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Wolverhampton City Council

Strategic Development Sites

Project Summary Report

August 2011

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	Originator	Checked by	Reviewed by	Approved by
ORIGINAL	NAME **Heather Baker**	NAME **Matt Keegans-Wood**	NAME **Kevin Boyle**	NAME **Jon Ashton**
DATE **August 2011**	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
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REVISION	NAME	NAME	NAME	NAME
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Contents

1 Introduction

1.1 Project Background

Jacobs UK Ltd has been commissioned by Wolverhampton City Council (WCC) to compile desk study information to identify potential geotechnical and contamination constraints to development for a portfolio of strategic development sites located across Wolverhampton.

A total of sixty strategic development sites have been identified within Wolverhampton which have been provisionally allocated potential end uses as Employment Sites (18 No.), Housing Sites (34 No.) and Commercial Sites (8 No.).

Each of the strategic sites have had geo-environmental desk study reports prepared for the purposes of informing site allocations to be made in the Wolverhampton Area Action Plans (AAPs) and other Local Development documents. The location of the sites and the referencing system are shown on the plan included in Appendix A. The Development Sites are grouped together within strategic local areas;

Stafford Road Strategic Sites – this covers land north of City Centre, west and east of Stafford Road associated with the Stafford Road AAP, up to Junction 2 of M54 Motorway. Sites are not in area affected by historic coal mining. This group includes 6No. Employment Sites (ES4, ES5, ES12, ES13, ES14 and ES15) and 5No. Housing Sites (HS0, HS1, HS2, HS3 and HS24).

Bilston Corridor Strategic Sites – covers land east and south east of City Centre in the location of the Bilston Corridor AAP. All sites are located in area affected by historic coal mining with the exception of five housing sites (HS12, HS25, HS26, HS27 and HS29). This group includes 5No. Employment Sites (ES2, ES16, ES17, ES18 and ES19) and 21No. Housing Sites (HS4, HS5, HS8, HS9, HS10, HS11, HS12, HS13, HS14, HS18, HS19, HS20, HS23, HS25, HS26, HS27, HS28, HS29, HS30, HS31 and HS32).

City Centre Strategic Sites – covers land adjacent the City centre Ring Road and the area south of the City centre (Blakenhall), in the location of the City Centre AAP (with the exception of HS33 which is located to the north west of the City Centre). Sites are not located in areas affected by historic coal mining. This group includes 1No. Employment Site (ES0), 7No. Housing Sites (HS6, HS7, HS15, HS16, HS21, HS22 and HS33) and 8No. Commercial Sites (CS0, CS1, CS2, CS3, CS4, CS5, CS6 and CS7).

Wednesfield Strategic Sites - covers land to the west of the City in the area of Wednesfield and Neachells Industrial area. Sites are located in area affected by historic coal mining. This group includes 6No. Employment Sites (ES6, ES7, ES8, ES9, ES10, and ES11).

This report should be read in conjunction with the site specific geo-environmental desk study reports produced for each Strategic Site.

1.2 Objectives

The main objective of the Project Summary Report is to provide an overall risk and remedial cost rating for all sites and in each of the strategic areas to enable preliminary ranking of the sites to be undertaken in terms of the potential

geotechnical and contamination constraints to development and enable WCC to prioritise the sites for possible regeneration.

1.3 Report Structure

The Project Summary Report will outline the key findings of the preliminary geotechnical and contamination risk assessments undertaken for all sites within each strategic area and overall.

The risk assessments provided the basis for deriving estimated remediation costs for each site and these will be presented in a summary table for each strategic area outlining the risk rating, total cost and cost per hectare for each site for comparison purposes. An overall summary for all sixty strategic sites will also be presented in tabular form. The sites will be ranked in terms of the potential remediation costs per hectare.

The report will conclude with a précis of the site prioritisation process with recommendations on how to develop the site ranking strategy further.

1.4 Report Limitations

Reference should be made to Appendix B which details the methodology used to compile the geo-environmental desk study reports.

The desk study reports were compiled using information provided by WCC GIS (site historical plans and landfill gas buffer plans), WCC site investigation database (ground condition data), WCC Planning (Mineral Commodity Maps) and WCC Environmental Health (contaminated land and landfill information). Third Party information was also used including utility plans and Environment Agency website data (landfills, aquifers, flood risk). The accuracy of the reviewed data cannot be verified by Jacobs.

The risk classification for the sites has been based on a qualitative assessment of the desk top information reviewed without undertaking a site inspection / walkover. Therefore, there may be physical and/or environmental site features not identified within the desk study reports which may affect the risk rating and estimated remedial costs.

The indicative cost estimates will be subject to inflationary, regulatory and market effects. In addition, the estimated costs should be expected to vary, potentially significantly, as site investigation and development of the site proceeds and additional information becomes available.

The remediation cost estimates specifically omit the following items due to insufficient information being available to derive a reliable cost estimate at the desk top study stage;

(i) Demolition of above ground buildings / structures.
(ii) Removal of asbestos containing materials (ACM's) within buildings / structures.
(iii) Removal or diversion of live (and redundant) utilities.

The remediation cost estimates are for the purposes of comparison and to allow a provisional ranking of the Strategic Sites to be based on a qualitative assessment for the exclusive use of WCC for strategic planning purposes. They are not to be

used for redevelopment budget costing for construction purposes by WCC or third parties.

Notwithstanding the limitations, it is considered that the methodology adopted to formulate preliminary risk ratings and remediation cost estimates for the Strategic Sites provides a satisfactory baseline to allow decisions to be made by WCC on prioritising sites for further assessment.

2 Risk Assessment and Remedial Cost Estimation

2.1 Risk Assessment Methodology

A preliminary risk assessment was undertaken for each site to identify the main potential geotechnical and contamination constraints to development based upon review of the site history, ground conditions and environmental setting. The method for risk evaluation was based on guidance by CIRIA 552 'Contaminated land risk assessment - a guide to good practice' (2001) which is a qualitative method of interpreting the risks based on the magnitudes of both the potential consequence (severity) and the probability (likelihood) of the risk occurring. The guidance was also adopted for the estimation of geotechnical risk (as well as contamination) for consistency in assessing potential ground constraints at each of the Strategic Sites.

The main basis for identifying the key potential geotechnical and contamination risks was a thorough review of the historical development / land use of the site and surrounding areas (historical OS mapping), the geological conditions of the site (using available mapping and previous investigation data) and a review of the environmental setting and sensitivity of the site (including flood risk, landfill data and WCC environmental health consultation). Following identification of the main potential risks, a decision was made on the severity and likelihood of the risk occurring using Jacobs professional knowledge and experience of working with WCC on numerous regeneration sites in the region since 2002.

Each identified risk was allocated a risk level based on likelihood and severity and a corresponding risk score allocated (see Table 1). The total score for all risk levels were averaged (and rounded up or down) to produce an overall risk rating for potential geotechnical and contamination risk at each site.

Risk Score	Risk Level
1	Very Low
2	Low
3	Moderate / Low
4	Moderate
5	High
6	Very High

Table 2A Risk Scores and levels

Desk top information used to inform geotechnical and contamination risk assessments was then utilised to inform the derivation of estimated costs for remediation works taking into consideration the identified geotechnical and contamination constraints to development.

Reference should be made to each of the site specific reports for further details of the preliminary risk assessment and to Appendix B for further details on methodology.

2.2 Remediation Cost Estimate Methodology

The project brief provided by WCC requested that the desk studies outlined preliminary remedial cost estimates for identified development geotechnical and contamination constraints based on the review of desk top data and the proposed end use of the site.

In general, cost estimates for remediation of ground constraints are usually produced following a detailed site inspection and intrusive ground investigation. Given that there was to be no site inspection or ground investigation an alternative methodology was required to formulate cost estimates. A number of assumptions regarding the site and ground conditions had to be formulated to enable the methodology to function adequately given the inherent uncertainties attached to estimating costs at this juncture.

The geotechnical cost estimates were derived based on desk top information, key outputs from the preliminary risk assessment and applying Jacobs professional judgement and geotechnical experience of involvement in a large number of regeneration projects for WCC.

For contamination estimates, the Best Practice Note 27 (BPN27), produced by English Partnerships (2008) was applied as it sets out guidance on assessing the costs of preparing for redevelopment, previously developed land or 'Brownfield' sites affected by contamination and/or dereliction. The BPN sets out estimated costs based on the key influencing factors including site area, previous and proposed land use and likely risk to controlled waters.

Two of the Employment Sites (ES12 and ES19) have been split into separate areas for the purposes of risk assessment and for estimating remedial costs due to their significant area and the distinct differences in current/former site use, ground conditions and constraints identified at the site by the risk assessment. The difference in areas is reflected in the summary tables in Section 2.3.

Reference should be made to each of the site specific reports for further details of the cost estimations and to Appendix B for further details on methodology.

2.3 Risk Assessment and Remediation Cost Summary Tables

The key outputs from the preliminary risk assessment and remediation cost estimation exercise are presented in Tables 2-B, 2-C, 2-D, 2-E and 2-F below. The sites are ranked in ascending order relevant to the estimated cost per hectare (based on developable area) for geotechnical and contamination remediation.

Table 2–B Risk Assessment and Remediation Cost Estimate Summary - All Sites

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
HS33	4	Non-mining	2.3	0	2.3	-	Unknown building on site	Low	£45,000	Moderate /Low	£10,000	£55,000	**£23,913**
HS22	4	Non-mining	2	0	2	-	School and Recreation area	Low	£45,000	Low	£10,000	£55,000	**£27,500**
ES12 Area 2	1	Non-mining	8.2	0	8.2	-	Recreation area and orchard	Moderate	£738,000	Moderate /Low	£0	£738,000	**£90,000**
CS4	6	Non-mining	2.5	0	2.5	-	Commercial and Residential, and a small garage	Moderate /Low	£262,500	Moderate /Low	£75,000	£337,500	**£135,000**
HS0	1	Non-mining	12.5	0.8	11.7	Network Rail land, open watercourse	Cold Stores, substation, public house, recreation area	Moderate	£613,500	Moderate	£1,190,000	£1,803,500	**£154,145**
HS12	5	Non-mining	5.2	0.2	5	Culvert	Oil Blending Depot and Chemical Works, Engineering Works, Tool Pressing Factory, Railway Sidings, small Garage	Moderate	£250,000	High	£1,045,000	£1,045,000	**£209,000**
CS0	6	Non-mining	4.5	0	4.5	-	Timber and Saw Mills garages.	Moderate /Low	£742,500	Moderate /Low	£350,000	£1,092,500	**£242,778**
CS7	6	Non-mining	12	0.2	11.8	Canal	Depot, warehousing, workshops, Brewery, Railway Sidings	Moderate	£2,159,300	Moderate	£730,000	£2,889,300	**£244,856**
HS25	5	Non-mining	1.2	0	1.2	-	Engineering Works, Depot, other Works	Moderate	£161,500	Moderate	£142,500	£304,000	**£253,333**
HS24	1	Non-mining	7.7	0	7.7	-	Motor Engineering Works, fuel service station, industrial estate	Moderate	£452,000	Moderate	£1,675,000	£2,127,000	**£276,234**
CS3	6	Non-mining	7	0	7	-	Railway sidings, depot, warehouses, Timber Yard, Brewery, Garage	Moderate	£890,000	Moderate	£1,137,500	£2,027,500	**£289,643**
CS2	6	Non-mining	3.6	0.3	3.3	Ring road, footpath and subway	Engineering Works, Cattle Market, Abattoir	Moderate /Low	£445,500	Moderate /Low	£555,000	£1,000,500	**£303,182**
ES15	1	Non-mining	1	0.05	0.95	Network Rail Land	Smith, Blacksmiths, Garage, Limekiln, Timber and Builders Yard, depots	Moderate	£171,000	Moderate /Low	£118,750	£289,750	**£305,000**
HS16	4	Non-mining	9.8	0.1	9.7	Culvert	Iron Works, Tin plating and sheet metal works, Engineering Works (Sheet Metal and Fabricators, Galvanising, Heating and Plumbing Works, Engines, Compressors, Steel Fabricators), Scrap yards, Garages, builders yards, vehicle repair yard, Toy Works, dairy,	Moderate	£505,000	Moderate	£2,517,000	£3,022,500	**£311,598**
ES13	1	Non-mining	10.5	0	10.5	-	Refuse Tip, Engineering Works, Civic Amenity Site, Warehousing	Moderate	£1,500,000	Moderate /Low	£1,807,500	£3,307,500	**£315,000**
HS1	1	Non-mining	9.6	0	9.6	-	Electrical Engineering Works, Battery Works, Scrapyards, Bus depot	Moderate	£570,000	Moderate	£2,525,000	£3,095,000	**£322,396**
ES0	3	Non-mining	5.4	0	5.4	-	Motor Vehicle and Cycle Engineering Works, Tin and Japan Works, Electrical Engineering Works	Moderate	£986,000	Moderate	£743,000	£1,796,000	**£332,593**
CS5	6	Non-mining	7.3	0	7.3	-	Garages, light industrial/commercial, Timber and Saw Mills	Moderate /Low	£1,341,000	Moderate /Low	£1,112,500	£2,453,500	**£336,096**
CS1	6	Non-mining	8	0.2	7.8	Subway and tunnel	Electro Plate Works, Garages, Engineering Works, Brass Founders, depot	Moderate	£1,287,000	Moderate /Low	£1,350,000	£2,637,000	**£338,077**
HS29	5	Non-mining	6.25	0.65	5.6	Disused railway tunnel	Iron and Steel Works, canal depot	High	£343,000	High	£1,617,500	£1,960,500	**£350,089**
HS32	5	Mining	3.4	0.2	3.2	Network Rail Land	Brick Works, Coal Mining, infilled clay pit	Moderate	£947,200	Moderate	£240,000	£1,187,200	**£371,000**
HS27	5	Non-mining	3	0.8	2.2	Network Rail viaduct	Iron Works, Timber Yard, Electric Battery Manufacturer	Moderate	£360,000	High	£485,000	£845,000	**£384,091**

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
HS28	5	Mining	4.9	0.1	4.8	1 mineshaft	Iron Works, Nail and Spring Works, garage, scrap yard residential housing	Moderate	£493,000	Moderate	£1,460,000	£1,953,000	**£406,875**
HS21	4	Non-mining	3.1	0	3.1	-	Iron Works, Electrical Engineering Works, Star Works (steel casements), Wire Works, Printing Works and spray painting workshop, Garages, Timber Yard	Moderate	£495,500	Moderate	£770,000	£1,265,500	**£408,226**
ES5	1	Non-mining	2.3	0.1	2.2	Network Rail Land	Electrical Engineering Works, Sidings	Moderate	£360,000	Moderate	£550,000	£910,000	**£413,636**
CS6	6	Non-mining	9.4	1	8.4	Network Rail Land	Iron Works, Foundry, Chemical Works, Railway sidings, Drop Forgings	Moderate	£1,591,500	High	£1,985,000	£3,576,500	**£425,774**
ES12 Area 1	1	Non-mining	35.5	0	35.5	-	Steel stockholder, depots, Engineering Works, Sewage Works	High	£6,390,000	Moderate	£8,875,000	£15,265,000	**£430,000**
HS15	4	Non-mining	6.3	0.1	6.2	Culvert	Iron and Tin Works (and plating), Galvanizing Works, Aluminium Works, Clock Works, Safe Works/ Engineering Works (Tool makers), Brick Works, Iron Works and Enamel Works, metal works, engineering works (hospital and surgical enamelware, with steel pressings and stamp	Moderate	£756,000	Moderate	£1,925,000	£2,681,000	**£432,419**
HS2	1	Non-mining	4.25	0.25	4	Telephone Exchange	Sheet Metal Engineering Works/Factory, Timber Yard, Electro-plating Works,	Moderate	£217,500	High	£1,706,250	£1,793,750	**£448,438**
ES4	1	Non-mining	5.8	0.9	4.9	Network Rail Land	Chemical Works, Manure Works, Abattoir, Iron Works, Foundry, Garage, Depot, Engineering Works	Moderate	£960,000	Moderate	£1,280,000	£2,240,000	**£457,143**
HS30	5	Mining	1.65	0.18	1.47	2 mineshafts onsite	Metal Works	Moderate	£218,500	High	£495,000	£713,500	**£485,374**
HS20	5	Mining	5.6	0.59	5.01	13 mineshafts on site	Iron Works, Conduit Works, Engineering Works	High	£1,705,000	Moderate	£951,000	£2,656,000	**£530,140**
HS7	4	Non-mining	3	0	3	Culvert	Timber Yards, Engineering Works (screws and rivets), Garage and Scrap Yard	Moderate /Low	£460,000	Moderate	£1,200,000	£1,660,000	**£553,333**
HS19	5	Mining	5	1	4	12 mineshafts on site	Railway land, light industrial (not specified)	Moderate	£1,468,000	Moderate /Low	£800,000	£2,268,000	**£567,000**
HS3	1	Non-mining	11	0.5	10.5	Network Rail Land	Electrical Engineering Works, Railway Land, Wire Works, Builders Yard, Motor Works	Moderate	£606,000	High	£5,372,500	£5,978,500	**£569,381**
HS8	5	Mining	2.4	0.4	2	Network Rail, Highway and pavement	Tube Works (Iron), Water Pipe Works, Engineering Works	Moderate	£640,000	Moderate	£550,000	£1,190,000	**£595,000**
HS6	4	Non-mining	4.2	0	4.2	-	Tower and Fort Metal Spinning Works (chrome plating), Laundry, Garage, Motor Spares Depot, Engineering Works, Japan Works, Electroplating Works	Moderate /Low	£681,000	Moderate	£1,867,500	£2,548,500	**£606,786**
HS10	5	Mining	2	0	2	-	Tube Works (Iron), Boiler Works, Engineering Works, depot	Moderate	£614,000	Moderate	£650,000	£1,264,000	**£632,000**
HS31	5	Mining	8.5	1.6	4.75	Canal, Network Rail land	Printing and Ink Works, Engineering Works, Industrial Estate	High	£1,219,250	High	£1,663,750	£3,079,500	**£648,316**
HS13	5	Mining	2.9	1.05	1.85	Culvert, Railway Land, 9 mineshafts	Varnish Works, Coal Yard, Scrap Metal Yard, Enamelling Works,	Moderate	£730,750	High	£487,500	£1,218,250	**£658,514**
HS4	5	Mining	10.6	2.64	7.96	20 mineshafts on site	Galvanised and Tinned Wrought Hollow-ware, Nut and Bolt Works	High	£3,049,250	Moderate	£2,209,500	£5,258,550	**£660,622**

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
HS17	5	Mining	12	5.33	6.67	Railway Land, Canal, 23 mineshafts on site	Iron Foundry, Railway Land, Builders Yard, Repair Depot.	High	£2,652,500	High	£1,940,000	£4,592,500	**£688,531**
HS5	5	Mining	7	2.18	4.82	Canal, 12 mineshafts	Iron Works, Stamping Works, Engineering Works (vending machine), Railway sidings salt grit/storage, Iron Foundry, Zinc Extracting Works, Hollowware Works, Sheet Metal Works, scrap yard	High	£1,326,950	High	£2,055,750	£3,382,700	**£701,805**
ES6	2	Mining	4.6	0	4.6	-	Iron Foundry, Engineering Works, Rubber Sheeting Works,	Moderate /Low	£1,449,000	Moderate	£1,955,000	£3,404,000	**£740,000**
ES16	3	Mining	16.5	4.6	11.9	Network Rail Land, 2 culverts, small area in north ownership unclear, 39 mineshafts	Boiler Works, Brick Kiln Works, Lanesfield Coliery, Iron and Tin Sheet Metal Works, Refuse Tip	High	£7,718,500	High	£2,005,000	£9,723,500	**£817,101**
HS9	5	Mining	3.7	0.05	3.65	1 mineshaft on site	Tube Works (Iron), Boiler Works, Chemical Works, Coal Yards, Boat, Dock and Wagon Works	Moderate	£1,140,550	High	£2,073,750	£3,214,300	**£880,630**
HS26	5	Non-mining	2.5	0.2	2.3	Canal	Steel Works, Brick Works, Paint Works, Scrap Metal, Zinc Alloy Works	High	£366,500	High	£1,667,500	£2,034,000	**£884,348**
ES14	1	Non-mining	7.3	0.6	6.7	Network Rail Land, culvert	Gas Works, Engineering Works, Railway sidings	High	£1,273,800	High	£5,120,000	£6,393,800	**£954,299**
ES12 Area 3	1	Non-mining	3.5	0	3.5	-	Closed Landfill	**Very High**	£1,744,200	High	£1,837,500	£3,581,700	**£1,023,343**
ES10	2	Mining	9.4	1.3	8.1	culvert, 1 mineshaft on site	Engineering Works, Depot, Garages, Drop Forging and Dye Casting Works	High	£7,615,000	High	£1,235,000	£8,850,000	**£1,092,593**
ES8	2	Mining	2.9	0.1	2.8	1 mineshaft on site	Watery Lane Industrial Estate, commercial units, sub-station	High	£2,697,000	Moderate	£362,500	£3,059,500	**£1,092,679**
ES2	3	Mining	3.7	0.9	2.8	Culvert, 9 mineshafts on site	Engineering Works, Pattern Makers Works, Civic Amenity Site, Scrap Yard, Enamel Factory.	High	£2,632,000	Moderate	£459,500	£3,091,500	**£1,104,107**
ES18	3	Mining	11.4	1.1	10.3	culvert, 10 mineshafts on site	East Park Heat Treatment Works, Scrap Yards, Iron Works, Chillington Tool Works, sidings	Moderate	£9,332,000	High	£2,105,000	£11,437,000	**£1,110,388**
ES7	2	Mining	2.2	0.1	2.1	1 mineshaft on site	Galvanising Works	Moderate	£1,810,750	Moderate	£525,000	£2,335,750	**£1,112,262**
HS18	5	Mining	6.3	0.8	5.5	9 mineshafts on site	Iron Works	High	£1,812,500	High	£4,537,500	£6,350,000	**£1,154,545**
ES19 Area 3	3	Mining	5.5	1.6	3.9	13 mineshafts in zone,	Engineering Works, Brass Founders, Printing Works, Foundry, Steel Plating Works, Transformer Works	High	£3,711,500	Moderate	£975,000	£4,686,500	**£1,201,667**
ES17	3	Mining	6.5	2.7	4.8	Public footpath, 2 culverts, 11 mineshafts	Landfill/refuse tip, Waste Management and Recycling Depot, Scrap Yard, Transformer Manufacture	High	£3,688,700	High	£2,083,000	£5,771,700	**£1,202,438**
ES19 Area 1	3	Mining	22.6	13.2	9.4	95 mineshafts in zone, culvert	Works, Depots, Warehousing, Garages,	High	£10,219,000	Moderate	£1,175,000	£11,394,000	**£1,212,128**

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
HS14	5	Mining	2.8	1.05	1.75	Culvert, 11 mineshafts on site	Chemical Works, Varnish Works, Iron Works, Rolling Mills, Conduit Works, Tube Works, Engineering Works (Copper Balls), Scrap Metal Yard,	High	£746,250	High	£1,443,750	£2,190,000	**£1,251,429**
ES9	2	Mining	5.6	0.73	4.87	Network Rail, sewage pumping stn, culvert and drain	Zinc Foundry, Electrical Engineering Works, Engineering Works, Garage Repair, Scrap Metal Yard, Sewage pumping Stn, Oil and gas burner manufacture	Moderate	£4,577,400	Moderate	£1,536,250	£6,113,650	**£1,255,370**
HS23	5	Mining	0.75	0.7	0.65	1 mineshaft on site	Iron and Steel Works	Moderate	£259,500	High	£577,500	£837,000	**£1,287,692**
HS11	5	Mining	0.8	0.54	0.26	6 Mineshafts, Culvert	Engineering Works, Stone and Concrete Works and Steel Pressing Works	Moderate	£199,300	Moderate	£162,500	£361,800	**£1,391,538**
ES19 Area 2	3	Mining	12.9	7.3	5.6	58 mineshafts in zone	Glassware Works, Engineering Works, Arc Welding Equipment Works	High	£6,116,000	Moderate	£2,380,000	£8,496,000	**£1,517,143**
ES19 Area 4	3	Mining	4	3.3	0.7	26 mineshafts in zone,	Refuse Tip (associated with Sewage Works), Iron and Steel Works	High	£1,152,100	High	£210,000	£1,362,100	**£1,945,857**

NB: Costs are for **comparison and prioritisation purposes only** based on information available at the time of writing of reports, it is recommended that these are reviewed when further information becomes available

Table 2-C Risk Assessment and Remediation Cost Estimate Summary –Stafford Road Corridor

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
ES12 Area 2	1	Non-mining	8.2	0	8.2	-	Recreation area and orchard	Moderate	£738,000	Moderate /Low	£0	£738,000	**£90,000**
HS0	1	Non-mining	12.5	0.8	11.7	Network Rail land, open watercourse	Cold Stores, substation, public house, recreation area	Moderate	£613,500	Moderate	£1,190,000	£1,803,500	**£154,145**
HS24	1	Non-mining	7.7	0	7.7	-	Motor Engineering Works, fuel service station, industrial estate	Moderate	£452,000	Moderate	£1,675,000	£2,127,000	**£276,234**
ES15	1	Non-mining	1	0.05	0.95	Network Rail Land	Smith, Blacksmiths, Garage, Limekiln, Timber and Builders Yard, depots	Moderate	£171,000	Moderate /Low	£118,750	£289,750	**£305,000**
ES13	1	Non-mining	10.5	0	10.5	-	Refuse Tip, Engineering Works, Civic Amenity Site, Warehousing	Moderate	£1,500,000	Moderate /Low	£1,807,500	£3,307,500	**£315,000**
HS1	1	Non-mining	9.6	0	9.6	-	Electrical Engineering Works, Battery Works, Scrapyards, Bus depot	Moderate	£570,000	Moderate	£2,525,000	£3,095,000	**£322,396**
ES5	1	Non-mining	2.3	0.1	2.2	Network Rail Land	Electrical Engineering Works, Sidings	Moderate	£360,000	Moderate	£550,000	£910,000	**£413,636**
ES12 Area 1	1	Non-mining	35.5	0	35.5	-	Steel stockholder, depots, Engineering Works, Sewage Works	High	£6,390,000	Moderate	£8,875,000	£15,265,000	**£430,000**
HS2	1	Non-mining	4.25	0.25	4	Telephone Exchange	Sheet Metal Engineering Works/Factory, Timber Yard, Electro-plating Works,	Moderate	£217,500	High	£1,706,250	£1,793,750	**£448,438**
ES4	1	Non-mining	5.8	0.9	4.9	Network Rail Land	Chemical Works, Manure Works, Abattoir, Iron Works, Foundry, Garage, Depot, Engineering Works	Moderate	£960,000	Moderate	£1,280,000	£2,240,000	**£457,143**
HS3	1	Non-mining	11	0.5	10.5	Network Rail Land	Electrical Engineering Works, Railway Land, Wire Works, Builders Yard, Motor Works	Moderate	£606,000	High	£5,372,500	£5,978,500	**£569,381**
ES14	1	Non-mining	7.3	0.6	6.7	Network Rail Land, culvert	Gas Works, Engineering Works, Railway sidings	High	£1,273,800	High	£5,120,000	£6,393,800	**£954,299**
ES12 Area 3	1	Non-mining	3.5	0	3.5	-	Closed Landfill	**Very High**	£1,744,200	High	£1,837,500	£3,581,700	**£1,023,343**

NB: Costs are for **comparison and prioritisation purposes only** based on information available at the time of writing of reports, it is recommended that these are reviewed when further information becomes available

Table 2-D Risk Assessment and Remediation Cost Estimate Summary –Bilston Corridor

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
HS12	5	Non-mining	5.2	0.2	5	Culvert	Oil Blending Depot and Chemical Works, Engineering Works, Tool Pressing Factory, Railway Sidings, small Garage	Moderate	£250,000	High	£1,045,000	£1,045,000	**£209,000**
HS25	5	Non-mining	1.2	0	1.2	-	Engineering Works, Depot, other Works	Moderate	£161,500	Moderate	£142,500	£304,000	**£253,333**
HS29	5	Non-mining	6.25	0.65	5.6	Disused railway tunnel	Iron and Steel Works, canal depot	High	£343,000	High	£1,617,500	£1,960,500	**£350,089**
HS32	5	Mining	3.4	0.2	3.2	Network Rail Land	Brick Works, Coal Mining, infilled clay pit	Moderate	£947,200	Moderate	£240,000	£1,187,200	**£371,000**
HS27	5	Non-mining	3	0.8	2.2	Network Rail viaduct	Iron Works, Timber Yard, Electric Battery Manufacturer	Moderate	£360,000	High	£485,000	£845,000	**£384,091**
HS28	5	Mining	4.9	0.1	4.8	1 mineshaft	Iron Works, Nail and Spring Works, garage, scrap yard residential housing	Moderate	£493,000	Moderate	£1,460,000	£1,953,000	**£406,875**
HS30	5	Mining	1.65	0.18	1.47	2 mineshafts onsite	Metal Works	Moderate	£218,500	High	£495,000	£713,500	**£485,374**
HS20	5	Mining	5.6	0.59	5.01	13 mineshafts on site	Iron Works, Conduit Works, Engineering Works	High	£1,705,000	Moderate	£951,000	£2,656,000	**£530,140**
HS19	5	Mining	5	1	4	12 mineshafts on site	Railway land, light industrial (not specified)	Moderate	£1,468,000	Moderate /Low	£800,000	£2,268,000	**£567,000**
HS8	5	Mining	2.4	0.4	2	Network Rail, Highway and pavement	Tube Works (Iron), Water Pipe Works, Engineering Works	Moderate	£640,000	Moderate	£550,000	£1,190,000	**£595,000**
HS10	5	Mining	2	0	2	-	Tube Works (Iron), Boiler Works, Engineering Works, depot	Moderate	£614,000	Moderate	£650,000	£1,264,000	**£632,000**
HS31	5	Mining	8.5	1.6	4.75	Canal, Network Rail land	Printing and Ink Works, Engineering Works, Industrial Estate	High	£1,219,250	High	£1,663,750	£3,079,500	**£648,316**
HS13	5	Mining	2.9	1.05	1.85	Culvert, Railway Land, 9 mineshafts	Varnish Works, Coal Yard, Scrap Metal Yard, Enamelling Works,	Moderate	£730,750	High	£487,500	£1,218,250	**£658,514**
HS4	5	Mining	10.6	2.64	7.96	20 mineshafts on site	Galvanised and Tinned Wrought Hollow-ware, Nut and Bolt Works	High	£3,049,250	Moderate	£2,209,500	£5,258,550	**£660,622**
HS17	5	Mining	12	5.33	6.67	Railway Land, Canal, 23 mineshafts on site	Iron Foundry, Railway Land, Builders Yard, Repair Depot.	High	£2,652,500	High	£1,940,000	£4,592,500	**£688,531**
HS5	5	Mining	7	2.18	4.82	Canal, 12 mineshafts	Iron Works, Stamping Works, Engineering Works (vending machine), Railway sidings salt grit/storage, Iron Foundry, Zinc Extracting Works, Hollowware Works, Sheet Metal Works, scrap yard	High	£1,326,950	High	£2,055,750	£3,382,700	**£701,805**
ES16	3	Mining	16.5	4.6	11.9	Network Rail Land, 2 culverts, small area in north ownership unclear, 39 mineshafts	Boiler Works, Brick Kiln Works, Lanesfield Colliery, Iron and Tin Sheet Metal Works, Refuse Tip	High	£7,718,500	High	£2,005,000	£9,723,500	**£817,101**
HS9	5	Mining	3.7	0.05	3.65	1 mineshaft on site	Tube Works (Iron), Boiler Works, Chemical Works, Coal Yards, Boat, Dock and Wagon Works	Moderate	£1,140,550	High	£2,073,750	£3,214,300	**£880,630**
HS26	5	Non-mining	2.5	0.2	2.3	Canal	Steel Works, Brick Works, Paint Works, Scrap Metal, Zinc Alloy Works	High	£366,500	High	£1,667,500	£2,034,000	**£884,348**
ES2	3	Mining	3.7	0.9	2.8	Culvert, 9 mineshafts on site	Engineering Works, Pattern Makers Works, Civic Amenity Site, Scrap Yard, Enamel Factory.	High	£2,632,000	Moderate	£459,500	£3,091,500	**£1,104,107**

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
ES18	3	Mining	11.4	1.1	10.3	culvert, 10 mineshafts on site	East Park Heat Treatment Works, Scrap Yards, Iron Works, Chillington Tool Works, sidings	Moderate	£9,332,000	High	£2,105,000	£11,437,000	**£1,110,388**
HS18	5	Mining	6.3	0.8	5.5	9 mineshafts on site	Iron Works	High	£1,812,500	High	£4,537,500	£6,350,000	**£1,154,545**
ES19 Area 3	3	Mining	5.5	1.6	3.9	13 mineshafts in zone,	Engineering Works, Brass Founders, Printing Works, Foundry, Steel Plating Works, Transformer Works	High	£3,711,500	Moderate	£975,000	£4,686,500	**£1,201,667**
ES17	3	Mining	6.5	2.7	4.8	Public footpath, 2 culverts, 11 mineshafts	Landfill/refuse tip, Waste Management and Recycling Depot, Scrap Yard, Transformer Manufacture	High	£3,688,700	High	£2,083,000	£5,771,700	**£1,202,438**
ES19 Area 1	3	Mining	22.6	13.2	9.4	95 mineshafts in zone, culvert	Works, Depots, Warehousing, Garages,	High	£10,219,000	Moderate	£1,175,000	£11,394,000	**£1,212,128**
HS14	5	Mining	2.8	1.05	1.75	Culvert, 11 mineshafts on site	Chemical Works, Varnish Works, Iron Works, Rolling Mills, Conduit Works, Tube Works, Engineering Works (Copper Balls), Scrap Metal Yard,	High	£746,250	High	£1,443,750	£2,190,000	**£1,251,429**
HS23	5	Mining	0.75	0.7	0.65	1 mineshaft on site	Iron and Steel Works	Moderate	£259,500	High	£577,500	£837,000	**£1,287,692**
HS11	5	Mining	0.8	0.54	0.26	6 Mineshafts, Culvert	Engineering Works, Stone and Concrete Works and Steel Pressing Works	Moderate	£199,300	Moderate	£162,500	£361,800	**£1,391,538**
ES19 Area 2	3	Mining	12.9	7.3	5.6	58 mineshafts in zone	Glassware Works, Engineering Works, Arc Welding Equipment Works	High	£6,116,000	Moderate	£2,380,000	£8,496,000	**£1,517,143**
ES19 Area 4	3	Mining	4	3.3	0.7	26 mineshafts in zone,	Refuse Tip (associated with Sewage Works), Iron and Steel Works	High	£1,152,100	High	£210,000	£1,362,100	**£1,945,857**

NB: Costs are for **comparison and prioritisation purposes only** based on information available at the time of writing of reports, it is recommended that these are reviewed when further information becomes available

Table 2-E Risk Assessment and Remediation Cost Estimate Summary – City Centre Area

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
HS33	4	Non-mining	2.3	0	2.3	-	Unknown building on site	Low	£45,000	Moderate /Low	£10,000	£55,000	**£23,913**
HS22	4	Non-mining	2	0	2	-	School and Recreation area	Low	£45,000	Low	£10,000	£55,000	**£27,500**
CS4	6	Non-mining	2.5	0	2.5	-	Commercial and Residential, and a small garage	Moderate /Low	£262,500	Moderate /Low	£75,000	£337,500	**£135,000**
CS0	6	Non-mining	4.5	0	4.5	-	Timber and Saw Mills garages.	Moderate /Low	£742,500	Moderate /Low	£350,000	£1,092,500	**£242,778**
CS7	6	Non-mining	12	0.2	11.8	Canal	Depot, warehousing, workshops, Brewery, Railway Sidings	Moderate	£2,159,300	Moderate	£730,000	£2,889,300	**£244,856**
CS3	6	Non-mining	7	0	7	-	Railway sidings, depot, warehouses, Timber Yard, Brewery, Garage	Moderate	£890,000	Moderate	£1,137,500	£2,027,500	**£289,643**
CS2	6	Non-mining	3.6	0.3	3.3	Ring road, footpath and subway	Engineering Works, Cattle Market, Abattoir	Moderate /Low	£445,500	Moderate /Low	£555,000	£1,000,500	**£303,182**
HS16	4	Non-mining	9.8	0.1	9.7	Culvert	Iron Works, Tin plating and sheet metal works, Engineering Works (Sheet Metal and Fabricators, Galvanising, Heating and Plumbing Works, Engines, Compressors, Steel Fabricators), Scrap yards, Garages, builders yards, vehicle repair yard, Toy Works, dairy,	Moderate	£505,000	Moderate	£2,517,000	£3,022,500	**£311,598**
ES0	3	Non-mining	5.4	0	5.4	-	Motor Vehicle and Cycle Engineering Works, Tin and Japan Works, Electrical Engineering Works	Moderate	£986,000	Moderate	£743,000	£1,796,000	**£332,593**
CS5	6	Non-mining	7.3	0	7.3	-	Garages, light industrial/commercial, Timber and Saw Mills	Moderate /Low	£1,341,000	Moderate /Low	£1,112,500	£2,453,500	**£336,096**
CS1	6	Non-mining	8	0.2	7.8	Subway and tunnel	Electro Plate Works, Garages, Engineering Works, Brass Founders, depot	Moderate	£1,287,000	Moderate /Low	£1,350,000	£2,637,000	**£338,077**
HS21	4	Non-mining	3.1	0	3.1	-	Iron Works, Electrical Engineering Works, Star Works (steel casements), Wire Works, Printing Works and spray painting workshop, Garages, Timber Yard	Moderate	£495,500	Moderate	£770,000	£1,265,500	**£408,226**
CS6	6	Non-mining	9.4	1	8.4	Network Rail Land	Iron Works, Foundry, Chemical Works, Railway sidings, Drop Forgings	Moderate	£1,591,500	High	£1,985,000	£3,576,500	**£425,774**
HS15	4	Non-mining	6.3	0.1	6.2	Culvert	Iron and Tin Works (and plating), Galvanizing Works, Aluminium Works, Clock Works, Safe Works/ Engineering Works (Tool makers), Brick Works, Iron Works and Enamel Works, metal works, engineering works (hospital and surgical enamelware, with steel pressings and stamp	Moderate	£756,000	Moderate	£1,925,000	£2,681,000	**£432,419**
HS7	4	Non-mining	3	0	3	Culvert	Timber Yards, Engineering Works (screws and rivets), Garage and Scrap Yard	Moderate /Low	£460,000	Moderate	£1,200,000	£1,660,000	**£553,333**
HS6	4	Non-mining	4.2	0	4.2	-	Tower and Fort Metal Spinning Works (chrome plating), Laundry, Garage, Motor Spares Depot, Engineering Works, Japan Works, Electroplating Works	Moderate /Low	£681,000	Moderate	£1,867,500	£2,548,500	**£606,786**

NB: Costs are for **comparison and prioritisation purposes only** based on information available at the time of writing of reports, it is recommended that these are reviewed when further information becomes available

Table 2-F Risk Assessment and Remediation Cost Estimate Summary –Wednesfield Area

Site Ref.	Batch	Mining OR Non-mining site	Total Area (Ha)	Non-developable area (Ha)	Developable Area (Ha)	Non-developable areas	Land Use	Geotechnical		Contamination		Total Cost (£)	Cost per Ha (based on developable site area) (£)
								Preliminary Risk Rating	Estimated Remediation Cost (£)	Preliminary Risk Rating	Estimated Remediation Cost (£)		
ES6	2	Mining	4.6	0	4.6	-	Iron Foundry, Engineering Works, Rubber Sheeting Works,	Moderate /Low	£1,449,000	Moderate	£1,955,000	£3,404,000	**£740,000**
ES10	2	Mining	9.4	1.3	8.1	culvert, 1 mineshaft on site	Engineering Works, Depot, Garages, Drop Forging and Dye Casting Works	High	£7,615,000	High	£1,235,000	£8,850,000	**£1,092,593**
ES8	2	Mining	2.9	0.1	2.8	1 mineshaft on site	Watery Lane Industrial Estate, commercial units, sub-station	High	£2,697,000	Moderate	£362,500	£3,059,500	**£1,092,679**
ES7	2	Mining	2.2	0.1	2.1	1 mineshaft on site	Galvanising Works	Moderate	£1,810,750	Moderate	£525,000	£2,335,750	**£1,112,262**
ES11	2	Mining	6.1	0.55	5.55	3 mineshafts on site, disused land ownership unclear	Steel Mills/Works	High	£5,163,250	High	£1,665,000	£6,828,250	**£1,230,315**
ES9	2	Mining	5.6	0.73	4.87	Network Rail, sewage pumping stn, culvert and drain	Zinc Foundry, Electrical Engineering Works, Engineering Works, Garage Repair, Scrap Metal Yard, Sewage pumping Stn, Oil and gas burner manufacture	Moderate	£4,577,400	Moderate	£1,536,250	£6,113,650	**£1,255,370**

NB: Costs are for **comparison and prioritisation purposes only** based on information available at the time of writing of reports, it is recommended that these are reviewed when further information becomes available

2.4 Discussion

It must be stressed that the estimated costs are for comparison purposes only at this juncture and may vary by an order of magnitude in light of further information becoming available and/or further investigation work being undertaken.

The key observations on the output of the summary tables are as follows;

2.4.1 All Strategic Sites

The overall summary table (Table 2-B) shows a general trend of the non-mining sites being positioned at the top of the table (low/moderate risk and low cost per hectare) with the mining impacted sites situated at the bottom of the table (moderate/high risk and high cost per hectare). The exception being the non-mining sites ES12 (Area 3), ES14 and HS26 which are high risk and cost per hectare, principally due to historic land use being either landfill (ES12) or heavy industrial (gas works at ES14 and steel works at HS26).

Given the above, it is evident that the sites within the Bilston Corridor generally fall within the moderate and high risk rating with associated relatively moderate to high potential remedial cost per hectare. These sites are characterised by heavy industrial and coal mining site history with potential development constraints and potential 'non-developable' areas which reduce the available site area for development. This has a particular impact on the smaller sites, e.g. HS11 loses over half of its 'developable' land, and results in the final estimated remedial cost being skewed towards the high end of the range (low end of the table). Large site are also affected where there are a very high number of recorded mineshafts within the site, e.g. ES19 - Areas 1, 2 & 4, which increases the geotechnical remedial costs significantly.

The cost of treating mineshafts is taken into account, however the 'stand-off' areas are considered non-developable and therefore the developable area is significantly reduced and the associated geotechnical remedial cost significantly increases.

The non-mining sites, which occupy the middle range of the table, are sites that have had a long heavy industrial site history which increases the risk for significant geotechnical and contamination constraints to be present.

2.4.2 Stafford Road Corridor

Table 2-C shows a general mix of Employment and Housing sites in the hierarchy highlighting the heterogeneous nature of the sites in terms of potential for contamination and geotechnical hazards based on the geological/environmental setting and historic site development.

For example, ES12-Area 2 and HS0 are both characterised by the presence of large areas of the site that have been subject to little (if any) previous housing or industrial development and have been assessed as having little (if any) potential to significantly impact a sensitive environmental receptor (e.g. human health or controlled waters) and hence therefore have low estimated remedial costs. In addition, with a thin coverage of Made Ground and minimal ground obstructions anticipated, the geotechnical constraints and remediation costs are estimated to be minimal.

Conversely ES14 and ES12-Area 3 are characterised by heavy industrial and landfill activities respectively, both assessed as having a high potential to impact the environment and to present potentially significant geotechnical constraints to development which is reflected in the relatively high estimated potential remedial costs.

2.4.3 Bilston Corridor

The Bilston Corridor sites (Table 2-D) are in the majority mining sites, characterised by generally moderate to high risk ratings and relatively moderate to high remedial cost estimates per hectare. Any non-mining sites within the Bilston Corridor are generally found within the top of the table with relatively low/low-moderate remedial cost estimates.

Mining sites within this area with significantly high remedial cost estimates (> £1,200,000 per hectare) are generally those with large numbers of mineshafts requiring treatment (ES19), large non-developable areas (ES19) or significant costs associated with previous land use i.e Landfills/refuse tips (ES17, ES19 Area 4), chemical works (HS14), and other heavy industries such as Iron and Steel Works (HS23).

2.4.4 City Centre

This group consists of sites in the city centre and the Blakenhall area, which are not affected by historical coal mining and industry has not been as extensive as the east and south of the City (Table 2-E). There are also fewer constraints to development in terms of open and culverted watercourses, railway embankments and canals etc. Therefore the non-developable areas are limited on these sites and the preliminary risk rating and remedial costs would be expected to be relatively low which is reflected in the table with low/moderate-low risk ratings and relatively low cost estimates.

2.4.5 Wednesfield

The area of Wednesfield (Neachall's industrial area) (Table 2-F) is located in a mining area of the city and the previous land use is of relatively heavy industry with Galvanising Works, Foundries and Steel Works. The risks associated with these land uses are reflected in the table with risk ratings for both geotechnical and contamination generally ranging from moderate to high, with relatively high remedial cost estimates per hectare.

3 Conclusions

The risk rating and remedial cost estimation exercise has resulted in identifying general trends and hierarchy between the Strategic Sites and their respective Action Plan Areas. It is apparent that the areas of the City (Bilston and Wednesfield) that have been affected by historic coal mining and have a long history of heavy industry have higher risks, constraints and estimated remedial costs in comparison with the areas with no mining history and less extensive industrial past (Stafford Road, City centre and Blakenhall).

However, there is a degree of uncertainty associated with the preliminary risk assessments and remediation cost estimates as a result of the relatively limited availability of site specific data and absence of a detailed site inspection. For this reason, the remedial cost estimates are conservative and have a contingency built into the rates to cover the degree of uncertainty attached to the preliminary assessment at this stage.

The key to refining the preliminary risk ratings and reducing the liabilities associated with remediation costs will be to undertake further investigative work commencing with a detailed site inspection / walkover to identify onsite and offsite physical and environmental constraints. The results would be fed back into the preliminary risk assessment to allow an intrusive site investigation to be designed for the site with the objective of confirming the presence of potential liabilities at the site (identified by the desk study) and refining the potential remedial costs. This will allow the initial contingency attached to the provisional costs to be rationalised to reflect the actual site conditions and the development potential of the site.

In addition to rationalisation of the ground abnormal costs, supplementary assessment of the waste management issues associated with the site should be undertaken, with particular emphasis on the sites where substantial demolition of above ground structures is required prior to development. It is likely that Site Waste Management Plans will be required (under current Statutory requirements) for a large number of the sites and it would be prudent to formulate an overall strategy for waste management and sustainability for all the sites prior to development. As such, this should be a material consideration for the detailed site inspections.

References

- CIRIA C552 (2001) Contaminated land risk assessment - a guide to good practice
- English Partnerships (2008). Best Practice Note 27, Contamination and Dereliction Remediation Costs.
- Environment Agency website information:
  - Flood Risk, Groundwater, Landfills
- Jacobs (2009) WCC Level 2 Strategic Flood Risk Assessment

Appendix A Strategic Sites Location Plan

Appendix B Report Methodology

Section 1: Introduction

Site Location and Description

A plan with the site location and boundary was provided by WCC from their GIS database (in pdf format) for each site which was the basis for further research on current site use and layout as follows;

- Site Area: measured using web based applications including *eMap digital mapping* and *MAGIC interactive map*.
- Site Description: Aerial photography available on *Bing Maps, Google Maps* (including Google Earth).

Utilities and Physical Land Constraints

Utility plans were obtained from key service providers and reviewed to identify potentially significant constraints to development within the site and immediately adjacent the site boundary. The utility constraints were considered as follows;

- Electricity (E-on): any apparatus exceeding 11kV in voltage was considered to be significant and included on the constraints plan in Figure 3.
- Gas (National Grid): Any underground gas supply pipes that are medium pressure and above were considered to be potentially significant and included within the constraints plan (Figure 3).
- Water and Sewers (Severn Trent): identify culverts, trunk sewers or mains and associated infrastructure, e.g. pumping facility, treatment works etc. Generally pipelines exceeding 500mm in diameter were considered potentially significant and were included on the constraints plans (Figure 3).
- Network Rail: identify embankment, cuttings, viaducts. It is assumed that high voltage electricity cables are associated with railway lines and are one of the constraints.
- Telecommunications (BT): identify main distribution exchange buildings.
- Other pipelines and cables: identify any other major pipelines and cables within influencing distance of site from other utility supply plans.
- Other open or culverted watercourses were considered through review of historical mapping, previous flood risk reports completed by Jacobs (2009), and WCC culvert mapping provided.

In addition to the above, other potential physical constraints and/or non-developable areas identified from mapping were included on the Constraints Plan (Figure 3) such as canals, main highways and associated infrastructure (bridges, roundabouts, subways, abandoned railway lines and tunnels, public footpaths, culverts and mines drainage. For the purposes of this report it has been assumed that no easement is required for identified utilities/services with the exception of high pressure gas mains, where significant stand off distances may be required for construction and development.

It was assumed that where culverted watercourses were clearly identified on mapping an easement would be required for future access and maintenance and this would therefore represent a non-developable area of the site. For the purposes of estimating the area it was assumed that culverts were 2m in width with 5m of easement required either side.

Section 2: Site History

WCC historical plans, including Parish Plans and Ordnance Survey plans (taken from the WCC GIS database) and aerial photographs (Google Earth) were reviewed. A summary table was provided listing of identified progressive changes in site use and physical land form which may have resulted in potential contamination and geotechnical constraints. Where considered relevant surrounding land use was also described.

Based on findings of historical review, identify if the site warrants separation into individual 'zones' according to the potential contaminative usage and geotechnical constraints associated with the historical development of the site. The site zoning is carried forward to inform the remedial cost estimations and allow zoned areas of the site to be considered separately according to the respective risk.

Section 3: Ground Conditions

Geology: Using available geological maps and memoirs; provide a description of expected Made Ground, superficial deposits and solid geological strata together with geological faults, glacial channels and outcrops or sub-crops.

Mining: where a site is identified from geological plans as falling within an area likely to be affected by former coal mining activities, a mineshaft risk assessment report was commissioned from Johnson Poole & Bloomer (JPB) to assess risk of mine entries within the site and within 20m of site boundary.

The JPB risk assessment report includes the following;

- A review of the mine plans held within JPB and WCC archives, together with any other information held by WCC in previous reports relating to the site.
- A plan showing the best plot position of the mine entries and a schedule of mine entries located both on and within 20m of the site boundary.
- A preliminary assessment of the mineshaft stand off zones in relation to the end use of the site, i.e. residential or industrial.
- Broad comment on mineable mineral seams and mine drainage records (where available) together with information provided by the Coal Authority, i.e. a Coal and Brine Report for each site.
- Brief reference to the potential presence of mines drainage culverts.

The areas associated with mineshafts and their stand-off zones are considered to be significant constraints to development and represent non-developable areas of the site. Development over known (treated) mineshafts is only considered possible with large industrial units, and not permitted in residential development. Given that there are no details relating to future development proposals available for Employment and Commercial Sites and that the proposed land use could comprise industrial or commercial buildings, a worst case scenario approach was adopted assuming commercial development and that the shafts areas would be considered 'non-developable'.

The total non-developable area of the site was calculated using the stand-off zones (radius) approximated in the JPB report, and expressed as a percentage of the total area. The mineshafts areas were then excluded from remedial cost estimates, with exception of treatment costs.

Mineral Resources: Review WCC Mineral Commodity maps*, geological mapping and previous ground investigation reports for site area. Include brief comment for

sites under 5ha with more detailed assessment and comment provided for sites over 5ha. Include a brief statement in each report on potential presence of mineral resources, i.e. (opencast) coal, sand and gravel / clay extraction and feasibility of possible future extraction.

**Large scale and restricted detail of Mineral Commodity maps (covering whole of 'Black Country') limited level of assessment for larger sites to overview of likely ground conditions on site. In some cases geological mapping was relied upon for assessment where Mineral maps were unclear.*

Previous Ground Investigations: Research of WCC (Property Services) site investigation database and British Geological Survey (BGS) boreholes to identify exploratory holes that have been undertaken on or adjacent to the site (limited to a maximum distance of 100m from the site boundary). Utilise relevant information on ground conditions to inform conjectured stratigraphical succession (see below).

Summary of Ground Conditions: Summarise the anticipated stratigraphical succession beneath the site area. For sites affected by former coal mining, identify the approximate depth to mineral (Coal) seams beneath the site that have been potentially mined in the past and may affect the site using geological mapping, available previous ground investigations (from WCC database) and BGS boreholes.

The assessment of ground conditions is an approximation based on information available at the time of writing of desk study reports and is likely to vary on site when further site specific information becomes available.

Section 4: Environmental Setting and Sensitivity

Hydrology and Flood Risk: Using WCC mapping, Environment Agency (EA) website, Ordnance Survey mapping, Jacobs Flood Risk Assessments (Jacobs 2009) and Severn Trent mapping describe predominant hydrological features and specify EA designated Flood Risk Zone at the site.

Hydrogeology: Using EA website and geological mapping identify aquifer status of geological strata beneath the site. Identify if the site falls within a Source Protection Zone (SPZ) and if an abstraction is within an influencing distance of site.

Ground Gases: Using EA website and consultation with WCC Environmental Health identify recorded landfill sites within 250m of the site, together with any other potential source of landfill/ground gas that could affect the site. Identify potential risks associated with former mine gases and radon.

Contaminated Land: Using DoE Industry Profiles, previous site investigation data (where available) and consultation with WCC Environmental Health, summarise potential contaminants based on potentially contaminative historic and current land usage, including adjacent site usage where relevant.

WCC Environmental Health Consultation: Review and summarise letter report from WCC Environmental Health on site specific environmental data, contamination investigations and/or remediation works, pollution incidents relevant to the site.

Section 5: Preliminary Risk Assessment

Compile (qualitative) preliminary risk assessments for potential geotechnical and contamination constraints to development using published methodology in CIRIA

552 'Contaminated land risk assessment - a guide to good practice' (2001). Allocate a score to each identified risk (1 – very low to 6 – very high) based on likelihood and severity to enable an overall risk classification to be assessed for each site. The total score for all risks are averaged and then rounded up or down accordingly to give the final risk banding. The outcome of the risk assessment is carried forward to inform the remediation cost estimates.

Geotechnical Risk Assessment

Identify potential geotechnical hazards based on the site history and anticipated ground conditions for the site. A list of general hazards expected on all sites was established with additional site specific hazards included where appropriate (including coal mining hazards, railway embankments/cuttings, geological faults). The geotechnical hazards identified are summarised below;

1. Made Ground: variable thickness and composition associated with previous development with potential impacts on ground bearing and foundation integrity.
2. Former Structures: associated with previous and current buildings/structures, with potential for buried ground obstructions affecting new development.
3. Underground Tanks/Wells/Cisterns: associated with previous and current buildings/structures with potential for collapse and surface settlement.
4. Groundwater: potential for shallow groundwater to affect construction and new development.

With the following additional hazards included on a site-specific basis;

5. Shallow Mining: identified from geological plans, previous GI and Coal Authority report; potential for ground settlement affecting new (and existing) development.
6. Mineshafts: recorded shafts identified within JPB mine entry risk assessment; potential for collapse of shaft and ground settlement affecting new and existing development.
7. Mines Drainage / culverts: identified from WCC mapping and JPB report; potential non developable area / stand-off and potential for ground settlement (due to collapse).
8. Spontaneous combustion: potential for subterranean fire if high coal content is entrained within Made Ground / fills.
9. Geological Faults: identified from geology maps to be onsite; potential for voided or broken ground potentially affecting foundations and structures of new development.
10. Embankments/Cuttings (rail): identified from mapping / aerial photos; potential for maintenance and construction constraints onsite.
11. Japanese Knotweed: where this invasive species is identified from previous investigations this is taken into account as this plant growth can have severe consequences for concrete and structures.

The consequence of a risk being realised associated with each hazard was generally consistent, with the likelihood of the event occurring determined on a site specific basis. Professional judgement and experience of carrying out works in the area of Wolverhampton on behalf of WCC was utilised in order to carry out the risk assessments, in particular with respect to assessment of mining related risks such as likelihood and consequence of shallow mining and mineshafts hazards.

Contamination Risk Assessment

In accordance with current guidance, the contamination risk assessment considers risk to controlled waters, risk to human health and risk to buildings and infrastructure separately. The key risks considered for each site are as follows;

Risks to Controlled Waters

- Groundwater – The consequence of groundwater contamination is determined based upon the sensitivity of the aquifer. If the site overlies a Principal Aquifer the consequence of contamination is considered to be severe if within Zone I or II of an SPZ, or medium if within the outer/catchment zone. If a site overlies a Secondary A Aquifer the consequence is considered mild and for Secondary B/Unproductive Aquifers the consequence is expected to be Minor.
- Surface Water – The consequence of surface water contamination is dependent upon both the location of surface waters in proximity to the site and their sensitivity. Severe consequences may be expected if open sensitive surface watercourses (such as a river or stream) run through the site or medium consequences if running adjacent or in close proximity. Mild consequences may be expected if a less sensitive watercourse (such as a canal) or contained watercourse (culvert or canal) runs through or adjacent to the site, or if a sensitive open watercourse is located in the immediate surrounding area. Minor consequences may be expected if there are not any watercourses in the immediate surrounding area.

Risks to Human Health

- Soil and groundwater contamination
  Construction Workers - The consequence of human health impacts are considered to be mild given that exposure time is expected to be relatively low and mitigation measures for protection of workers are expected to be in place.
  Future Site Users – The consequences of human health impacts are considered to be severe for the residential end use given that significant exposure is likely over a long period and sensitive human health receptors (e.g children) may be impacted. Consequences are considered to be medium in the industrial/commercial land use.
- Gases – the risk to human health from ground gases is considered to be severe in terms of construction workers and future site users who may be asphyxiated in both future end use scenarios.
- Asbestos – the risk from asbestos is considered to be severe to both construction workers and future site users (in both end use scenarios).

Risks to Buildings and Infrastructure

- Soil and groundwater contamination
  Aggressive Contaminants – the consequence of aggressive contaminants on infrastructure, specifically concrete is considered to be mild, given that building materials can be designed in accordance with the level of risk.
  Organic Contamination – the consequence of organic contaminants on water supply pipes is considered to be medium in the residential end use and mild in the commercial/industrial end use. This is based on the sensitivity of the receptor which may be exposed through ingestion and also that pipes may be designed in accordance with the level of risk.
  Ground Gases –

The accumulative and explosive risk to buildings and infrastructure from ground gases is considered to be severe in terms of both future end use scenarios.

Complete the section with a summary of the key potential pollutant linkages identified at the site which have been rated moderate, high or very high and carry forward to remedial cost estimation.

Section 6: Remedial Cost Estimates

A number of factors have an influence on the geotechnical and contamination remedial cost estimates which are discussed in the sections below. For purposes of remedial cost estimation the following are considered to represent potentially non-developable areas of the site and these areas have been excluded from cost estimations;

- Mineshaft stand off zones
- Railway Land (excluded where significantly encroaches within the site boundary
- Canals on site
- Culvert easements
- Other potentially non-developable areas such as viaducts, tunnels, significant strategic road networks, footpaths.

Geotechnical Costs

The estimated geotechnical ground abnormal costs are calculated based on the estimated areas of the site that will be occupied by built development (i.e 20% assumed for residential and 60% for industrial/commercial end uses as advised by WCC Planning Department). Geotechnical ground abnormals have been limited to the following categories to focus on the key constraints and associated costs likely at each site;

- Removal of Ground Obstructions: where site history indicates a potential for significant sub-surface physical obstructions (e.g. foundations, pile caps, basements, cellars) an allowance is included for removal (to an assumed maximum depth of 3m).
- Ground Treatment: where Made Ground coverage is anticipated to be significant, a form of ground treatment (i.e. excavate and re-compact, vibro-piling or CFA piling*) is allowed for to create a suitable bearing for development appropriate to the site conditions. Where a significant coverage of Made Ground is anticipated (>3m), vibro-piling is the preferred ground treatment option. Where Made Ground coverage is likely to be thin (<3m), excavate and re-compact is the preferred ground treatment solution.

**CFA piling is not considered a suitable foundation solution in mining affected areas*)

- Foundations: An allowance is included for reinforced concrete raft foundations for residential buildings in areas affected by coal mining and where abandoned mine shafts are known or suspected to be located onsite.
- Ground Gas protection within foundation construction: where a potential source of ground gas is identified in the risk assessment basic ground gas

protection measures (i.e. geo-membrane and/or granular sub-base) are allowed for within the foundation construction.

- Shallow Coal Workings: an allowance is included for the treatment of abandoned shallow coal workings. Thin worked coal seams within 30m depth are considered to be a potential risk to development that requires treatment. Where the Thick Coal seams are identified beneath the site, the influencing distance is extended to 50m depth.
- Treatment of mineshafts: There may be the potential for mineshafts outside the site boundary and within influencing distance to pose a risk and require treatment prior to development. However for the purposes of remedial cost estimation only costs associated with treatment of shafts within the site boundaries have been accounted for (as this is only a comparative exercise). If a mineshaft is noted as being treated but specification details to current standards are not available, it is assumed as being a potential risk and therefore full treatment is allowed for within cost estimates. Treatment costs for unrecorded shafts are not accounted for within cost estimates.
- Dewatering of excavations has been included where considered appropriate, at either 10 or 20% of the site area dependant upon site specific risk areas such as potential infilled basements, cellars, infilled canal basins, drainage ditches, deep areas of fill/Made Ground.

The total cost for each zone and the overall total is calculated using the spreadsheet and quoted within reports.

Cost estimates for geotechnical abnormals are those provided by both WCC geotechnical department and based on Jacobs' professional judgement and experience, construction cost databases and utilising significant previous experience of working on large scale regeneration projects in the Wolverhampton area.

The remediation cost estimates are for the purposes of comparison for the exclusive use of WCC for strategic planning purposes. They are not to be used for redevelopment budget costing for construction purposes by WCC or third parties.

Contamination Costs

The potential contamination remediation costs are estimated using the methodology described in the Best Practice Note 27 (English Partnerships 2008) taking into account the results of the preliminary risk assessment.

Cost influencing factors are discussed below;

- Site Area – remedial cost estimations are calculated based on the developable area of the site (i.e this is not associated with area of proposed building footprint as is the case with geotechnical costs),
- Land Use Category – Types of land use are described in the BPN from categories A – D with A as the least contaminative and D the most contaminative. Historical land uses not included within these examples were designated a category based on potential for contamination which was consistent throughout the desk study assessments.
- Water Risk – High water risk is considered to be appropriate in cases where open sensitive watercourses run through or adjacent to sites, or where sites are underlain by Principal Aquifers and in close proximity to SPZs (obviously this is also dependant upon the presence of a source on site). Low risk sites are considered to be those without any sensitive open watercourses in close

proximity (i.e those with canals running through site, or culverts beneath), or overlying Secondary A or B Aquifers.

Once the above cost-influencing factors have been determined, an informed judgement has to be made (on a site specific basis) on whether the remediation costs are likely to be towards the lower or upper end of the cost range for each site (or zone). The factors taken into account when making this decision include;

- Size of site: for small sites, less than 5ha in size, the higher end of the range should be considered to allow for the absence of economies of scale. Conversely, the lower end of the range should be used for large sites.
- Density of site: for large sites it is unlikely that the whole area would need remediation and therefore the lower bound costs should be used. For small sites that have been heavily developed, the upper bound would be more appropriate.
- Duration of use: where a site has been subject to a specific contaminative use for a very long period, it is likely that some contamination is more widespread and therefore remediation costs could be higher than anticipated and therefore the higher bound of costs would be appropriate. If a site has only recently been developed there is a reduced potential for widespread contamination and therefore the lower bound of costs would be appropriate.
- Geology: if the site is underlain by cohesive materials, the lateral and vertical migration of potential contamination is likely to be mitigated and therefore the lower bound of costs would be appropriate.

The total estimated contamination remediation cost is summed and carried forward and added to the geotechnical costs to give a total estimated remediation cost for the site.

Remedial cost estimates are taken from the Best Practice Note (BPN) (English Partnerships 2008) which are based on Spons Civil Engineering and Highway Works Price Book (2007) and BPN authors' experience of various remediation scenarios.

The remediation cost estimates are for the purposes of comparison for the exclusive use of WCC for strategic planning purposes. They are not to be used for redevelopment budget costing for construction purposes by WCC or third parties.

Section 7: Conclusions

A summary of the potential geotechnical and contamination risks is presented together with the key findings of the preliminary risk assessments, the overall site risk ratings and estimated remedial costs.

Recommendations are provided for further assessment which is likely to be required for future development of the site including a site walkover and intrusive investigation. Further consultations with various service providers and landowners (e.g Network Rail and British Waterways) are recommended where relevant.