northern boundary. Parren’s Covert is indicated adjacent to the north-eastern boundary. East: Fairchild’s Farm is shown adjacent to the central eastern boundary with Snape Gate Farm beyond the south-eastern corner

Map Ref	Site	Surroundings
	<p>farm) is located to the north-west. Between Halsnead Hall and Prince’s House a coal pit is marked. Carr House, a lodge and Windy Harbour (assumed hamlet) are located in the south-western corner.</p> <p>Many features present on current mapping are already shown in 1850. Many wooded areas are indicated around the site boundaries to the west, north and east, and surrounding Prince’s House and Halsnead Hall. Fox’s Clump is marked to the east with Snape Gate along the south-eastern boundary, Pheasant Clump along the southern boundary, Round Clump to the west of Big Water, the Old Wood to the south of Big Water, ‘Potters Pits’ to the west of Big Water and Paradise Covert along the western boundary.</p> <p>Ponds are shown to the north of the Main Drive where it enters the site and similar to the current day, an elongated water feature runs north-south to the west of Halsnead Hall before flowing southward into Big Water. Chapel Brook crosses the south-western corner of the site flowing towards the south-west. Small ponds are also indicated on the east of the site and an elongated water feature</p>	<p>of the site. Mill Wood (containing some small ponds) is located between Fairchild’s Farm and Snape Gate Farm and Brick Wood to the south-east of Snape Gate Farm.</p> <p>West: Beyond the northern half of the western boundary the land was being used for coal extraction – Halsnead Colliery is shown immediately beyond the central western boundary adjacent to Paradise Covert with Hig Hey Colliery, Houghton’s Hey Colliery and Whitton Colliery (along with numerous coal pits) to the north-west. A mineral railway runs to the north-west from Halsnead Colliery. Beyond Coalgate Lane running east-west to the north of these sites, additional collieries are indicated. To the immediate south-west of the site Holland House and a well are located in Windy Harbour.</p> <p>South: The history of the land to the south is outlined in Table 2.2.</p>

Map Ref	Site	Surroundings
	<p>(possibly a drain) adjacent to Sandfield Cottage on the north-eastern boundary. Other water features may be present but the quality of the mapping of this age makes this difficult to determine.</p>	
<p>Lancashire and Furness County Series 1:10,560 1894</p>	<p>The bounding road to the west is now indicated as Tarbock Road, becoming School Lane to the far south. A lodge is indicated at the eastern boundary of the drive to the east. The coal pit is no longer marked to the south of Prince's House. A small pond is indicated to the east of Halsnead Hall.</p>	<p>North: The quarry is now marked as 'old' and Stone Quarry Plantation has been re-named as Rimmers Covert. East: No change. West: By 1894, the site of Halsnead Colliery to the immediate west of Paradise Covert is marked as 'old colliery' and Halsnead Colliery has shifted to the north-west with shafts indicated. Paradise Farm is present to the north and a magazine is marked between the sites of the old and new Halsnead Collieries. An 'old colliery' is shown to the south of the mineral railway, while a new colliery has opened beyond Coalgate Lane. St Nicholas's Church has been constructed immediately adjacent to the western boundary just beyond Tarbock Road south of the Main Drive and Halsnead Hall Lodge entrance.</p>
<p>Lancashire and Furness County Series 1:10,560</p>	<p>An ice house is shown to the south of Prince's House and a Boat House is present adjacent to Big Water. Cock Glade is marked along a north-south running track to the</p>	<p>North: The old quarry is no longer marked. West: Halsnead Colliery is marked as disused as is Whiston Colliery to the north of Coalgate Lane with Whiston</p>

Map Ref	Site	Surroundings
1908	north-west of Prince's House.	Metallic Brick Works shown to be present to the east of this.
Lancashire and Furness County Series 1:10,560 1928	A Mineral Railway relating to Cronton Colliery (located on the southern site at this time) crosses the south-west corner of the site running in a north-west to south-east direction, to the north of Chapel Brook.	West: Halsnead Avenue (residential) has been constructed to the immediate east of the site adjacent to the Mineral Railway. To the north-west the brick works are now named Tushingham Metallic Brick Works. Old shafts are dotted across the former colliery sites.
OS Plan 1:10,560 1955-56	The land to the north of the Main Drive is now indicated as a football field. The vegetation of Paradise Covert is no longer present and residential housing has been built along the western boundary. Halsnead Hall has been partially demolished and the ice house and boat house are no longer indicated. A well is still present in the gardens to the immediate west. The north-east corner of the site is shown to be in use as a nursery.	West: Residential housing has expanded across the former colliery sites and to the east of the brick works. Tarbock Road has been re-named as Windy Arbor Road. North: Beyond the north-east corner of the site, an 'old sand pit' is shown to the south of Parren's Covert.
OS Plan 1:10,560 1966-67	More of the former buildings of Halsnead Hall have been demolished. Residential development along the western boundary has expanded and development is shown immediately south of the Main Drive where it enters the site. The nursery on the north-east of the site is named as Halsnead Park Nursery.	North: Residential development has extended adjacent to the north-western boundary of the site.

Map Ref	Site	Surroundings
	Cherry Tree Farm has been constructed to the north of Snape Gate Barn. Additional drains are present at various locations across the site.	
OS Plan 1:10,000 1977-78	'Potter's Pits' is no longer shown.	North: Residential development and school developments have extended to the north-east. West: Residential development has extended to the west. South: The M62 has been constructed adjacent to the southern boundary of the site with the roundabout junction with the M57 to the south-west.
OS Plan 1:10,000 1990-91	The nursery is no longer shown in the north-east of the site. The Mineral Railway across the south-west of the site is indicated as being dismantled. The site of the former Halsnead Hall and gardens is marked as a mobile home park.	East: Works and a timber yard are shown east of Parren's Covert. West: Works and a warehouse are shown to the south-west, south of the residential development.
Present Day	See Section 2.1	See Section 2.1

Land South of the M62

Table 2.2: Site History of Land South of M62

Date	Site	Surroundings
Lancashire and Furness County Series 1:10,560	The site is bounded by Fox's Bank Lane to the east, the South of Whiston site to the north, a small lane to the south-east and farmland/woodland to the south-west. The site predominantly comprises	North: The history of the land to the north is outlined in Table 2.1. East: Farmland and woodland, Little Foxshaw wood is present to the

Date	Site	Surroundings
1850	<p>farmland and wooded areas. Old Halsnead (house) is located on the north-east of the site.</p> <p>A brook enters the site along its south-eastern boundary and passes through the south of the site flowing east-west, leaving the site through its south-western boundary in Brook Covert. In addition Chapel Brook crosses the western corner of the site flowing southwards.</p> <p>In the central western area a pond and 'Sour Hey Pit' are indicated. 'Ravenhurst Pits' is marked to the south-west of Sour Hey Pit.</p> <p>Numerous small wooded areas are marked, including Great Foxshaw to the east, Gibraltar Covert to the south-east of Sour Hey Pit and The Old Wood to the north-west of the same. 'The Dacres' and 'Bridge Bog' are marked across the south-western corner. Pheasant Clump is located across the northern central boundary.</p>	<p>east of the site.</p> <p>South: Farm land to the south-east and to the south-west open land, wooded areas (including the remainder of Brook Covert and Ravenhurst Pits). The Dacres and Bridge Bog extend to the south from the south-western corner.</p>
Lancashire and Furness County Series 1:10,560 1894	<p>The brook to the south is identified as Fox's Bank Brook. A lodge is shown to the east of Old Halsnead, adjacent to the site boundary. Nut Wood is marked on the centre of the site. Fox's Bank Cottages have been constructed along the south-eastern boundary.</p>	<p>East: Fox's Bank has been constructed adjacent to the south-eastern corner.</p> <p>West: Chapel Brook is shown to flow through Dacre's Bridge Bog.</p>
Lancashire and Furness County Series 1:10,560 1908	No observable change	No observable change

Date	Site	Surroundings
Lancashire and Furness County Series 1:10,560 1928	Cronton Colliery has been constructed across the centre of the site to the east of Sour Hey Pit, accessed from the bounding road to the south with buildings constructed either side. Numerous buildings, structures and railway sidings are present. A Mineral Railway extends from the colliery out through the north-western boundary. A tank is marked adjacent to the site boundary next to the railway. A reservoir is present to the south of the colliery with a pumping house also indicated.	Little significant change
OS Plan 1:10,560 1955-56	A brick works is shown to the west of the colliery with associated excavations and a baths is shown to the north of the colliery. The Great Foxshaw wood has been replaced by a spoil heap to the east of the reservoir.	
OS Plan 1:10,560 1966-67	The spoil heap area has extended. Fox's Bank Brook flows via linear ponds out of the south-west of the site (Brook Covert). Additional spoil heaps are marked around the west of the mine works buildings. 'Ravenhurst Pits' has been filled in and is no longer shown.	East: Bluebell Farm (caravan site) has been constructed to the east. West: Strettlles Bog is now identified to the south-west
OS Plan 1:10,000 1977-78	A series of small ponds has been constructed (on the site of the former Gibraltar Covert) between the reservoir and linear surface water features. Sour Hey Pit has been filled in and is no longer shown as have the brick works excavations.	North: The M62 has been constructed adjacent to the northern boundary of the site with the roundabout junction with the M57 to the north-west. South: A road has been constructed along the south-western boundary

Date	Site	Surroundings
		of the site, connecting with the road running parallel to the south-eastern boundary (Cronton Road).
OS Plan 1:10,000 1990-91	Cronton Colliery buildings and works have been demolished (the colliery was decommissioned in 1984) and the spoil heap extends across the majority of the south-eastern corner of the site resulting in the diversion of Fox's Bank Brook to the south. A series of three bunded lagoons, one (southernmost) which appears to be water filled are present to the north of the spoil heap along the western site boundary. Part of the reservoir, ponds and water features are still present. Pheasant's Clump is no longer shown to the north. The Mineral Railway is marked as dismantled.	
Present Day	See Section 2.1	See Section 2.1

- 2.2.2 Additional information on the former Cronton Colliery post-1990 has been obtained from the sources in Section 3.6:
- By 1999 all structures had been removed from site other than the vent shafts in the central area; and
 - Restoration works carried out in 1999 included the removal of settlement lagoons, compaction of areas into three main plateaux and techniques to restore plant growth. During this restoration silt was taken from the lagoons and spread across the plateaux.

2.3 Topography

South of Whiston

- 2.3.1 In general the site slopes gently downwards from the north-east towards the south and south-west. Maximum elevations are between 50m to 55m aOD and lowest elevations between 20m to 25m aOD. To the south of The Old Wood is a narrow valley through which a small stream flows. The embankment to the west of the stream is particularly steep. A north-south strip of land running from the north-east of the mobile home park to the northern boundary was noted to have an undulating appearance with mounds and an uneven surface, suggestive of previous development (although none is evident from historic mapping).

Land South of the M62

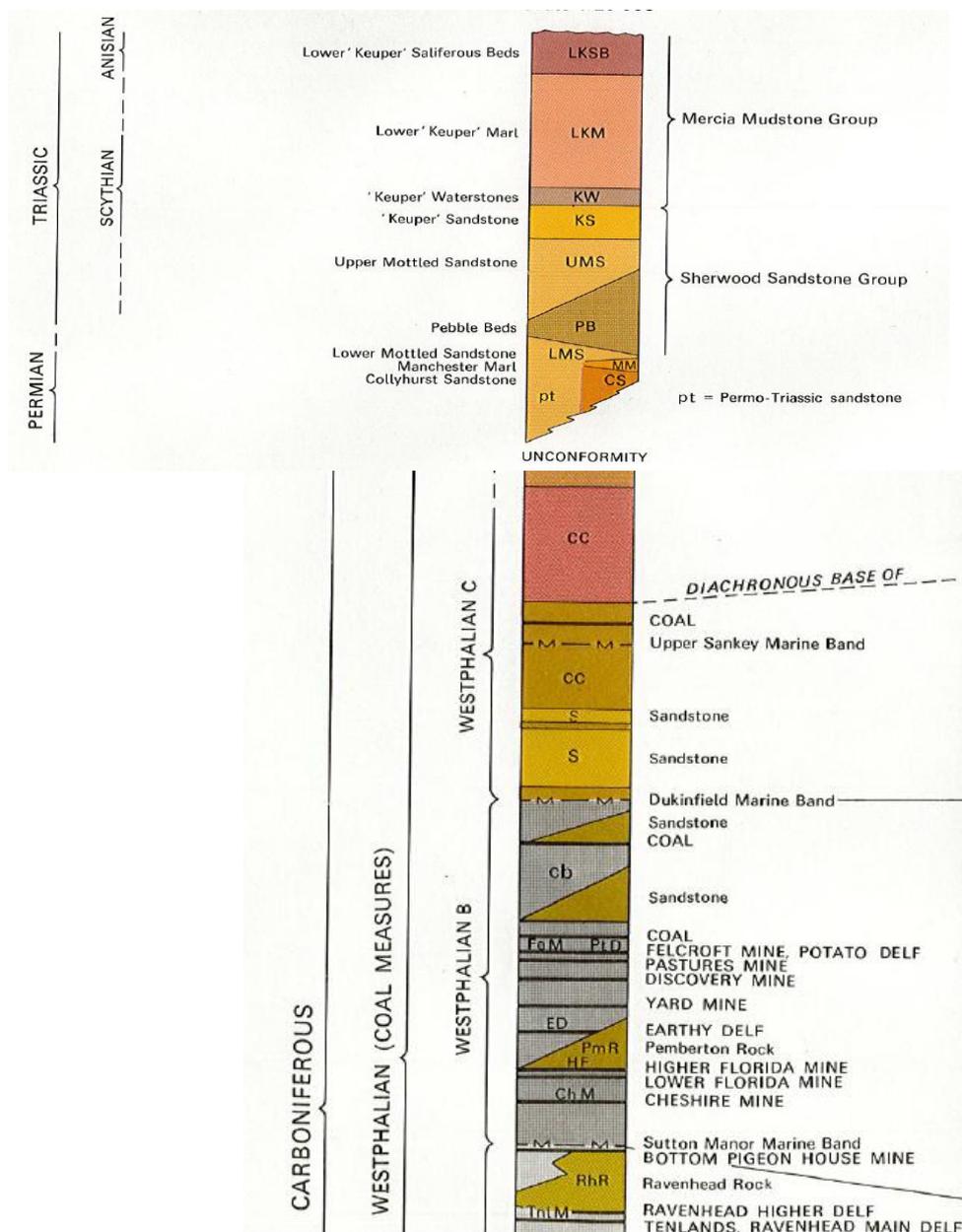
- 2.3.2 The site is relatively flat with the general slope from north-east to south-west. To the centre, east and south-east of the site, large raised flat plateau areas of re-graded colliery spoil are present (raised by 5m+ above the surroundings). Maximum elevations are between 45m to 50m aOD towards the north-east side of the site. Lowest elevations are approximately 20m aOD towards the south-west.

2.4 Published Geology

- 2.4.1 According to the solid geology 1:50,000 scale British Geological Survey (BGS) sheet No. 97 (Runcorn)iv, the SUE geology can be divided into two distinct sections to the east and west of the Eccleston West Fault which runs north-south across the eastern section of the South of Whiston site (north-west to south-east across the Land South of M62 site) with its downthrow to the east. See Figure 2.1 to Figure 2.3 for excerpts of the BGS mapping.
- 2.4.2 To the west of the Eccleston West Fault the SUE is underlain by Pennine Middle Coal Measures – mudstone, siltstone and sandstone interbedded with sandstone. The Coal Measures dip south-west at an angle of approximately 12 degrees. To the east of the Eccleston West Fault the Kinnerton Sandstone (Permo-Triassic sub-unit of Sherwood Sandstone) is present as bedrock

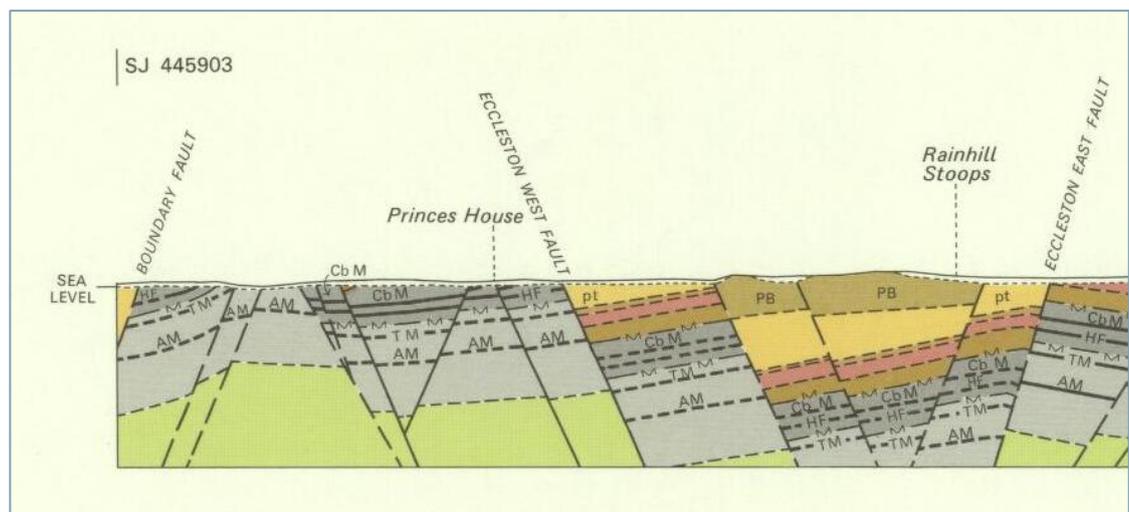
Source: Extract from Geological Survey of Great Britain (England and Wales):
 Runcorn Sheet 97 1:50,000 Series Solid Edition. Reproduced with the
 permission of the British Geological Survey ©NERC. All rights
 Reserved. Site location circled.

Figure 2.2: Excerpt of key from BGS Geological Mapping (Solid Geology)



Source: Extract from Geological Survey of Great Britain (England and Wales): Runcorn Sheet 97 1:50,000 Series Solid Edition. Reproduced with the permission of the British Geological Survey ©NERC. All rights Reserved.

Figure 2.3: Excerpt of Cross-Section from BGS Geological Mapping



Source: Extract from Geological Survey of Great Britain (England and Wales): Runcorn Sheet 97 1:50,000 Series Solid Edition. Reproduced with the permission of the British Geological Survey ©NERC. All rights Reserved.

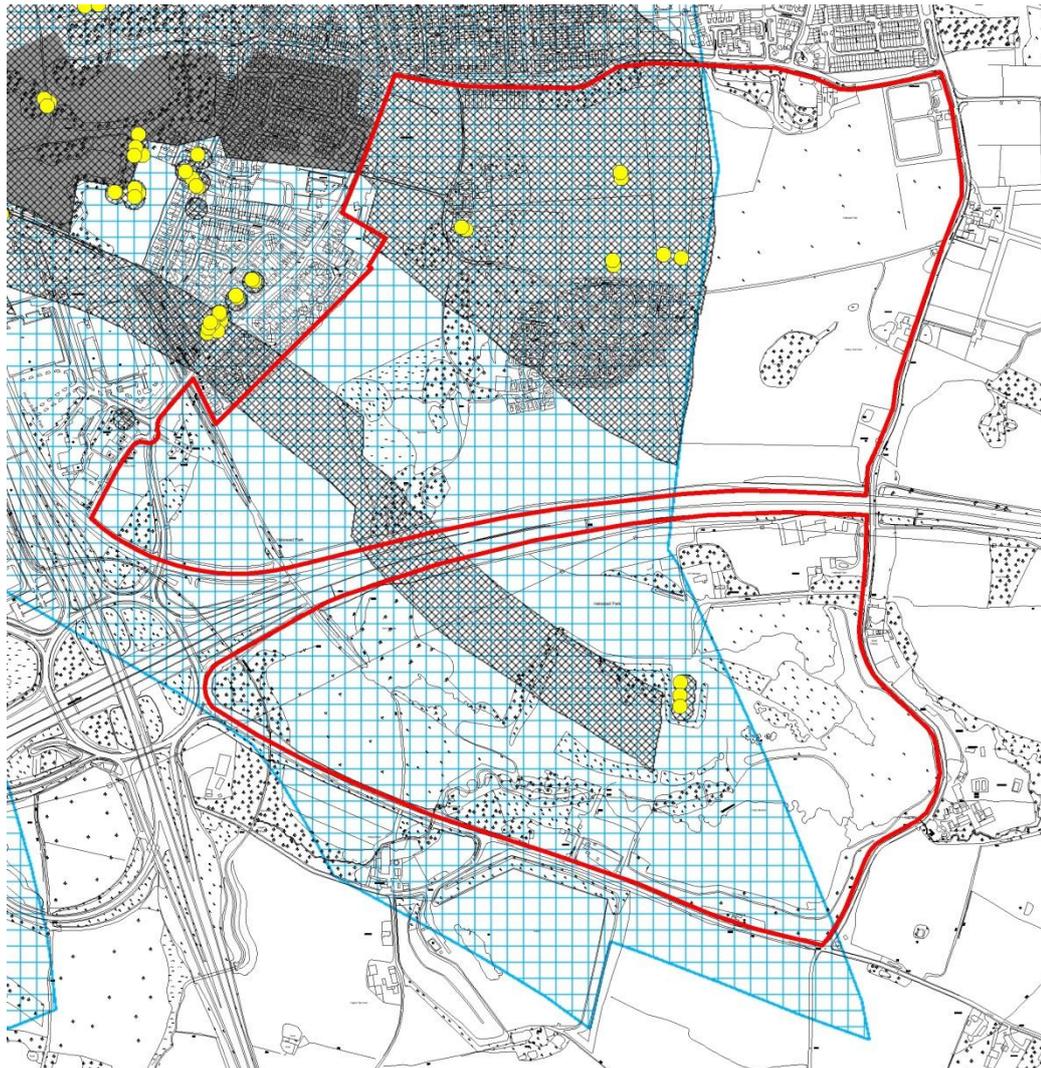
- 2.4.6 There are over one hundred and twenty boreholes recorded on the BGS Online Geoindex^v situated within the M62 corridor between the two sites, which are associated with the construction of the M62 Motorway. These show a varying thickness of Made Ground overlying firm to very stiff brown sandy gravelly clay. Bedrock is found to comprise varying layers of siltstone, mudstone and sandstone; this is encountered at depths in the approximate range 1.5-4.5 m bgl; there does not appear to be an observable trend in the depth of rockhead across the site. There do not appear to be any significant coal seams recorded within any of the boreholes reviewed.

- 2.4.7 There are no boreholes recorded on the BGS Online Geindex^v for the South of Whiston site, to the north of the M62, while there are approximately ten boreholes recorded on the BGS Online Geindex^v for the Land south of the M62. These boreholes are consistent with the ground model described within Section 5.1.
- 2.4.8 KMBC designate Cronton Mineral Railway Line (Site No 85) which traverses from the former site of Cronton Colliery, situated within the eastern half of the Land South of the M62, in cutting beneath the M62 through the south-west boundary of the South of Whiston site, as a Site of Local Geological Interest (SLGI) under the Council's adopted Proposals Map^{vi}. The designation simply lists the cutting as a Sandstone cutting.

2.5 Mining

- 2.5.1 A summary of the key coal mining features across the SUE and local area is provided within Figure 2.4.

Figure 2.4: Local Area Coal Mining Feature Location Plan



Source: Data provided by KMBC and the Coal Authority Web Mapping Service.

Key:

- Yellow dots: Mine entries
- Blue vertical cross hatching: Surface coal resource area
- Black diagonal cross hatching: Development high risk area (coincides with coal outcrop areas & probable shallow coal mine workings – with the

exception of the three shafts in the centre of the Land South of M62 site which are a development high risk area alone).

- Solid grey areas: Surface mining (past and current)

Coal Mine Entries

2.5.2 According to the Coal Authority, *“Mine entries indicate the entrance into a mine working, for which there are two types: shafts and adits. Mine shafts are vertical or near vertical entrances to a mine whereas adits are a walkable entrance to a mine as shown on plans held by the Coal Authority. Mine entry positions are taken from a variety of plan sources which vary in age, scale, accuracy and condition. These factors determine the accuracy of the mine entry position derived.”*

2.5.3 There are three mine shafts present in the centre of the Land South of M62 site related to the former Cronton Colliery.

2.5.4 On the South of Whiston site, there are two mine entries located to the south of Prince’s House (in the vicinity of a former coal pit marked on the 1850 historic plan of the area). There are also an additional six mine entries to the north and north-east of the mobile home park. Historic mapping does not indicate any workings in this area, it is therefore assumed that the workings pre-date the earliest mapping (1850) and are likely to relate to the working of shallow coal seams/outcrop areas.

Coal Outcrops

2.5.5 These are locations where workable coal seams are present at or close to the surface according to the Coal Authority, *“where an underground coal seam reaches rockhead, indicating coal that may have been worked at some time in the past. Whilst this dataset highlights areas of probable underground workings at shallow depth, it may also include areas where the un-viable seams of coal remain. This dataset contains a buffer of 50 m on the dip side of the outcrops position as held by the Coal Authority”.*

2.5.6 The coal outcrops are not shown specifically on Figure 2.4 but coincide in general with the development high risk area (with the exception of the location

of the three shafts in the centre of the Land South of M62 site). According to the Coal Authority online interactive map viewer^{vii}, coal outcrops are present in north-west to south-east trending bands across the central and north-western corner of the South Whiston site and in a band trending similarly across the south-western corner of the South Whiston site and on into the centre of the Land South of M62 site.

Probable Shallow Coal Workings

- 2.5.7 The location of probable shallow coal workings coincide with the location of the development high risk area previously discussed (with the exception of the location of the three shafts in the centre of the Land South of M62 site).
“Probable shallow coal mine workings contain locations and estimated extents of probable shallow underground workings for which no recorded plan exists, but where it is likely that workable coal at shallow depths has been mined before records were kept. The data has been estimated from available mining records by qualified mining surveyors.”

Development High Risk Area

- 2.5.8 *“The Development High Risk Area is the part of the coal mining reporting area which contains one or more recorded coal mining related features which have the potential for instability or a degree of risk to the surface from the legacy of coal mining operations. The combination of features included in this composite area includes mine entries; shallow coal workings (recorded and probable); recorded coal mining related hazards; recorded mine gas sites; fissures and break lines and previous surface mining sites. New development in this defined area needs to demonstrate that the development will be safe and stable taking full account of former coal mining activities. This area was formally known as the Development Referral Area.”*
- 2.5.9 The development high risk area coincides with probable shallow coal workings plus the area of the three shafts in the centre of the Land South of M62 site.

Coal Mine Gas Site

- 2.5.10 The process of coalification results in the production of mine gases, predominantly methane and carbon dioxide resulting from the anaerobic decomposition of ancient vegetation trapped within the rock. In Coal Measures, methane is generally absorbed in coal, trapped in gas pockets or dissolved in groundwater within the depositional sequence. Coal extraction results in the disruption of these gases, which may then vent to the surface via mine shafts and fault zones. Old mines pose the greatest hazard, given the lack of active ventilation.
- 2.5.11 The three former Cronton Colliery Shafts are classed by the Coal Authority as a Mine Gas Site, *“a site or property that has either been subject to investigation or remedial works by the Coal Authority to deal with an actual or potential mine gas occurrence.”* Vent stacks have been incorporated to allow the venting of gas from the mine.
- 2.5.12 The monitoring of gaseous emissions from the stack vents has previously been undertaken on behalf of the Coal Authority by International Mining Consultants Limited (IMC). The vent stacks were issuing gas in such high concentrations and quantities that the Coal Authority was understood to be considering the commercial feasibility of extracting gas from the site at one time. However it is understood that this venture did not proceed although the acquisition of this data (if available) would aid the further assessment of ground gas risks across the SUE.

Surface Coal Resource Area

- 2.5.13 According to the Coal Authority *“the Surface Coal Resource Areas define the coal resources capable of being extracted by surface mining methods, often referred to as ‘opencast’. This information is used by Local Planning Authorities as part of the duty to safeguard minerals from unnecessary sterilisation.”*
- 2.5.14 This covers the area of the SUE underlain by the Middle Coal Measures (the western two thirds of the site).

Past Surface Mining

- 2.5.15 There are no records of past or current surface mining for coal across the SUE, the closest is adjacent to the north-west including the site of the former Halsnead Colliery. *“Surface Mining Areas denote an area of coal extracted by surface excavations in the past or are being excavated currently, these sites do not necessarily reflect the extent of the excavation. Coal resources may still be available within these areas due to the inefficiencies of some historic mining techniques. These areas are often referred to as ‘opencast mining’.”*
- 2.5.16 The former Cronton Quarry to the immediate south of Land South of M62 is located within the Carboniferous Etruria Formation and was used for clay extraction. According to KMBC the quarry is known as Cronton Claypit and is still in use seasonally.

2.6 Hydrogeology

- 2.6.1 The approximately eastern third of the SUE is underlain by Permo-Triassic Sandstone bedrock which is classed as a Principal Aquifer. According to the Environment Agency (EA)^{viii}, Principal Aquifers are *“layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.”* It is also within a Groundwater Source Protection Zone (SPZ)^{viii} for several groundwater abstractions to the south and east, the closest of which is approximately 1.1km to the south of the southern border of the Land South of M62 site.
- 2.6.2 The Coal Measures bedrock strata across the SUE is classed as a Secondary A Aquifer^{viii} and is not included within the SPZ. According to the EA, Secondary A Aquifers are *“permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.”*
- 2.6.3 The sandstone component of the Coal Measures has the potential to transmit water. The sandstone beds are generally discontinuous as a result of faulting which can enhance permeability. The quality of the groundwater within Coal Measures is highly variable and often contains high total dissolved solids,

sulphate, sodium, chloride and iron concentrations, thus making the water unfit for public supply use. While the Permo-Triassic Sandstones to the east are within the total catchment of a Groundwater SPZ, the groundwater abstractions within influencing distance are for agriculture, industrial, commercial and public service use only, not potable supply^{viii}.

- 2.6.4 During mining the groundwater level beneath the former Cronton Colliery was lowered by pumping. Following the colliery closure in 1984 groundwater levels have risen and are likely to now be at a stable level (although this has not been confirmed).
- 2.6.5 The superficial Glacial Till deposits are classed as a Secondary A Aquifer^{viii} while the limited Alluvium deposits across the SUE are classed as a Secondary Undifferentiated Aquifer (assigned by the EA *“in cases where it has not been possible to attribute either category A or B to a rock type”*).
- 2.6.6 According to current mapping, issues and drains are present across the SUE suggesting the groundwater table (or a perched groundwater table) lies close to the surface. A well is present in the grounds of Fox’s Bank Cottages on the southern boundary of the Land South of M62 site.

2.7 Hydrology and Flood Risk

Hydrology

South of Whiston

- 2.7.1 To the north of Main Drive a linear (west-east) fishing lake is present. A small pond is located to the east, beyond Prince’s House Farm. Crossing the Main Drive, west of the mobile home park is a small drain which flows into a north-south oriented linear pond. From here the water flows southward via a small stream into ‘Big Water’ a relatively large lake (formerly the boating lake for Halsnead House) which outflows to the south via a small stream.
- 2.7.2 At the eastern boundary of the mobile home park is an additional small pond. To the west and south of Cherry Tree Farm are several small ponds. Along the South Whiston site boundary some residential properties including

Sandfield Cottage are present along the north-eastern boundary with an associated L-shaped pond.

- 2.7.3 The general direction of surface water flow across the site is considered to be from the north-east to the south-west.

Land South of the M62

- 2.7.4 The former Cronton Colliery site contains numerous drains, ponds and overflows. Issues and drains are also present within The Old Wood (north-west). Chapel Brook flows southward through the western-most corner of the site before passing beneath the A5080.
- 2.7.5 Fox's Bank Brook enters the site via the eastern boundary and then flows westward along the southern boundary of the site, joined by other site surface water features (drains, ponds and overflows) which generally flow to the west and south. Historical plans indicate that the Brook was diverted to clear space for the on-site storage of colliery spoil. Fox's Bank Brook exits the site through the south-western site boundary passing beneath the A5080 and adjacent to Strettles Bog. Fox's Bank Brook joins with Chapel Brook to form Ochre Brook. Ochre Brook flows southwards into Ditton Brook, which, in turn, outfalls to the River Mersey.
- 2.7.6 On the day of the site visit standing water and very boggy areas (there had been a period of moderately wet weather) were noted throughout the former colliery site. The direction of surface water flow across the site is considered to be from the north-east to the south-west.

Flood Risk

- 2.7.7 The South of Whiston site does not contain any EA designated flood zones in relation to flooding from rivers^{viii}.
- 2.7.8 Fox's Bank Brook enters the Land South of M62 site from the east adjacent to Bluebell Farm. Along the south of the site, in the former Cronton Colliery area there are EA designated flood zones 2 and 3 relating to Fox's Bank Brook^{viii}.

- 2.7.9 South of Whiston and Land South of M62 both contain areas at risk from surface water flooding, generally associated with surface water features – drains, lakes, streams and issues^{viii}.

2.8 Sensitive Land Uses and Designations

- 2.8.1 The SUE is located within a Site of Special Scientific Interest (SSSI) Impact Risk Zone (According to data.gov.uk “*Impact Risk Zones (IRZs) are a GIS tool developed by Natural England to make a rapid initial assessment of the potential risks posed by development proposals to: SSSIs, Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites. They define zones around each site which reflect the particular sensitivities of the features for which it is notified and indicate the types of development proposal which could potentially have adverse impacts*”)^{ix}. However, there are not any such designated sites in the local area and the current development proposals do not fall into the development descriptions requiring consultation with Natural England.
- 2.8.2 The SUE is located within a Surface Water Nitrate Vulnerable Zone (designated as being at risk from agricultural nitrate pollution)^{ix}.
- 2.8.3 A number of listed buildings and structures are present across the SUE^{ix}:
- Old Halsnead;
 - Barn at Snape Gate;
 - NE Lodge to Halsnead Park and Gate Piers adjacent to same;
 - Sandfield Cottage; and
 - Carr House and Farmhouse, with The Paddocks and The Stables adjacent.

2.9 Other Records

UXO Risk

- 2.9.1 The Zetica Bomb Risk Maps for Merseyside indicate that the SUE is within a zone of moderate bomb risk^x. Moderate-risk regions are those that show a bomb density of between 11 and 50 bombs per 1000 acres. While there was no specific target on site, its proximity to Liverpool and other local targets increase the risk.

Landfill Sites

- 2.9.2 The former Cronton Quarry to the immediate south of Land South of M62 is classed as an EA authorised inert landfill^{viii} (operators Grundy And Co Excavations Limited). The former quarry is located within the Carboniferous Etruria Formation and was used for clay extraction. According to KMBC the quarry is known as Cronton Claypit and is still in use seasonally. It has a live consent and an area for its expansion (and subsequent backfill) was allocated in the Joint Waste Local Plan in 2013.
- 2.9.3 In addition, to the immediate north-west of the South Whiston site, Coalgate Lane historic landfill is present^{viii} which accepted waste from January 1972 to January 1983 including inert, industrial, commercial, household and liquids/sludge.

Radon Risk

- 2.9.4 According to UK Radon Mapping provided by Public Health England^{xi} 1-3% of homes in the area are at or above the action level.

3 Previous Applications

3.1 Location of Information

3.1.1 A search was made of KMBC online Planning Portal to view the previous planning applications made within the SUE boundary and any pertinent supporting documents. No planning applications with relevant supporting documents were found for the South of Whiston site, however several highly relevant planning applications have been made for the Land South of the M62 site which did have useful supporting documents. While these reports have been produced specifically for other proposed developments and therefore any interpretation cannot be relied upon by KMBC in the future development of the SUE, they contain baseline data which provides background information supplementary to the site baseline discussed in Section 2.

3.2 Previous Relevant Applications

- 3.2.1 The pertinent previous applications for the Land South of M62 site are considered to be:
- Planning ref: 93/00231 – Removal of Colliery Spoil (600,000m³) and associated re-modelling and other ancillary works (with reference to planning ref: APP/8955). All information was provided by KMBC in the form of scanned copies of the paper file. The file contains a large quantity of correspondence, reporting, plans and other information such as site visit and progress reports;
 - Planning ref: 99/00682 – Drilling of up to two coal bed methane ‘GOB’ gas wells for investigation and extraction purposes. All information provided as for 93/00231;
 - Planning ref: 07/00929/COU and 15/00191/FUL – Change of use of site to informal country park (pertinent reporting: coal mining risk assessment report and a large scanned document containing a large number of reports, letters and other data); and
 - Planning ref: 03/01148/OUT – Proposed business park (online documents include Environmental Statement, Factual Report on GI, SI Report Vol I).
- 3.2.2 Application 93/00231 was completed, however it is not known whether 99/00682 proceeded despite being granted permission. Neither of the final two of the above applications are understood to have proceeded with 03/01148/OUT being withdrawn.

3.2.3 The supporting documents have been reviewed and pertinent supplementary baseline data to that provided in Section 2 has been summarised in subsequent sub-sections. Relevant direct quotations from reporting are presented in italics and quotations marks.

3.3 Planning ref: 93/00231 – Removal of Colliery Spoil (600,000m³) and associated re-modelling and other ancillary works (with reference to planning ref: APP/8955)

3.3.1 This application was made by Balfour Beatty Civil Engineering Limited. The application was for the removal of colliery spoil from the site for use in the proposed A5300 road works and permission was granted at the end of 1993. The spoil was proposed to be sourced from two principal areas:

- Area A – The spoil heap (440x280 m approximately) located adjacent to the south-eastern corner of the site. This area was to be levelled to form a plateau 14-17 m below the previous crest level.
- Area B – The area (approximately 520x270 m) housing two slurry lagoons to the north of the former (then existing) reservoir was to be remodelled, forming a plateau around 4 m higher than area A and including the infilling of the lagoons.

3.3.2 The reservoir was not proposed to be in-filled according to the proposals (however this is likely to have taken place around this time). Following re-modelling, no site slopes were to have gradients above 1:3. The plateau areas were to be power harrowed and rolled with a Cambridge roller with stone picking and rubble removal.

3.3.3 Following re-modelling, there was a scheme proposed for the vegetation establishment which included the import of recycled paper sludge (RPS) and digested sewage filter cake (DSC) followed by cross-ripping to incorporate this into the spoil and reduce compaction. Coarse sand and lime were used where necessary to counteract the acidic conditions on site. Conditions in the south-east of the site were noted to be particularly acidic. Following this a scheme of planting seed, shrubs and trees was proposed for the following five years. Herbicide treatments were included within the five year maintenance plan after vegetation establishment.

- 3.3.4 An additional aspect of the application (although only indirectly discussed with no exact plans or supporting documentation) was works on Fox's Bank Brook to include re-routing around the southern boundary of the south-eastern plateau, removal of a culvert, cleaning of the channel bed and improvements of the brook bank.
- 3.3.5 In July 1995, documents state that the scope of work included the removal of a slurry stockpile from near the western boundary of the site (approximately 15,000m²) remaining from a former coal washing operation. Given its coal content it was taken off-site to be blended with higher quality product for use in coal-fired power stations. This was noted to be complete by October 1995 (50,000 tonnes) with existing slurry pits emptied and lagoons filled in.
- 3.3.6 Some documents pertaining to the planning application for the previous coal washing operation at the site (APP/8955) were included in the scanned file received from KMBC. APP/8955 relates to a planning application by the National Coal Board made in mid-1985 for coal recovery operations including the erection of coal washing plant, re-working of the Cronton Colliery spoil heap and deposition of discard from coal recovery operations. It proposed that 13.5 ha were to be restored (at the time derelict former colliery buildings, spoil heap and associated lagoons). The site was recommended to be returned to a land form "*suitable for forestry use*". The exact dates that processing and disposal actually took place at the site are not clear from the documents included but it is believed to be until 1993 by Hillside Coal (complaint letters are present in the file relating to breaches of environmental, noise and dust planning conditions at this time).

3.4 Planning ref: 99/00682 – Drilling of up to two coal bed methane 'GOB' gas wells for investigation and extraction purposes

- 3.4.1 It is not known whether this application by Evergreen Resources Ltd (which was granted planning permission) proceeded – the planning application included a clause for decommissioning and restoration within 6 months of completion. The wells were to be located on the western boundary of the former Cronton Colliery site near the location of the former slurry stockpile within a specific testing/production enclosure with a designated access roadway.

- 3.4.2 According to the supporting documentation, Cronton Colliery worked a total of 13 seams of coal (70-400 cm in thickness) between the early 1900s and closure in 1984. The shallowest workings are reported to lie at 100 m bgl with the deepest below 750 m bgl, with the majority within an area 1.5x3.5 km overlapping with the workings of the Halsnead and Whiston Collieries. The supporting information explains that following abandonment the three shafts Nos. 1, 2 and 3 were filled, grouted and capped in 1985, however some time afterwards gas emissions were detected in the vicinity of the shaft tops with a decision taken to drill through the concrete casings and install vents to temporarily mitigate the problem. It was stated that the gas emissions were being monitored on a regular basis from May 1996.
- 3.4.3 The Coal Mining Report accompanying APP/99/00682 states that the location is within the likely zone of influence on the surface from eight seams of coal at approximately 80-490 m depth and that ground movement from these past workings should by now have ceased.
- 3.4.4 A recommendation from the Environment Agency for this application was that water and gas pressures should be recorded monthly and data supplied to the planning authority and Environment Agency at intervals of no less than every 6 months.

3.5 Planning ref: 03/01148/OUT – Proposed Business Park

Parkman Environment – Former Cronton Colliery Site, Site Investigation Interpretative Report Volume 1, Report No. 19399/OR/02B August 1999ⁱⁱⁱ

- 3.5.1 This report was produced for the North West Regional Development Agency to identify short term liabilities associated with the former Cronton Colliery site and to identify actions required to make the site safe. Note this report covers the former Cronton Colliery site only – covering the south-eastern two thirds of the Land South of M62 site only with a narrow strip to the north-west associated with the former Mineral Railway. This report was also understood to have been produced prior to restoration works – spoil re-grading.

compaction etc. The following summarises the information presented in this report.

Works Undertaken on Site 1990-1999

- 3.5.2 *“The A5300 Knowsley Express route was constructed between 1994 and 1996, linking Junction 6 of the M62 motorway with the A562. The route was an extension of the M57 motorway and effectively completed the Liverpool outer ring road.”*
- 3.5.3 *“The Knowsley Link Road was completed by Balfour Beatty Limited (BBL), who established a compound on the colliery site. By agreement with the British Coal Corporation, the Contractor excavated materials from the spoil heaps on site for use as embankment fill on the highway construction contract.”*
- 3.5.4 *“It was anticipated that 400,000m³ of suitable material would be won from the colliery spoil for incorporation into the highway works. It is understood that the exported material comprised mostly burnt colliery shale. It is thought that the burnt shale material had arisen from subterranean fires on site. The un-burnt material that was retained on site was considered unsuitable for use as embankment fill as it was susceptible to expansion on contact with water and included high concentrations of sulphates and iron pyrites.”*
- 3.5.5 *“The licence agreement also made provision for the importing of inert unsuitable materials, from the highway contract to the colliery site, although it is not understood whether any material was subsequently deposited on the study site.”*
- 3.5.6 *“Under terms of the agreement BBL undertook to landscape the materials remaining on the colliery site following completion of the highway contract and to carry out a programme of planting, to reduce the visual impact of the derelict site. As the colliery spoil material was largely infertile, an imported organic growing medium was ploughed into the upper 0.5 m of the landscaped plateaux to support planting. This comprised degraded sewage sludge and waste paper mulch.”*

Mining

- 3.5.7 Parkman Environment made a visit to the mining record office of the Coal Authority to view plans of mine workings within the former Cronton Colliery and Mineral Railway site boundary. Three shafts were identified within the central area of the site:
- Cronton Colliery No. 1 (SJ 47418 89300);
 - Cronton Colliery No. 2 (SJ 47421 89324); and
 - Cronton Colliery No. 3 (SJ 47423 89347).
- 3.5.8 *“Mining activity at Cronton is summarised below in order of increasing depth, beginning with the earliest and shallowest worked seams. In addition to the recorded workings below, further shoulder workings were encountered during the site investigation.”* these are discussed in more detail in the Site Investigation sub-section below.
- 3.5.9 *London Delf (or Felcroft) Seam: The workings for this seam cover the west and southern two thirds of the site, access to the workings is from Shaft No. 1 and the depth of the seam is noted as 130 yards (approximately 119m). The workings underneath the site are noted as having underground water, and appear to have been worked until the early to late 1920’s. The worked coal seam was 7ft (2.2m) thick.*
- 3.5.10 *Crombourke (or Pasture) Seam: Extraction from this seam was carried out in two workings. These comprised early workings beneath the central part of the site, with subsequent more extensive workings located in the south of the study site. The workings were accessible from all three shafts, and were worked between 1917 and the late 1930’s. It appears that pillar and stall techniques were used on the earlier workings and longwall techniques were used on the later.*
- 3.5.11 *Yard Seam: These workings were confined to the western half of the site, and were mined using the longwall method and completed between the mid-1920’s and early 1930’s. Access to the workings was from Shaft No.s 2 & 3.*

- 3.5.12 *Ince Six Feet (or Earthy Delf) Seam: Within the study area, these workings were confined to the north-western corner of the (Cronton Colliery) site and were mined using the longwall method.*
- 3.5.13 *Higher Florida (or Higher Bug) Seam: The workings for this seam lay beneath the western two thirds of the (Cronton Colliery) site, and were worked using both longwall and pillar and stall techniques. Access was from Shaft No.s 1 & 3 and the works were completed in the early 1920's. The major coal seam was 6ft 11 inches (2.11m) thick. The plans indicate that two pumps were used to de-water these workings, pumping a total of 186,200 gallons (846m³) per day. One of these pumps appears to be associated with the position of the No. 2 shaft. The second pump is shown to the south of the No. 1 shaft.*
- 3.5.14 *Cheshire (or Pigeon House) Seam: The workings for this seam were restricted to a small area just to the north of the (Cronton Colliery) site. Access was from Shaft No. 1 and the depth of the seam noted in Shaft No. 3 was 236 yards (216m). The workings were carried out using the pillar and stall technique and were completed between December 1935 and February 1936. The major coal seam was 2 ft 5.5 inches (0.75m) thick.*
- 3.5.15 *Haigh Yard (or Burgy) Seam: The workings for this seam were confined to the western half of the site. Access was from Shaft. No.s 2 & 3; the workings were carried out using longwall techniques and were abandoned in the period between 1945 and 1949.*
- 3.5.16 *Rushy Park Seam: These workings extend fully west to east across the (Cronton Colliery) site and were carried out using longwall techniques. Access was from Shaft No.s 2 & 3 and the works were completed between the mid 1930's and early 1940's. The worked coal seam was 4 feet 2 inches (1.27m) thick. The abandonment plan indicates that a pump was located at the bottom of No. 2 shaft which extracted 47,750 gallons (217m³) of water per day."*
- 3.5.17 *Parkman also discuss a shallow "3 ft Coal Seam" which they understood to sub-crop across the SUE.*

Site Investigation

- 3.5.18 A site investigation was completed by Exploration Associates under the supervision of Parkman April-May 1999 comprising twenty-four trial pits (0.9m to 4.0m bgl) and twenty-three cable percussion boreholes (0.6m to 13.45m bgl) across the former Cronton Colliery Site (as described in paragraph 3.5.1); nineteen of which had groundwater/gas monitoring standpipes installed. Nine boreholes were drilled by rotary open hole and coring with a further eight sunk by open hole drilling. A further ten boreholes were sunk by open hole rotary methods in order to install gas monitoring standpipes adjacent to the shafts.
- 3.5.19 The GI generally encountered colliery spoil overlying Glacial Till, underlain by Permo-Triassic Sandstone or Coal Measures, which were generally encountered as mudstone. Alluvial deposits were encountered within the south-eastern area, close to Fox's Bank Brook. The level of the base of the colliery spoil was found to range from 36.74m aOD to 18.40m aOD, although more commonly the base was found to be between 33m aOD and 26m aOD. The maximum thickness of spoil (12.0m) was encountered in the north-eastern spoil mound. The southern and north-western mound appeared to comprise some 6m of spoil.
- 3.5.20 The Glacial Till was generally between 0.5m and 1.5m thick, although thicknesses up to 6.5m were encountered in the south-eastern corner of the site.
- 3.5.21 Rockhead was encountered in twelve cable percussion boreholes between 36.64m aOD and 23.37m aOD. The strata appeared to be dipping to the south/south-east in accordance with the published geology.
- 3.5.22 Boreholes were sunk to identify the location of the shallow 3ft coal seam across three different fault blocks across the site. Coal Authority records indicated that the shallow 3ft seam had not been worked however the site investigation proved old workings. The seam where encountered was between 0.4m and 0.7m thick.
- 3.5.23 Ninety-seven samples were submitted for chemical analysis of a standard list of determinands. Twenty-seven of these were found to be above the old

- ICRCL thresholds (arsenic, copper and boron). Generally these elevated concentrations did not appear to be leachable.
- 3.5.24 Relatively little groundwater was encountered during the site works; mainly seepages of perched groundwater from the colliery spoil. During the monitoring programme, groundwater was present towards the base of the Glacial Till, probably in hydraulic continuity with the groundwater encountered in the underlying bedrock.
- 3.5.25 Monitoring of the standpipes, with response zones in various strata, indicated that the groundwater was encountered between 19.28m aOD and 42.02m aOD. (This large variation is assumed to be associated with large topographic variation and different filter zone elevations.)
- 3.5.26 Groundwater was encountered within the Glacial Till. Two boreholes encountered groundwater within the underlying rock (approximately 26.0m aOD). The logs at these locations show no Glacial Till present between colliery spoil and bedrock.
- 3.5.27 Due to insufficient quantity, no groundwater samples were obtained during the works, however four sets of surface water samples were obtained from bodies across the site and one set from mine workings in the north-east corner of the site. Elevated concentrations of iron were noted up to 89.3mg/l. pH values were generally between 7 and 8.
- 3.5.28 The gas installations were monitored on three separate occasions. Elevated carbon dioxide (>1.5%v/v) across the site with values >10%v/v at five locations along the western and eastern boundaries away from the shaft locations. Elevated methane results (>1.05v/v) were detected in nine standpipes with concentrations >5%v/v to the east of the site.
- 3.5.29 Given the previous investigations into the commercial extraction of gas from the shaft locations, the flow rates observed were not considered to be significant and Parkman concluded that the shafts are the main conduit for the mine gas to rise to the surface.

Sinclair Knight Merz – Environmental Statement Cronton Colliery November 2003^{xii}

- 3.5.30 The Environmental Statement covers the whole of the Land South of M62 site, proposed for commercial development. Relevant excerpts have been provided below.

Cronton Colliery History

- 3.5.31 *“Prior to the colliery development, the coalfield outcrops in the west of the site and it is probable that there are bellpits or other historic shallow mine workings.”*
- 3.5.32 *“The colliery comprised three shafts with associated winding house, mineral railway, workshops and head pit baths. A coal preparation plant was located in the south of the site adjacent to the mineral railway. Here coal was washed to remove ash and shale using mine water pumped to a nearby reservoir as process water. Coal spoil and washery discard were dumped in the south-eastern part of the mine site. North of the shafts were the baths and canteen together with a small sewage plant and a petrol pump. A brickworks was located north-west of the shafts to produce bricks made from seat earth clay extracted with the coal.”*
- 3.5.33 *“Demolition rubble from the former brick works is presumed to have been disposed of within the colliery spoil heap. The power plant was also demolished and possibly disposed of in the same way. The remainder of the mine buildings were demolished following closure in the late 1980s. The three mine shafts are fenced with vents installed for the discharge of methane. It is not known how the underground storage tank for the petrol pump was treated. This may still be present, possibly containing petrol residues.”*
- 3.5.34 *“The spoil heap extended over the mine water reservoir and eventually in-filled this. A series of lagoons were constructed initially for settlement of washery slurry. The soil tip itself was washed to recover coal left over from historic inefficient washing processes and spoil, particularly in the form of burnt shale, was used as roadstone in local road construction programmes notably the*

- M57. Following extraction of roadstone, the tips were landscaped and planted.”*
- 3.5.35 *“The only remains of the mineral railway is a sandstone cutting leading to a bridge across the M62 and subsequently designated as a site of geological interest. A remaining reservoir on site has been recently filled in.”*
- 3.5.36 *“The only remains of Cronton Colliery are spoil heaps and three mine shafts that are currently discharging methane to atmosphere. The shafts are located in a fenced enclosure and methane is monitored by the Coal Authority who also own the land within the enclosure and the minerals (coal and methane).”*
- 3.5.37 *“The spoil heaps form three landscape plateaux varying in height up to 10m.”*
- 3.5.38 *“Although the coal mining report indicated that there were no shallow workings, earlier investigations indicate that shallow workings and voids were located in an area west of the three shafts on site. They suggest that an area of 160m by 90m may be affected. Possible shallow mine workings at depths between 5m to 20m bgl were encountered to the west of the three shafts in the 2003 Parkman Investigation.”*

Former Cronton Colliery Site – Contamination Summary

- 3.5.39 *“No significant contamination was encountered within Made Ground. Hotspots of phenol, sulphide and PAH compounds were found at three locations... and both acid and alkaline conditions were found throughout the site. No PCBs or petroleum range hydrocarbons were detected above laboratory detection limits.”*
- 3.5.40 *“Tests found 9 out of 30 locations in the colliery spoil with a loss on ignition (LOI) greater than 25%, with a maximum of 70% LOI. Samples with a LOI of 25% or greater are generally considered to be combustible. These results indicate that some locations may contain combustible concentrations of coal.”*
- 3.5.41 *“Analysis of phytotoxic contaminants within the Made Ground found hotspots of boron and zinc which may affect landscaped areas. These may need to be*

considered for treatment with lime or additional soil covering if the areas are to be planted.

3.5.42 *“No asbestos was detected in samples of the Made Ground.”*

3.5.43 Hotspots of benzo(a)pyrene were found at two locations and one location contained a concentration of 20mg/kg of naphthalene which coincided with the former petrol pump location. Other contamination hotspots and high levels of LOI coincided with the former mineral railway and washing plant area.

3.5.44 *“Soil leachate testing showed elevated concentrations of sulphate.”*

Farmland Areas (remainder of Land South of M62 site) – Contamination Summary

3.5.45 No significant contamination was encountered in farmland areas although alkaline conditions were encountered and slightly elevated zinc concentrations which SKM identified may affect future landscaping. No asbestos was detected and soil leachate concentrations were low.

Groundwater – Contamination Summary

3.5.46 Groundwater monitoring was undertaken in 1999 and 2003. Results were compared with standards for drinking water and Environmental Quality Standards (EQSs).

3.5.47 The 1999 Parkman investigation found contaminant concentrations above guidelines from the coal mining area to the west of the mine shafts. Iron levels ranged from 18mg/l to 3530mg/l indicating that oxidation of pyrite seams and spoil at the site has resulted in ferruginous groundwater. The water was not found to be acidic. Surface water sampling carried out in 1999 showed only slightly elevated iron concentrations in these waters.

3.5.48 The Parkman 2003 Site Investigation groundwater monitoring found contaminant concentrations above Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) guidance values at ten locations (including sulphide, TPH, GRO, benzo(a)pyrene and PAH). These guidance values are now superseded.

Ground Gas

- 3.5.49 Measurements for ground gas carried out in 1999 and 2003 indicated concentrations of carbon dioxide and methane above BRE trigger values for building protection within the former colliery site. There was a significant amount of venting recorded from pit shafts; however the boreholes with elevated methane are some distance from the shafts.
- 3.5.50 Within the former colliery area methane concentrations ranged from <0.1%v/v to 32.55%v/v and carbon dioxide from <0.1%v/v to 29%v/v. the maximum concentrations were encountered in the south-east corner in a spoil heap. At this location the underlying geology is Sherwood Sandstone with Glacial Till (low gas generation potential) suggesting that the spoil has the potential for significant gas production.
- 3.5.51 At one location within the adjacent farmland gas concentrations exceeded BRE action values with methane ranging from 0.5%v/v to 5.8%v/v and carbon dioxide ranged from 1.4%v/v to 2.8%v/v. the Parkman 2003 gas monitoring results show the former colliery site to be a CIRIA Characteristic Situation 4 requiring active gas protection measures. One area of the adjacent farmland was found to be a CS 2 with appropriate under floor protection measures required.

Slope Stability

- 3.5.52 *“The south facing slopes of the most southern tip are steep and one section has suffered a failure within the last 5 years. It is understood that stabilisation works are shortly to be undertaken with the slopes re-graded to a 1 in 3 angle.”*

3.6 Planning ref: 07/00929/COU and 15/00191/FUL – Change of use of site to informal country park

Merseyside Environmental Advisory Service Technical Review Comments on: Mouchel (2008) Desk Study Assessment and Gap Analysis Report, Cronton Colliery, Knowsley. Produced for the Land Restoration Trust. Report No. 797035/R/01/A^{xiii}

- 3.6.1 The Mouchel Desk Study Report was not available within the publicly available documents via the planning portal, however a summary and series of comments on the report by Merseyside Environmental Advisory Service was included.
- 3.6.2 Key points included within the summary were as follows:
- A coal mining report dated 1997 confirmed that the coal seams ranged in depth between 80m and 730m bgl. It also stated that there are three capped shafts present within the colliery site and vent shafts have been installed to allow venting of mine gas. The Coal Authority has retained ownership of the shafts and vents;
 - In June 2000 a risk assessment was undertaken using the data from the previous investigation. It was concluded that there were no contaminants of concern at the site that posed an unacceptable risk to human health;
 - In March 2004 a further investigation was carried out as the site was considered for commercial/industrial use comprising 49 trial pits, 30 cable percussive boreholes and 16 rotary boreholes. The maximum depth of spoil identified was 12m bgl. Over the two investigations analysis was undertaken on 128 samples and a human health risk assessment was undertaken on samples from the top 1m by Mouchel (2008) screened against Soil Guideline Values and CIEH Generic Assessment Criteria for residential without plant uptake. All contaminants apart from arsenic had a UCL95 below the screening value. Hotspots of benzo(a)pyrene, chrysene, lead, arsenic, nickel, pH, dibenzo(ah)anthracene and naphthalene were encountered that could pose a risk to human health if located in regularly accessed areas;

- A number of determinands exceeded UK drinking water standards and Environmental Quality Standards; and
- The presence of Japanese Knotweed and Himalayan Balsam were noted in the 2008 report.

Baker-Barnett – Coal Mining - Risk Assessment Report for the Proposed Development to form a Country Park on Land Situated at The Former Cronton Colliery, instructed June 2015. Ref 15/NSB/SB/2572^{xiv}

- 3.6.3 Baker Barnett prepared a Coal Mining Risk Assessment for use as part of a planning application in respect of the proposed development of a country park at the former Cronton Colliery site. As part of this assessment, a Non Residential Coal Authority Coal Mining Report was acquired dated 8th June 2015 (ref 51000903234001). Pertinent excerpts of the reporting are quoted below. Note this report covers the former Cronton Colliery site only – covering the south-eastern two thirds of the Land South of M62 site only with a narrow strip to the north-west associated with the former Mineral Railway
- 3.6.4 They note that the 3ft seam outcrops through part of the site. *“It is possible that the 3ft seam may have been exploited in the past by shallow un-charted coal mine workings, extending some 140m from the outcrop to the south west” (referring to shallow workings as <30m deep the distance of 140m is derived from a dip of 1 in 4.5, a vertical dimension of 30m and + 5m to account for the ground not being level). The area where shallow old mine workings may exist is classed by the Coal Authority as a development high risk area. “If it is proposed to construct any buildings or structures in the area where shallow mine workings may be present, we would recommend that the area is drilled to prove the coal seam. The probe drilling should also check for voids, which could indicate the presence of unrecorded workings. The Coal Authority’s consent will be required for any such drilling operations.”*
- 3.6.5 A visit to the Coal Authority Mines Records Office in Mansfield was undertaken on the 9th June 2015 by Baker Barnett and the abandoned mine plan records were examined within the vicinity of the site.

- 3.6.6 The depth of coal seams beneath the site (at this specific location) were calculated from the No.1 Shaft section as (below ground level):
- London Delph Seam Level: 134.67m;
 - Crombouke Level: 138.66m;
 - Yard Seam: 161.71m;
 - Florida Inset Level: 206.65m; and
 - Higher Florida Level: 206.79m.
- 3.6.7 In the coal mining report it states that *“the property is in the likely zone of influence from workings in 12 seams of coal at 100m to 670m depth and last worked in 1976. Any ground movement from these coal workings should have stopped by now.*
- 3.6.8 *“There may be un-recorded mine shafts (bell pits) or adits near the outcrop of the 3ft seam. If any earth moving or landscaping works, are to take place within the vicinity of the 3ft coal seam outcrop, we would recommend that whilst the top-soil is being stripped and excavations are being carried out, the ground should be checked visually for anomalies and signs of bell pits, old mine shafts or adits.”*
- 3.6.9 *“The mine workings are known to be flooded. The water level in the workings was measured in September 2013, at a depth of 119m below ground level, in a borehole drilled down to the London Delph Seam horizon, on the site, by Alkane Energy. The surface level of the borehole is about 29 m A.O.D, which would put the water level in September 2013 at 90 m below A.O.D.”*
- 3.6.10 *“Any methane pushed out from the working by risking mine water or emitting from the coal left underground by atmospheric pressure should be safely vented to the general air by the steel tubes through the mine shaft caps; the same can be said for carbon dioxide gas, which is likely to be present above the mine water.”*
- 3.6.11 *“Provided that the 3ft coal seam is not exposed at the surface, there should be no risk of spontaneous combustion or ignition of coal which may lead to the production of carbon monoxide, which would affect the proposed development. However if coal is found in the ground, during excavation,*

landscaping or earthworks, it should not be exposed, until the advice of a suitably qualified person has been sought.”

3.6.12 They note *“the Coal Authority’s consent must also be obtained before any coal is excavated, disturbed or intersected.”*

3.6.13 *“It would be prudent for the developer and owner of the site to liaise with the Coal Authority to check the level of the minewater, over time until it stabilises.”*

4 Qualitative Contaminated Land Assessment

4.1 Regulatory Context

- 4.1.1 The legislative regime under which historic contaminated land is managed in the UK is Part 2A of the Environmental Protection Act (EPA), 1990. The framework for the assessment of potential land contamination adopted in this report is based on current guidance documents regarding the implementation of Part 2A of the EPA and the assessment of potentially contaminated land, with particular reference to:
- Department of the Environment Food and Rural Affairs (DEFRA) (2012)^{xv}: “*Environmental Protection Act 1990: Part 2A, Contaminated Land Statutory Guidance*”, April 2012;
 - Environment Agency (2009)^{xvi}: “*Human Health Toxicological Assessment of Contaminants in Soil*”, Science Report – SC050021/SR2;
 - Environment Agency (2009)^{xvii}: “*Updated Technical Background to the CLEA Model*”, Science Report - SC050021/SR3;
 - British Standard (BS) 10175:2011^{xviii}, “*Investigation of Potentially Contaminated Sites*”;
 - Environment Agency (2012)^{xix}. “*Groundwater Protection Policy and Practice, GP3*”;
 - NHBC, EA, CIEH (2008)^{xx}: “*Guidance for the Safe Development of Housing on Land Affected by Contamination*”, R&D Publication 66: 2008
 - Department for Communities and Local Government (2012)^{xxi}: “*National Planning Policy Framework*”.
- 4.1.2 Part 2A principally deals with sites where individual historic contamination linkages present a “Significant Possibility of Significant Harm” (SPOSH) or a Significant Possibility of Significant Pollution to Controlled Waters (SPOSPCOW) representing an unacceptable level of contamination risk for each linkage. The Part 2A clean-up is the minimum which can be done on a cost basis to make and keep the site in a “just safe” condition for an existing use.
- 4.1.3 Elimination of liability under Part 2A is not always achievable largely because of the inherent risk basis of the statutory regime, the technical difficulty in establishing levels of contamination that are likely to represent SPOSH, and the variable distribution of contamination at many sites. Statutory guidance on Part 2A (DEFRA, 2012) recognises that sites require prioritisation by Local

Authorities under the statutory Part 2A site inspection programme to ensure that only those sites likely to present the greatest risks are identified. However it should be recognised that considerable investigation is often required to establish whether sites are likely to meet the definition of contaminated land under Part 2A. Such investigation may be beyond the scope of project budgets for nominally “low risk sites” necessitating judgement on an acceptable level of investigation. Since the designation of Contaminated Land is the responsibility of the Local Authority, it is advised that consensus is sought on any recommendations regarding the significance of contaminated land risks and remedial measures through consultation with the Regulator(s).

- 4.1.4 Section 161 of the Water Resources Act 1991 states that the EA can recover clean-up costs on person(s) who caused or knowingly permitted the entry or presence of any poisonous, noxious or polluting matter or any solid waste into controlled waters.
- 4.1.5 Contamination and environmental considerations are studied by developing a conceptual model that describes the environmental features of the SUE together with the expected interaction of potential contamination sources and the wider environment.

4.2 Planning Context

National Planning Policy

- 4.2.1 New development is regulated under the Town and Country Planning Act 1990 (as amended). This regime provides a mechanism for the planning authority to enforce the proper investigation of a development site in order to ensure that once development has occurred the site is suitable for its intended use. In England, the National Planning Policy Framework (NPPF, Department for Communities and Local Government, 2012)^{xxi} provides guidance on the implementation of contaminated land and pollution management requirements to address contamination risks associated with future site uses through the planning system. Paragraphs 120 and 121 of the NPPF state the following:
- 4.2.2 *“120: To prevent unacceptable risks from pollution and land instability, planning policies and decisions should ensure that new development is*

appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

- 4.2.3 121. *Planning policies and decisions should also ensure that:*
- *the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*
 - *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990”*

Local Planning Policy Guidance

- 4.2.4 The Knowsley Local Plan Core Strategy was adopted in January 2016^{xxii}. Under the transitional arrangements for moving to the Local Plan system, the vast majority of the previous Knowsley Replacement Unitary Development Plan (UDP, adopted June 2006) policies were “saved” by the Secretary of State on 12 June 2009.
- 4.2.5 The Local Plan Core Strategy Appendix C gives a full schedule of which UDP Policies continue to be saved including the following policy on contaminated land:
- 4.2.6 **“POLICY ENV5: CONTAMINATED LAND**
- *1. New development will not be permitted if there is existing contamination on the site which could, as a result of the proposed development, place the occupiers or users of the development, ecological systems, the water environment or surrounding land uses at unacceptable risk.*
 - *2. Where there is evidence that a site may be unacceptably affected by contamination, proposals shall be accompanied by a site investigation report and schedule of remedial measures.*

- 3. *Where remedial measures are necessary then a verification report must be submitted before the development is brought into use to demonstrate that remedial work has been satisfactorily completed.*
- 4. *Where on-going monitoring and risk assessment are necessary, reports must be submitted to the Council on an agreed basis. The developer must undertake any further investigations or remedial measures which the risk assessment shows to be required.”*

4.3 Qualitative Contaminated land Risk Assessment

- 4.3.1 A qualitative risk assessment in accordance with NHBC, EA, CIEH (2008)^{xx} has been undertaken.

Conceptual Model – Identified Potential Sources, Pathways and Receptors

- 4.3.2 A key element of the geo-environmental (contaminated land) risk assessment is the development of a conceptual model which is done undertaking a Source-Pathway-Receptor analysis of the SUE:
- Sources (S) are potential or know contaminant sources e.g. a former land use;
 - Pathways (P) are environmental systems through which a contaminant could migrate e.g. air, groundwater; and
 - Receptors (R) are sensitive environmental features that could be adversely affected by a contaminants e.g. Site occupiers, groundwater resources.
- 4.3.3 When a source, relevant pathway and receptor are present, a contaminant linkage is considered to exist whereby there is a circumstance through which environmental harm could occur and a potential environmental liability is created. The sources, pathways and receptors expected on the SUE are summarised below.

Non-Asbestos Potential Sources of Contamination

Table 4.1: Potential Sources of Contamination

Source	South of Whiston	Land South of M62	Likely Contaminants
S1 - Made ground/contaminants associated with former/current (non-mining) development	Electricity sub-station and pump house present on mobile home park. Made Ground is likely to be present at the site of the former Halsnead House and current mobile home park. Potential for chemicals associated with recent agricultural activity on-site farmland. Fly tipping/waste burning on site.	Likely to be present in the vicinity of Old Halsnead, Halsnead Farm and Villas in the north-east. Made Ground may be present at the base of the electricity transmission line pylons. Chemicals associated with recent agricultural activity on-site.	Unknown for the South of Whiston site, although hydrocarbons and PCBs may be associated with historic electricity sub-stations. For the Land South of the M62 site, previous investigations encountered: alkaline conditions and slightly elevated zinc levels were identified on non-mining areas in a previous investigation.

Source	South of Whiston	Land South of M62	Likely Contaminants
S2 - Made Ground associated with former coal mining	Former coal pit area to the south of Prince's House Farm and unidentified former mining activity associated with recorded mine entries to the north and north-east of the mobile home park. Line of former mineral railway crosses the south-west of the site.	Former Cronton Colliery site including re-distributed spoil plateaux and line of former mineral railway. Former lagoon dredgings understood to have been re-distributed across spoil plateaux.	Unknown for the South of Whiston site although likely to include elevated metals, sulphate, polycyclic aromatic hydrocarbons (PAHs) and acidic conditions. For the Land South of the M62 site, previous investigations encountered: elevated concentrations of arsenic, copper, lead, boron, phenol, PAH, naphthalene, chrysene, benzo(a)pyrene, dibenz(ah)anthracene, along with acidic and alkaline conditions, (and phytotoxic zinc and boron levels) were identified in the area of the former Cronton Colliery. In addition, coal fragments remaining in colliery spoil have a high loss on ignition (LOI) up to 70% - which means they are likely to be combustible.

Source	South of Whiston	Land South of M62	Likely Contaminants
S3 - Potential for in-filled land	'Potter's Pits' was in-filled by 1977. The former coal pit to the south of Prince's House Farm and mine entries to the north and north-east of the mobile home park may also contain in-filled land.	Former brook, reservoir and lagoon areas have been in-filled following closure of Cronton Colliery, (assumed with mine spoil only). Former Ravenhurst Pits, Sour Hey Pit and brick works excavations historically present on site have all been in-filled (1967-1977).	Assuming the in-filled areas were with colliery spoil for land South of M62 and with coal mining arisings (former coal pit and mine entries) or M62 arisings (Potter's Pits) for the South of Whiston site.
S4 - Potential for buried structures	Eight mine entries present on site, potential for underground structures associated with former coal mining. Underground structures may also be present at the site of the former Halsnead House.	Underground storage tank (UST) associated with former Cronton Colliery fuel pump may still be in situ. Other USTs may be present including any associated with small package sewerage treatment plant. Three mine shafts located in centre of site.	Potential for hydrocarbon contamination at former petrol pump UST (naphthalene encountered in previous investigation). Unknown for others.
S5 - Contaminated leachates generated on-site	Associated with abandoned mine workings and Coal Measures beneath the site.	Associated with abandoned mine workings and Coal Measures beneath the site.	According to previous investigations on the former Cronton Colliery site: elevated iron, sulphide, total petroleum hydrocarbons (TPH), gasoline range organics (GRO), benzo(a)pyrene and PAH.

Source	South of Whiston	Land South of M62	Likely Contaminants
S6 - Contaminated leachates generated off-site	Potentially associated with historic landfill adjacent to the north-west and former collieries, brick works and abandoned mine workings. Also potentially associated with Made Ground on site and current/historic site uses.	Potentially associated with former quarry (EA landfill site) to the south and adjacent abandoned mine workings. Also potentially associated with Made Ground on site and historic site uses.	Unknown.
S7 - Ground/mine gases generated on-site	Associated with abandoned mine workings and Coal Measures beneath the site along with any other strata containing elevated quantities of organic matter.	Associated with abandoned mine workings and Coal Measures beneath the site along with any other strata containing elevated quantities of organic matter.	Methane, carbon dioxide principally from mine gas sources. Also carbon monoxide. The SUE is in an area affected by radon gas.
S8 - Ground/mine gases generated off-site	Potentially associated with historic landfill adjacent to the north-west and abandoned mine workings.	Potentially associated with landfill adjacent to the south and abandoned mine workings.	Methane, carbon dioxide principally from mine gas sources. Also carbon monoxide. Potential for hydrogen sulphide from off-site landfills. The SUE is in an area affected by radon gas.
S9 - Potential for unexploded ordnance (UXO) to be present	Unknown UXO.	Unknown UXO.	Explosive risk.

Source	South of Whiston	Land South of M62	Likely Contaminants
S10 - Potential for site soils to contain invasive species (stem, crown, rhizome, seeds)	No invasive species were identified during the site walkover, however this does not preclude their presence.	Himalayan Balsam observed on site during walkover, other studies report presence of Japanese Knotweed.	Japanese Knotweed, Himalayan Balsam.

Source: Sections 2 and 3

Potential for Asbestos Presence

- 4.3.4 There is the potential for asbestos to be present at locations of previous demolition and areas of fly tipping, for example, the area of the former Halsnead House (current mobile home park) and the former location of Cronton Colliery buildings.
- 4.3.5 Mott MacDonald is not insured for, and therefore cannot undertake surveys to identify or provide any guidance on the treatment of, asbestos. Should the presence of asbestos contamination be suspected a specialist contractor should be appointed to provide advice on the management of asbestos contamination. Please refer to the Disclaimer presented in Appendix C.

Potential Contamination Transport Pathways

- P1 - Human uptake pathways:
 - Inhalation of indoor and outdoor dust and vapours;
 - Direct soil and dust ingestion;
 - Consumption of home grown produce and soil attached to home grown produce
 - Dermal contact indoors and outdoors;
- P2 - Vertical migration of leachates in the unsaturated zone;
- P3 - Vertical and horizontal migration of contaminants in the saturated zone;

- P4 - Engineered contaminant transport pathways (e.g. piling for foundations, drainage runs);
- P5 - Overland flow (where surfacing/geology is impermeable or saturated);
- P6 - Direct contact with construction materials;
- P7 - Horizontal and vertical migration of ground/mine gases (also via abandoned mine workings and geological faults as well as natural migration);
- P8 - Ground/mine gas accumulation in voids, buildings and confined spaces;
- P9 - Plant uptake pathways ;and
- P10 - Wind-blown dusts.

Potential Receptors

- R1 - Future site users – occupiers of residential properties across the site and employees within any commercial development/users of the proposed country park across the southern site;
- R2 - Construction and maintenance workers of the proposed SUE;
- R3 - Users of adjacent sites, particularly adjacent residential properties, schools and farmland;
- R4 - Groundwaters – the bedrock Principal Aquifer and SPZ3 beneath the eastern third of the SUE and to a lesser extent the Secondary (A/undifferentiated) Aquifers present as bedrock beneath the western two-thirds of the SUE and within the superficial deposits across the site;
- R5 - Surface waters – Particularly Chapel Brook and Fox's Bank Brook along with numerous small streams, drains and ponds across the SUE;
- R6 – Buried and surface future structures and infrastructure associated with the new SUE development, including concrete foundations; and
- R7 - Fauna and flora.

4.4 Preliminary Qualitative Risk Assessment including Initial Conceptual Model

- 4.4.1 For each potential source-pathway-receptor linkage identified (conceptual model), the potential risk has been evaluated for receptors, based on the

probability of the linkage occurring, and its relative severity. The result of this assessment is presented in Table 4.2. The methodology for the assessment is presented in Appendix D.

Table 4.2: Qualitative Contaminated Land Risk Assessment (Note: Risk is initial assessment prior to any future investigation and mitigation)

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
S1 - Made ground/contaminants associated with former/current development S2 - Made ground associated with former coal mining S3 - Potential for in-filled land	R1 - Future site users	P1 - Human uptake pathways P10 - Wind-blown dusts	Medium	Likely	Moderate	Following development and the intended use of the SUE as residential housing, commercial properties and a country park, without remediation it is likely that end users will come into direct contact with contaminated soils (particularly in garden areas)

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
<p>S7 - Ground/mine gases generated on-site</p> <p>S8 - Ground/mine gases generated off-site</p>	R1 - Future site users	<p>P1 - Human uptake pathways</p> <p>P4 - Engineered contaminant transport pathways</p> <p>P7 - Horizontal and vertical migration of ground/mine gases</p> <p>P8 - Ground/mine gas accumulation in voids, buildings and confined spaces</p>	Medium	Likely	Moderate	<p>and/or potentially noxious/explosive ground/mine gases. The SUE is also in an area affected by radon gas. Engineered contaminant pathways may also be created during construction. Therefore the risk is considered to be MODERATE.</p>

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
<p>S1 - Made ground/contaminants associated with former/current development</p> <p>S2 - Made ground associated with former coal mining</p> <p>S3 - Potential for in-filled land</p>	<p>R2 - Construction and maintenance workers</p>	<p>P1 - Human uptake pathways</p> <p>P10 - Wind-blown dusts</p>	<p>Severe</p>	<p>Likely</p>	<p>High</p>	<p>Given the nature of their work, it is likely that construction and maintenance workers will come into contact with soils and ground/mine gas during site clearance, preparation, construction and maintenance. Ground/mine gases pose an elevated risk in enclosed spaces,</p>

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
S7 - Ground/mine gases generated on-site S8 - Ground/mine gases generated off-site	R2 - Construction and maintenance workers	P1 - Human uptake pathways P4 - Engineered contaminant transport pathways P7 - Horizontal and vertical migration of ground/mine gases P8 - Ground/mine gas accumulation in voids, buildings and confined spaces	Severe	Likely	High	particularly during foundation construction. Until further information is obtained about gas concentrations, the contamination status of the SUE and UXO risk, the risk to site workers is considered to be HIGH. It should be noted that risks to site workers can be mitigated through safe working practices.
S9 - Potential for unexploded ordnance (UXO)	R2 - Construction and maintenance workers	P1 - Human uptake pathways (direct contact)	Severe	Likely	High	

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
<p>S1 - Made ground/contaminants associated with former/current development</p> <p>S2 - Made ground associated with former coal mining</p> <p>S3 - Potential for in-filled land</p>	R3 - Users of adjacent sites	<p>P1 - Human uptake pathways</p> <p>P10 - Wind-blown dusts</p>	Mild	Low	Low	<p>Prior to any mitigation, contaminants present within site soils may be able to migrate to adjacent sites though wind-blown dusts (especially in the colliery spoil areas where vegetation is somewhat sporadic).</p> <p>Ground gases generated on-site within abandoned coal workings/Coal Measures have the potential to migrate off-site via to network of coal mines, geological faults and geological strata. However, much of the local area itself has been constructed upon abandoned coal mines.</p> <p>The risk to users of adjacent sites is therefore considered to be LOW.</p>
S7 - Ground/mine gases generated on-site	R3 - Users of adjacent sites	<p>P1 - Human uptake pathways</p> <p>P7 - Horizontal and vertical migration of ground/mine gases</p> <p>P8 - Ground/mine gas accumulation in voids, buildings and confined spaces</p>	Mild	Low	Low	<p>Prior to any mitigation, contaminants present within site soils may be able to migrate to adjacent sites though wind-blown dusts (especially in the colliery spoil areas where vegetation is somewhat sporadic).</p> <p>Ground gases generated on-site within abandoned coal workings/Coal Measures have the potential to migrate off-site via to network of coal mines, geological faults and geological strata. However, much of the local area itself has been constructed upon abandoned coal mines.</p> <p>The risk to users of adjacent sites is therefore considered to be LOW.</p>

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
<p>S1 - Made ground/contaminants associated with former/current development</p> <p>S2 - Made ground associated with former coal mining</p> <p>S3 - Potential for in-filled land</p> <p>S4 - Potential for buried structures</p> <p>S5 - Contaminated leachates generated on-site</p> <p>S6 - Contaminated leachates generated off-site</p>	R4 - Groundwaters	<p>P2 - Vertical migration of leachates in the unsaturated zone</p> <p>P3 - Vertical and horizontal migration of contaminants in the saturated zone</p> <p>P4 - Engineered contaminant transport pathways</p>	Medium	Likely/High	Moderate/High	<p>The Kinnerton Sandstone is a Principal Aquifer and SPZ, while the Coal Measures and superficial deposits are Secondary (A/undifferentiated). Issues suggest a relatively high/perched groundwater table. In one past investigation on the former Cronton Colliery site, Glacial Till was found to be between 0.5-6.5 m (providing limited protection of the underlying aquifer) and in some places colliery spoil directly overlay bedrock. Given the sensitivity of the receptor, likelihood of contact with contamination and the potential creation of new engineered pathways (e.g. piling, drainage runs) the risk to groundwater within this stratum is considered to be MODERATE (Secondary Aquifers)/HIGH (Principal Aquifer).</p>

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
<p>S1 - Made ground/contaminants associated with former/current development</p> <p>S2 - Made ground associated with former coal mining</p> <p>S3 - Potential for in-filled land</p> <p>S4 - Potential for buried structures</p> <p>S5 - Contaminated leachates generated on-site</p> <p>S6 - Contaminated leachates generated off-site</p>	R5 - Surface waters	<p>P3 - Vertical and horizontal migration of contaminants in the saturated zone</p> <p>P4 - Engineered contaminant transport pathways</p> <p>P5 - Overland flow</p>	Mild	Likely	Moderate/Low	<p>There are numerous surface watercourses, drains and ponds across the SUE. Groundwater within the superficial deposits and shallow bedrock is likely to be in continuity with surface waters. Site development has the potential to directly impact surface waters, however overflows currently drain into Fox's Bank Brook on the Land South of M62 site meaning that surface waters are already being impacted by mine waters. Therefore the risk to surface water receptors is considered to be MODERATE/LOW.</p>

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
<p>S1 - Made ground/contaminants associated with former/current development</p> <p>S2 - Made ground associated with former coal mining</p> <p>S3 - Potential for in-filled land</p> <p>S5 - Contaminated leachates generated on-site</p> <p>S6 - Contaminated leachates generated off-site</p>	<p>R6 – Buried and surface future SUE structures and infrastructure</p>	<p>P6 - Direct contact with construction materials</p>	<p>Mild</p>	<p>Likely</p>	<p>Moderate/Low</p>	<p>Chemical agents that are destructive to concrete may be found in both natural materials and Made Ground. Sulphates and acids occurring in soil and groundwater are the agents most likely to attack concrete. The effects can result in expansion and softening of concrete. Elevated concentrations of sulphate along with acidic/alkaline conditions are known to be present on-site (coal works are associated with elevated pyrite – and hence sulphate levels).</p>

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
<p>S7 - Ground/mine gases generated on-site</p> <p>S8 - Ground/mine gases generated off-site</p>	<p>R6 – Buried and surface future SUE structures and infrastructure</p>	<p>P7 - Horizontal and vertical migration of ground/mine gases</p> <p>P8 - Ground/mine gas accumulation in voids, buildings and confined spaces</p>	<p>Medium</p>	<p>Likely</p>	<p>Moderate</p>	<p>Without mitigation, potentially explosive ground/mine gases can migrate and accumulate in buried structures/confined spaces.</p> <p>Some invasive species, which are believed to be present on site (e.g. Japanese Knotweed) have the potential to grow through structures and impact upon foundations.</p>
<p>S10 - Potential for site soils to contain invasive species</p>	<p>R6 – Buried and surface future SUE structures and infrastructure</p>	<p>P6 - Direct contact with construction materials</p>	<p>Mild</p>	<p>Likely</p>	<p>Moderate/Low</p>	<p>The risks are considered to be LOW/MODERATE, with the former coal mining areas and spoil heaps a higher risk.</p> <p>Note: Historic buildings and structures (Grade II Listed) are known to be present on site which also have the potential to be impacted.</p>

Source	Receptor	Pathway	Consequence	Probability	Risk	Comments
<p>S1 - Made ground/contaminants associated with former/current development</p> <p>S2 - Made ground associated with former coal mining</p> <p>S3 - Potential for in-filled land</p> <p>S10 - Potential for site soils to contain invasive species</p>	R7 - Fauna and flora	P9 - Plant uptake pathways	Mild	Likely	Moderate/Low	<p>Given the potential for contaminants which may impede the growth of vegetation and the proposal to create a new country park on a former colliery site, along with proposals for landscaping and private gardens the risks are considered to be MODERATE/LOW. There are known to be invasive species on site and the inappropriate management of soils could result in their spread.</p>

5 Preliminary Geo-technical Assessment

5.1 General

- 5.1.1 Previous planning applications and supporting documents as discussed earlier within this report, provide significant ground investigation information dating from 1999 for the eastern half of the Land South of the M62, the former Cronton Colliery location, and equally, the M62 construction corridor between the two land parcels contains extensive borehole data. Elsewhere however, published ground data is sparse. The following information is based on publically available borehole records and online resources, as well as information obtained for previous planning applications which is also publically available. Intrusive investigations will be required in order to validate the following information, gain an understanding of the conditions on the wider site and to undertake preliminary and detailed design.
- 5.1.2 This section provides an initial assessment of potential geological hazards and the associated risk.
- 5.1.3 The natural ground model for the site is anticipated to comprise a relatively thin mantle (3-15m) of firm to stiff Glacial Till overlying Middle Carboniferous Coal Measures (beneath the South of Whiston site), and the Upper Coal Measures (beneath the Land South of the M62), with Alluvial Deposits (soft, sandy clays) encountered along the southern boundary of the southern site area, associated with Fox Brook. The Coal Measures are extensively faulted through the region in a N-S trending fault field, with extensional throws of the order of 5-20m, bounded on the eastern side by the Eccleston West fault. 3 faults are detailed to traverse beneath the proposed site. The Coal Measures dip at 120 to the SW, and 7 seams are indicated to outcrop/subcrop at rockhead beneath the site. Of these 6 outcrop within the NE quadrant of the South of Whiston site, whilst 1 seam (the 3ft seam) outcrops/subcrops beneath the SE quadrant of the South of Whiston site and centrally through the Land South of the M62, prior to terminating against the Eccleston West Boundary Fault. Hence both the northern and southern site areas could be susceptible to mining risks.
- 5.1.4 As previously described, there is a significant history of industrial development across both the northern and southern site areas associated with coal mining and associated processes. Shafts, buildings, settlement lagoons, spoil heaps,

drainage galleries, mineral railways and subsequent restoration development plateaux have amended the local topography. Mining plans consulted within previous planning phases and associated historic ground investigations, detail locations for such surface features associated with Cronton Colliery within the southern land parcel, however for the northern land parcel (South of Whiston site), there is a relative paucity of data.

5.2 Geological Hazards

- 5.2.1 No historical mining records have been obtained for the site north of the M62, with historical records only being reported for the former Cronton Colliery site, south of the M62. A large majority of the site is within a Surface Coal Resource Area and a Development High Risk Area. It is therefore recommended that a detailed Coal Authority Risk Assessment is obtained for the whole site.
- 5.2.2 Coal Authority Report (Ref 51000903234001) obtained by Baker and Barnett Ltd for the Cronton Colliery site, reported that this eastern portion of the Land South of the M62 is “*within the likely zone of influence of 12 seams of coal at 100-670m depth, last worked in 1976; any ground movement associated with such workings should have ceased by now.*” The hazard due to ground subsidence associated with deep mining is therefore deemed low, nevertheless as discussed above, seven seams are detailed to outcrop/subcrop within the wider site, specifically as follows: 3ft, Lyons Delf, Felcroft Mine, Pastures Mine, Earthy Delf, Higher Florida Mine, Lower Florida Mine. The Coal Authority Report acknowledges this as follows: “*the property is in an area where the Coal Authority believe there is coal at or close to the surface. This coal may have been worked at some time in the past. The potential presence of coal workings at or close to the surface should be considered prior to any site works or future development activity*”.
- 5.2.3 Considering shallow mining risk, the main hazard is collapse of old workings. A rule of thumb is that collapse migration generally extends 10x coal seam thickness above the working; should collapse migration reach rockhead then settlement or indeed collapse (sinkhole) of overlying superficial soils can occur. Considering typical seam thicknesses are of the order of 0.6-1.5 m, adopting the higher value, a potential hazard to foundations exist where

worked seams are evident within 15 m of rockhead. As previously discussed, ground conditions within the southern land parcel have previously been investigated, however north of the M62 (South of Whiston site), no historic investigation data is available. Reviewing regional data, superficial deposits are anticipated to be of the order of 3-15 m thick, hence it would therefore be prudent to assume that shallow mining risk could be influenced by worked seams within 30 m of the site platforms/existing ground levels. Applying this risk to plan views of mapped outcrop/subcrop of coal seams assuming a 12° dip to the south-west, the hazard zone extends 140 m south-west of the mapped outcrop locations.

- 5.2.4 Deep mining hazard is likely to be restricted to the potential of encountering an unidentified mine shaft or the collapse of a shaft, or the migration of mine gas. As discussed earlier there are a minimum of three capped shafts associated with Cronton Colliery and numerous shafts associated with earlier workings on the South of Whiston Site. All mine entry points as designated by the Coal Authority are provided on the Geo-Environmental and Geo-Technical Constraints Plan (Appendix A).
- 5.2.5 Non-mining geo-technical risks are standard risk for such 'brownfield' development sites. Alluvial Deposits or backfilled sludge lagoons, identified within the Land South of the M62 will have the potential for consolidation and induced settlement or bearing failure, and potential for gas generation. All Made Ground areas will also have risk of variable composition, variable compactive effort and variable distribution which could lead to both total and differential settlement concerns. Again gas generation could be an issue depending upon the Made Ground composition and flammability potential will require consideration. Sub-surface obstructions associated with the former industrial uses across the site pose a risk to foundation options.

5.3 Geo-technical Risk Register

- 5.3.1 Table 5.1 summarises potential geo-technical risks identified at this desk-top study stage. Quantification of risk will require further investigation.

Table 5.1: Summary of Geo-Technical Risk

Geological Formation	Engineering Hazards
Made Ground (Including Colliery Spoil)	<ul style="list-style-type: none"> ■ Variations in Made Ground composition, thickness and strength therefore resulting in differential and/or excess settlement; ■ Potential for perched water within Made Ground deposits; ■ Variable pore water pressure; ■ Presence of previously unrecorded settlement lagoons and buildings associated with the former collieries; ■ Obstructions (tyres and timber encountered during previous GI, potential for boulders); ■ High Loss on Ignition (LOI), up to 70% with many greater than 25%, suggests high potential for combustion of several areas of Made Ground; and ■ High sulphate content suggests risk to concrete foundations.
Superficial Deposits (Devensian Till and Alluvium)	<ul style="list-style-type: none"> ■ Hard bands may cause obstructions to piling activities; ■ Variable thickness – sometimes not present; and ■ Variable composition - potential variations in strength of deposits leading to differential settlement.
Pennine Middle Coal Measures	<ul style="list-style-type: none"> ■ Highly variable rockhead level due to potential surface coal workings and infill with colliery spoil; ■ Presence of pyrite indicates potential issues with aggressivity towards concrete foundations; ■ Shallow coal working of the 3ft seam encountered in previous GI within Coal Authority High Development Risk Area, although not recorded; ■ Several extensively worked seams at various depths indicated on Coal Authority Plans, potential for collapse and subsidence; ■ 3 No. capped coal shafts visually identified on site, with more potential entries identified by Coal Authority mapping to the north; and ■ There may be economically viable coal resources still present beneath the site. These will be sterilised if development goes ahead.

6 Conclusions and Recommendations

6.1 Conclusions

- 6.1.1 A plan detailing the geo-environmental and geo-technical constraints across the SUE suitable to be represented visually is included within Appendix A which should be used in conjunction with this report.
- 6.1.2 Any development of the site will have to address the source-pathway-receptor linkages and associated risks identified in Table 4.2 along with the geo-technical risks as detailed in Table 5.1.
- 6.1.3 It is recommended that further data be sourced and additional desk based assessment be undertaken as outlined in Section 6.2 in order to inform and refine the existing geo-environmental and geo-technical risk assessments and design an intrusive ground investigation (GI) which should be carried out in order to fully investigate the constraints associated with the SUE.
- 6.1.4 It should be noted that the former and current SUE uses have the potential to warrant remedial action both geo-environmentally and geo-technically. Ground conditions across the Land South of Whiston require further investigation to determine the ground model and geo-technical parameters for geo-technical design. Made Ground extent and composition forms the greatest uncertainty for future development; other than mining risk, the natural ground deposits are likely to be low risk.
- 6.1.5 The recommendations in Section 6.2 are intended to resolve uncertainties in relation to cost of any mitigation and remediation which may be required.

6.2 Recommendations

Recommendations for Further Desk Based Assessment

- 6.2.1 The following actions are recommended to inform future GI and planning applications as part of an expanded desk study in order to confirm the findings of the current study and to adequately design forthcoming intrusive GI:
- Consultation with the Knowsley Council planning department and Contaminated Land Officer should be undertaken to source the reports missing from the planning portal in relation to the previous investigation at

Cronton Colliery which took place in 2004. If appropriate permissions for data usage are given, the data from the 1999 and 2004 investigations should be extracted and re-assessed against current standards appropriate to the proposed end-use of the Land South of M62 site. This will provide a more accurate picture of the baseline contamination status of this site and allow a detailed GI to be designed in this area, targeting areas of concern and identifying data gaps. If the data is available in AGS/excel format it will speed the process up considerably; and

- A Coal Authority Report should be obtained for the SUE in its entirety to inform a Coal Mining Risk Assessment (CMRA). While a CMRA is available for the former Cronton Colliery site, it was written specifically for a previous development and does not include the western section of the Land South of M62 site or the South of Whiston site. The CMRA will inform the GI design, particularly across the South of Whiston site in the area of the former coal pit to the south of Prince's House Farm and the mine entries to the north of the mobile home park. Abandoned mine plans should be acquired for the whole of the SUE area;
- Gas emission data from the three mine shafts in the centre of the former Cronton Colliery site has been monitored previously as part of an investigation by the Coal Authority into the commercial extraction of methane. In addition, permission was granted for the drilling of a 'GOB' gas monitoring well at the site in 1999 (it is not known if this venture went ahead). It is recommended that the Coal Authority be approached to enquire as to whether this data would be available to inform further ground gas investigation and assessment; and
- Advice should be sought from a certified Unexploded Ordnance (UXO) Consultant to determine the site-specific risk with regard to UXO and requirement for survey.

Ground Investigation Recommendations

- 6.2.2 Given that the geo-environmental and geo-technical ground conditions will directly impact upon the final end-use and costs of development in specific areas of the site, to inform any future planning applications, targeted GI is recommended to be undertaken across the high risk areas which are more ground condition sensitive to choice of development (see paragraphs 6.2.3

and 6.2.4 for more detail). Non-targeted GI is recommended to be completed across the lower risk (previously undeveloped) areas to determine a site baseline.

Geo-Environmental Investigation Objectives

6.2.3 The GI should address the following contamination objectives:

- To obtain contamination data to progress a Generic Quantitative Risk Assessment sufficient to assess the source-pathway-receptor linkages and risks identified in Table 4.2 for the redevelopment of the SUE, including (but not limited to):
 - To obtain data on the contamination profile of the Made Ground, any colliery spoil and in-filled land on the South of Whiston site, specifically targeting known areas of former mining to the south of Prince's House Farm and the north of the mobile home park along with the in-filled Potter's Pits, electricity sub-station and pump house (following closure of the mobile home park) and any areas of waste burning; and
 - To obtain data confirming the contamination profile of the Made Ground, in-filled land and colliery spoil on the Land South of the M62 site (including the former Sour Hey Pit, brick works excavations, in-filled reservoir, lagoons and former Ravenhurst Pits) following a full review of existing data, along with filling in any data gaps. Ideally the suspected petrol pump UST should also be investigated further.
- To obtain data to quantify risks to hydrogeological contamination receptors on site. In particular, to assess risks to the Sandstone Principal Aquifer and across the eastern third of the site;
- To obtain data to progress the assessment of surface water contamination risks from leachates generated on-site and groundwater baseflow;
- To undertake a scheme of initial monitoring for ground/mine gases across the entire SUE at a level and frequency in accordance with BS8576:2013^{xxiv} and CIRIA C665^{xxiii}; and
- To undertake an exploratory GI as defined by BS10175:2011^{xviii}.

Geo-technical Investigation Objectives

6.2.4 The GI should address the following geo-technical objectives:

- To investigate the extent of shallow mine-workings within the identified hazard zones and consider identification of non-visible mine-entry points within the SUE;
- To investigate any existing spoil heaps or backfilled former sludge lagoon areas for material composition, distribution, compressibility and potential for engineering re-use;
- To investigate historic building locations to determine the presence or otherwise of buried foundations and/or floor slabs;
- To establish the depth to rockhead across the site and the nature and distribution of superficial deposits, including the potential for sand bands within the Glacial Till; and
- To obtain geo-technical samples for laboratory testing to determine strength, stiffness, compressibility, potential for material re-use and aggressivity to concrete.

Ground Investigation Scope

- 6.2.5 Note: The GI recommendations are based on current information on the SUE. It is recommended that the GI scope is reviewed against the findings of the further desk based assessment discussed previously.
- 6.2.6 It is recommended that, on completion of additional desk study actions, a GI specification and design are formulated in accordance with BS10175:2011^{xviii} and BS 8575:2013^{xxiv} to cover the contamination investigation design aspects and BS5930:2015^{xxv} to cover geo-technical investigation design aspects. The GI specification should be based on the Thomas Telford UK Specification for GI.
- 6.2.7 It is recommended that the general geo-environmental scope of intrusive GI should comprise the following:
- Detailed site walkover to identify potential access/feasibility issues in advance and ensure all investigation locations are accessible;
 - Cable percussion boreholes (some with rotary follow-on), Cone Penetration Tests (CPT's) and trial pits to obtain information regarding:
 - The on-site presence, distribution and nature of Made Ground, colliery spoil, in-filled materials, Glacial Till/Alluvium and the exact location of

the boundary between the Coal Measures and Kinnerton Sandstone bedrocks;

- Environmental samples of soil should be taken and the risks identified in the qualitative contamination risk assessment investigated in relation to the development of the site through appropriate total soil and leachate extract testing of soils. The testing should include contaminants of potential concern based on current and historical land uses;
 - Groundwater and gas monitoring installations will be required within boreholes to allow groundwater levels and noxious/explosive gas concentrations and flow rates to be monitored over an extended period of time;
 - Groundwater should be sampled from standpipes to assess its contamination status, particularly in areas of identified potential contamination sources;
 - Surface waters should be sampled from Big Water, Chapel Brook, Fox's Bank Brook along with other drains, overflows and ponds across the SUE to determine the impact local groundwater and the legacy of coal mining is having on surface waters;
 - Samples of blacktop material on-site should be taken and tested to determine the type of binder (to determine whether the material is classed as hazardous or not); and
 - Additional leachate testing will be required in accordance with BS EN 12457-2 for assessing the suitability of material for disposal to off-site landfill where appropriate (although soil treatment facilities are more sustainable and cost-effective).
- Investigation should only take place following advice from a UXO consultant and clearance of any identified invasive species within the investigation locations/access paths.

6.2.8 The geo-technical scope of intrusive GI is recommended to comprise the following:

- Total and water soluble sulphate contents of soil and groundwater should be measured to assess aggressivity of the ground to buried concrete in accordance with BRE Special Digest 1^{xxvi} Standards;

- In-situ testing comprising of Standard Penetration Testing. These tests should be undertaken in all boreholes at appropriate spacing to provide information for assessment of geotechnical parameters; and
- Samples of Made Ground, superficial deposits and bedrock should be subject to geotechnical classification, compressibility, strength and earthworks testing to inform earthworks and foundation design.

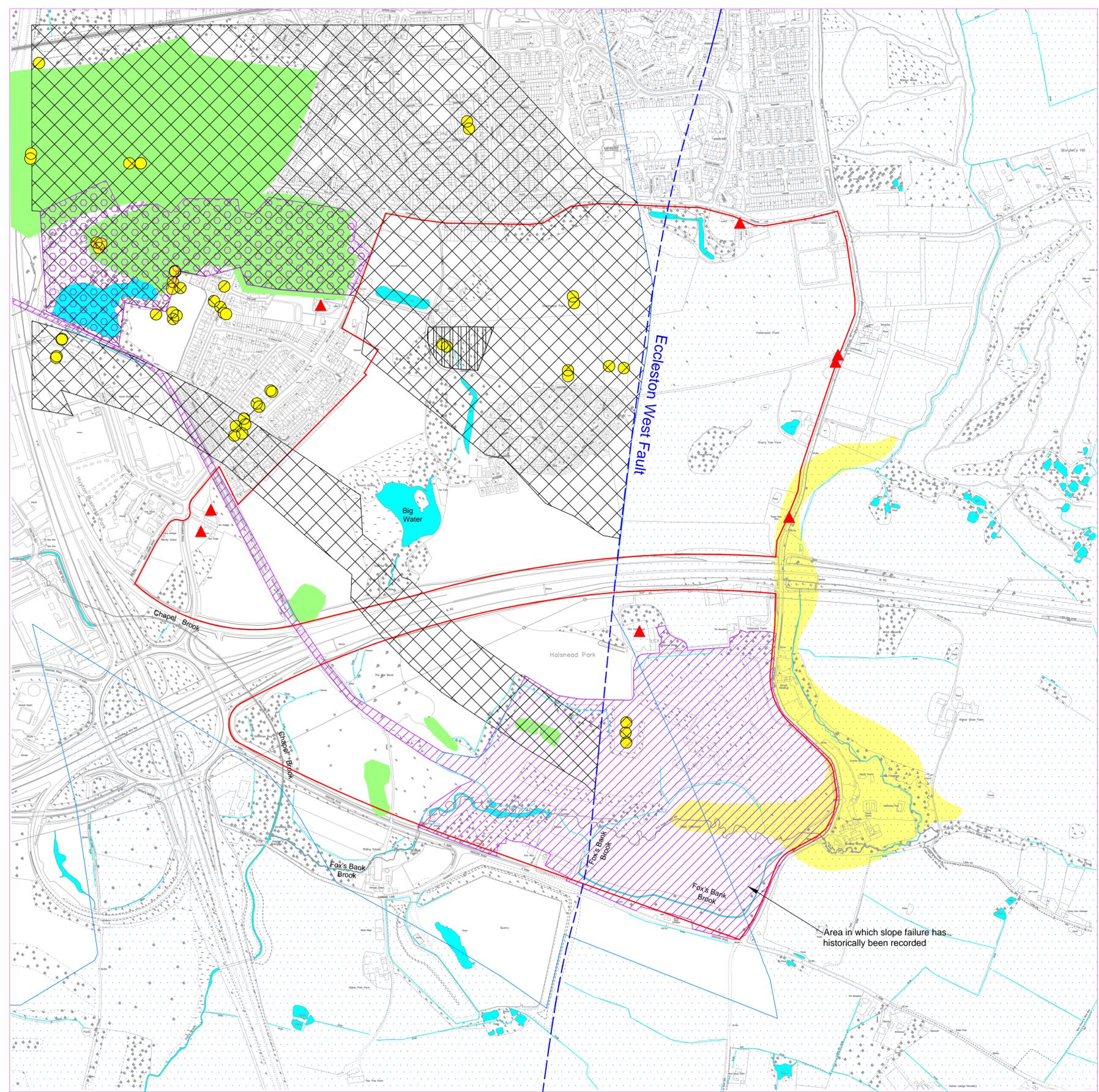
Interpretative Scope

- 6.2.9 It is recommended that a Generic Quantitative Contamination Risk Assessment (GQRA) (defined under CLR 11^{xxvii}) is undertaken following receipt of the GI data in order to verify the risks along the potential contamination linkages identified in section 5.4. While it would not be appropriate to undertake a remediation strategy at the current stage, the aforementioned GQRA would allow the approximate scope of remediation to be determined for costing purposes.
- 6.2.10 Interpretative reporting may also include comments on the scope of development abnormalities relating to physical (geotechnical) properties of the Site which may affect the foundation design and the suitability of earthworks and landscaping materials on site for retention and re-use in the scheme.

Appendices

A.	Figures _____	79
B.	Site Photos _____	80
C.	Disclaimer _____	95
D.	Contaminated Land Risk Assessment Methodology _____	97
E.	References _____	103

A. Figures



Notes

This drawing is to be viewed in conjunction with MM Report 373379/BNI/MNS/GE/A August 2016: South of Whiston and Land South of the M62 - Phase 1 Geo-Environmental and Geo-Technical Risk Assessment

Key to symbols

	Mine Entries (Approximated from Coal Authority Interactive Viewer)
	Listed Buildings
	Coal Authority Development High Risk Area (Approximated from Coal Authority Interactive Viewer)
	Surface Mining - Past and Current (Approximated from Coal Authority Interactive Viewer)
	Potentially Infilled Land - Clay Extraction (Data provided by Knowsley Council)
	Former Coal Pit (Approximated from historic mapping)
	Former Cronton Colliery and associated mineral railway, Local Geological Site 85, to west (Approximated from historic mapping)
	Principal Aquifer and Groundwater Source Protection Zone (Approximated from BGS mapping)
	Surface Water Features (OS Open Data)
	Alluvial Deposits (BGS Map Sheet 97, Drift, 1977)
	Approximate Location of Geological Fault (BGS Mapping)
	Proposed Site Boundary

Reference drawings

The Coal Authority Interactive Map Viewer App, Available at: <http://mapapps2.bgs.ac.uk/coalauthority/home.html>

British Geological Survey of Great Britain Map Sheet 97 1:50,000 Series Drift Edition, 1977 Available at: <http://www.bgs.ac.uk/data/maps/>

British Geological Survey of Great Britain Map Sheet 97 1:50,000 Series Solid Edition, 1980 Available at: <http://www.bgs.ac.uk/data/maps/>

Contains OS data © Crown Copyright [and database right] (2016).

*Ordnance Survey © Crown copyright. All rights reserved. Licence number *****

P3	10/01/2017	N.B	Listed buildings added	N.S	C.W
P2	08/09/2016	N.B	Hatching amended for clarity	N.S	C.W
P1	15/08/2016	N.B	Preliminary Issue	N.S	C.W
Rev	Date	Drawn	Description	Ch'k'd	App'd



5 Woodland Road West
Colwyn Bay
LL29 7DH
GB

T (0)1492 534601
F
W www.mottmac.com

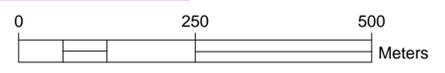
Client

Knowsley Council,
Municipal Buildings,
Huyton,
L36 9UX

Title

South of Whiston and Land South of the M62, Phase 1 Geo-Environmental and Geo-Technical Risk Assessment, Constraints Plan

Designed	N/A	Eng check	L McGovern
Drawn	N Bergeson	Coordination	N Haynes
Dwg check	N Spofforth	Approved	C Williams
Scale at A1	Status	Rev	Security
1:5000	PRE	P3	STD
Drawing Number	373379/MM/GE/001		



B. Site Photos

B.1 South Whiston Site (all photos taken 01/08/16)

Figure B.1: Looking south-east across open farmland



Figure B.2: Evidence of waste burning in The Old Wood



Figure B.3: Looking west down towards a small bridge of the watercourse running through The Old Wood with evidence of fly tipping in the foreground



Figure B.4: Looking north towards Big Water



Figure B.5: Looking north across Big Water



Figure B.6: Outfall from Big Water



Figure B.7: Additional evidence of waste burning



Figure B.8: Looking south-east across open farmland towards M62 with power lines crossing 'Land South of M62' beyond



Figure B.9: Looking north at assumed substation building within mobile home park



Figure B.10: Looking north-west at remains of Halsnead House outbuildings within mobile home park



Figure B.11: Sign at entrance of mobile home park



Figure B.12: Looking north-east from Main Drive towards undulating ground to north of mobile home park



Figure B.13: Looking east at Prince’s House Farm buildings



Figure B.14: Looking north across fishing pond to north of Main Drive



Figure B.15: Looking east across former nursery site to south of Main Drive



B.2 Land South of M62 Site (all photos taken 01/08/16)

Figure B.16: Looking north-east across hardstanding area at former Cronton Colliery entrance (assumed to be associated with former administrative buildings)



Figure B.17: Looking west at small package sewerage treatment plant



Figure B.18: Looking south at small package sewerage treatment plant



Figure B.19: Looking west across outer extent of former Cronton Colliery site



Figure B.20: Looking west along access track through former Cronton Colliery site, showing standing water and boggy conditions to left



Figure B.21: Coal fragments present across the colliery spoil plateau



Figure B.22: Looking north towards location of three capped former Cronton Colliery shafts



Figure B.23: Looking east at overflow and Fox's Bank Brook to west of colliery spoil plateaux



Figure B.24: Looking north-east towards an additional brick structure (overflow) and deep water warning sign



Figure B.25: Looking north where Fox's Bank Brook crosses the A5080 (Cronton Road Debris Screen)



Figure B.26: Looking north-east across farmland to west of Fox's Bank Brook with extensive Himalayan Balsam



Figure B.27: Looking north across farmland just north of the access track off the A5080



Figure B.28: Looking north-west across farmland just north of the access track off the A5080



Figure B.29: Looking west across farmland just north of the access track off the A5080 with communications tower in distance (on boundary of South of Whiston site)



C. Disclaimer

This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of Mott MacDonald Ltd (MM) being obtained. MM accepts no responsibility or liability for the consequences of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purposes agrees, and will by such use or reliance be taken to confirm his agreement to indemnify MM for all loss or damage resulting there from. MM accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

To the extent that this document is based on information supplied by other parties, MM accepts no liability for any loss or damage suffered by the client stemming from any conclusions based on data supplied by parties other than MM and used by MM in preparing this report.

The findings and opinions of this report are based on information obtained from a variety of sources as detailed in this report, and which MM have assumed to be reliable. Nevertheless MM cannot and does not guarantee the authenticity or reliability of the information provided to it from others. To the extent that this document is based on information obtained from ground investigations, persons using or relying on it should recognise that any such investigations can examine only a fraction of the subsurface conditions. In any ground investigation there remains a risk that pockets or “hot-spots” of contamination may not be identified, because investigations are necessarily based on sampling at localised points. Certain indicators or evidence of hazardous substances or conditions may have been outside the portion of the subsurface investigated or monitored and thus may not have been identified or their full significance appreciated. Such risks can be mitigated to a degree by carrying out further ground investigation, or during construction works by on-site visual observation and validation testing.

It is also possible that environmental monitoring has not identified certain conditions because of the relatively short monitoring period. Accordingly it is possible that the ground investigation and monitoring failed to indicate the presence or significance of hazardous substances or conditions. If so, their

presence could not have been considered in the formulation of MM's findings and opinions.

Mott MacDonald is not insured for, and therefore will not undertake surveys to identify asbestos or provide any guidance on the treatment of asbestos, or similar for toxic mould or radioactive contamination. Should the presence of asbestos, toxic mould or radioactive contamination be suspected during the course of the study, Mott MacDonald would recommend the appointment of a specialist contractor to address the issue and would not provide advice on risk or remedial measures

D. Contaminated Land Risk Assessment Methodology

The following classification published by the NHBC, EA, and CIEH (2008)^{xx} has been developed from *DOE Guide to Risk Assessment and Risk Management for Environmental Protection and the Statutory Guidance on Contaminated Land* (Defra September 2006). The methodology differs from that presented in *Contaminated Land Risk Assessment, A Guide to Good Practice* (CIRIA C552, 2001), particularly in terms of the definitions of classification of consequence, which include a consideration of immediacy of hazards.

The key to the classification is that the designation of risk is based upon the consideration of both:

- **the magnitude of the potential consequence (i.e. severity)**
[takes into account both the potential severity of the hazard and the sensitivity of the receptor]; and
- **the magnitude of probability (i.e. likelihood)**
[takes into account both the presence of the hazard and receptor and the integrity of the pathway].

The potential consequences of contamination risks occurring at this Site are classified in accordance with Table D.1 below:

Table D.1: Classification of Consequence

Classification	Definition of Consequence
Severe	<p>Highly elevated concentrations likely to result in “significant harm” to human health as defined by the EPA 1990, Part 2A, if exposure occurs.</p> <p>Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce.</p> <p>Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population.</p> <p>Catastrophic damage to crops, buildings or property.</p>
Medium	<p>Elevated concentrations which could result in “significant harm” to human health as defined by the EPA 1990, Part 2A if exposure occurs.</p> <p>Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce.</p> <p>Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population.</p> <p>Significant damage to crops, buildings or property.</p>

Classification	Definition of Consequence
Mild	<p>Exposure to human health unlikely to lead to “significant harm”.</p> <p>Equivalent to EA Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce.</p> <p>Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population.</p> <p>Minor damage to crops, buildings or property.</p>
Minor	<p>No measurable effect on humans.</p> <p>Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems.</p> <p>Repairable effects of damage to buildings, structures and services.</p>

The probability of contamination risks occurring at this Site is classified in accordance with Table D.2 below. Note: A pollution linkage must first be established before probability is classified. If there is no pollution linkage then there is no potential risk. If there is no pollution linkage then there is no need to apply tests for probability and consequence

Table D.2: Classification of Probability

Classification	Definition of Probability
High Likelihood	There is pollutant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.
Likely	There is pollutant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely

Classification	Definition of Probability
	over the long-term.
Low Likelihood	There is pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.
Unlikely	There is pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.

For each possible pollution linkage (source-pathway-receptor) identified, the potential risk can be evaluated based upon the following probability x consequence matrix shown in Table D.3.

Table D.3: Overall Contamination Risk Matrix

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate / Low risk	Low risk
	Low likelihood	Moderate risk	Moderate / Low risk	Low risk	Very low risk
	Unlikely	Moderate / Low risk	Low risk	Very low risk	Very low risk

R&D 66:2008 presents definitions of the risk categories, together with the investigatory and remedial actions that are likely to be necessary in each case. These definitions are reproduced in Table D.4. These risk categories apply to each pollutant linkage, not simply to each hazard or receptor.

Table D.4: Definition of Risk Categories and Likely Actions Required

Risk Category	Definition and likely actions required
Very high	<p>There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to be site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.</p>
High	<p>Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.</p>
Moderate	<p>It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.</p>
Low	<p>It is possible that harm could arise to a designated receptor from identified hazard, but it is likely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.</p>

Risk Category	Definition and likely actions required
Very low	It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that this harm if realised would normally be mild or minor.
No potential risk	There is no potential risk if no pollution linkage has been established.

E. References

-
- ⁱ Liverpool OS Explorer Map 275 (St Helens, Widnes and Runcorn) 1:25,000
- ⁱⁱ Arup - The Land Trust Cronton Country Park Flood Risk Assessment, REP/239754/C001, Rev A | 30 March 2015
- ⁱⁱⁱ Parkman Environment – Former Cronton Colliery Site, Site Investigation Interpretative Report Volume 1, Report No. 19399/OR/02B August 1999
- ^{iv} Geological Survey of England and Wales 1:63,360/1:50,000 geological map series 97 (Runcorn) Solid (1980) and Drift (1977)
- ^v <http://www.bgs.ac.uk/geoindex/>, correct as of 17/08/16
- ^{vi} <http://www.knowsley.gov.uk/residents/building-and-planning/local-plan/adopted-documents>, correct as of 17/08/16
- ^{vii} Coal Authority Interactive Map Viewer
<http://mapapps2.bgs.ac.uk/coalauthority/home.html>, correct as of 14/08/16
- ^{viii} Environment Agency What's in My Backyard online mapping tool:
http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e, correct as of 11/08/16
- ^{ix} MAGIC online mapping, <http://magic.defra.gov.uk/MagicMap.aspx>, correct as of 11/08/16
- ^x Zetica regional bomb risk mapping:
http://www.zetica.com/uxb_downloads.htm, correct as of 11/08/16
- ^{xi} <http://www.ukradon.org/information/ukmaps#>, correct as of 12/08/16
- ^{xii} Sinclair Knight Merz – Environmental Statement Cronton Colliery, November 2003
- ^{xiii} Environmental Service Comments on Mouchel (2008) Desk Study Assessment and Gap Analysis Report, Cronton Colliery, Knowsley. Produce for the Land Restoration Trust. Report No. 797035/R/01/A
- ^{xiv} Baker-Barnett – Coal Mining - Risk Assessment Report for the Proposed Development to form a Country Park on Land Situated at The Former Cronton Colliery, instructed June 2015. Ref 15/NSB/SB/2572
- ^{xv} Department of the Environmental Food and Rural Affairs (2012): “*Environmental Protection Act 1990: Part 2A, Contaminated Land Statutory Guidance*”, April 2012.
- ^{xvi} Environment Agency (2009): “*Human Health Toxicological Assessment of Contaminants in Soil*”, Report ref. SC050021/SR2.
- ^{xvii} Environment Agency (2009): “*Updated technical background to the CLEA Model*”, Report ref. SC050021/SR3.
- ^{xviii} British Standards Institution (2011): “*Investigation of Potentially Contaminated Sites*”, BS10175:2011

-
- ^{xix} Environment Agency (2013): “*Groundwater Protection: Principles and Practice*”, Ref. GP3. August 2013 Version 1.1.
- ^{xx} NHBC, EA, CIEH (2008): “*Guidance for the Safe Development of Housing on Land Affected by Contamination*”, R&D Publication 66: 2008
- ^{xxi} Department for Communities and Local Government (2012): “*National Planning Policy Framework*”.
- ^{xxii} <https://localplanmaps.knowsley.gov.uk/documents/knowsley-local-plan-adopted-core-strategy.pdf>, correct as of 13/08/16
- ^{xxiii} Wilson, S, *et al.* (2007): “Assessing risks posed by Hazardous Ground Gases to Buildings”, CIRIA, Report ref. C665
- ^{xxiv} British Standards Institution (2013): “Guidance on investigation for ground gases – Permanent gases and Volatile Organic Compounds (VOCs)”, BS8576:2013
- ^{xxv} British Standards Institution (2015): “Code of Practice for Ground Investigations”, BS5930:2015
- ^{xxvi} BRE Special Digest 1 (2005): Concrete in Aggressive Ground
- ^{xxvii} Environment Agency (2004): “Model Procedures for the Management of Land Contamination”. Ref. CLR11