THE MERSEY GATEWAY PROJECT

CONTAMINATION OF SOILS, SEDIMENTS AND GROUNDWATER

CHAPTER 14.0

CONTAMINATION OF SOILS, SEDIMENTS AND GROUNDWATER

C O N T E N T S

14. CONTAMINATION OF SOILS, SEDIMENTS AND GROUNDWATER

14.1 Introduction

14.1.1 This Chapter of the Environmental Statement (ES) provides a summary of the detailed assessment of contamination issues in relation to soils, sediments and groundwater. This Chapter summarises those significant contamination effects identified by site investigations and technical assessment work and sets out mitigation and remedial measures where appropriate, concluding with a summary of the residual effects following mitigation.

14.1.2 This assessment draws on desk-based studies using published information relating to historical land uses, ground conditions and information from previous investigations together with information obtained from site investigations undertaken specifically for the Project.

14.2 Purpose of the Study

14.2.1 The work undertaken for the contamination assessment is intended to provide sufficient information to allow an assessment of ground conditions and potential effects associated with contamination as a result of the construction and operation of the Project. Potential mitigation measures to reduce the identified effects have been provided, followed by a description of residual effects and requirements for future monitoring.

14.2.2 Further investigations will ultimately be required to confirm detailed design criteria and to enable the design and any mitigation measures to be finalised.

14.3 Study Area

14.3.1 The study area for the contamination assessment is based on the Project area between St Michaels Golf Course in Widnes and the M56 Junction 12 in Runcorn (Figure 1.3, Chapter 1) which is located in North West England. For the purposes of this Chapter this is referred to as the Project area. Where relevant information was obtained relating to historical land uses and ground conditions outside the Project area, these were also included as part of the assessment.

14.3.2 In addition to the information obtained from the desk based studies, a series of site investigations have been undertaken. The locations of the exploratory holes and geophysical transits were chosen in order to investigate ground conditions in the Project area and areas of possible contamination highlighted from the desk studies and historical investigations, reports and plans. The site investigations have been undertaken in phases to take into account developing proposals for the Project area and to take into account information obtained on ground conditions from preceding phases. Each investigation took account of the information available at the time the investigation was designed.

14.3.3 For the purposes of assessing the results of the investigations, the Project has been divided into a number of areas (A-I). These are shown on Figure 14.1 (Appendix 14.1). These areas are consistent with those outlined in the Construction Methods Report (MG_REP_EIA_010), although they have been sub-divided further for the purposes of this assessment. The areas used in this assessment can be summarised as follows (the areas from the construction methods report (CMR) (Chapter 2, Appendix 2.1) are shown in brackets):

a. Area A – Main Toll Plaza (St Michaels Golf Course) (CMR Area A);
b. Areas B1 to B2 – Ditton Junction to Freight Line (CMR Area B), which includes toll plazas;
c. Area C – Freight Line to St Helens Canal (CMR Area C), which includes the Widnes Loops and toll plazas;
d. Area D – Mersey Gateway Bridge (CMR Area D) and approach viaducts;
e. Area E – Astmoor Viaduct (CMR Area E);
f. Area F – Bridgewater Junction (CMR Area F);
g. Areas G1 and G2 – Central Expressway, Lodge Lane Junction and Weston Link Junction (CMR Area G);
h. Area H – M56 Junction 12 (CMR Area H); and
i. Areas I1 and I2 – Widnes De-linking (CMR Area I) of existing road embankments

14.3.4 A description of the construction proposals and methods with particular reference to where these require consideration of ground conditions is outlined below, a more detailed description is contained within the Construction Methods Report (Chapter 2 Appendix 2.1). A summary of the proposed foundation works which are most relevant to this topic is as follows.

a. It is proposed that the ground beneath the embankments in Widnes for the new carriageways would be improved by the installation of a grid of vibro-concrete columns. The resulting grid of vibro-concrete columns would be overlain with geotextile membranes and layers of imported granular fill material;
b. The construction of culvert extensions for Stewards Brook in Area A would involve some excavation below ground level;
c. Towards the centre of the Widnes Loops Junction in Area C there would be two single span bridges allowing the on-slip road to pass beneath the main carriageway of the new road (Widnes Loops East Bridge) and the on-slip itself before it merges with the main carriageway (Widnes Loops Slip Road Bridge). These would be box structures with spans of approximately 20m that would eliminate the need to excavate deep foundations.

These would be founded on ground that had been improved using the techniques described above;

d. Piled foundations comprising replacement methods would be required for abutments and approach viaducts such as at the Ditton Junction, Victoria Road Viaduct and the northern and southern abutments. Piling excavation arisings and pile caps arisings would be re-used in the works where possible;

e. The piled foundations for the approach viaducts in Area D would comprise groups of large diameter rotary bored cast in situ concrete piles with a stone piling platform created at each pier location in order to construct these. Temporary pile casings to support the excavation would be driven down, using vibration methods, to the level of the glacial clay or the bedrock;

f. The towers in the Estuary would be supported by large diameter piles or rectangular barrettes. Barrettes are large rectangular piles formed using conventional diaphragm walling equipment and techniques, which can accommodate high horizontal forces, moments and vertical loads. These barrettes would be taken down to rockhead within a piled cofferdam;

g. Piled foundations are likely to be required for structures at Bridgewater Junction and Lodge Lane Junction in Runcorn, earthworks would be needed for the formation of new embankments and the highway carriageway. A new retaining wall will be constructed on the south-east side of the existing north roundabout at M56 Junction 12 in Area H. This would involve the installation of a line of contiguous bored concrete piles over a length of 75m and 262m of inverted reinforced concrete retaining wall; and

h. The existing embankment and viaduct linking to the Widnes Eastern Bypass in Area I would be removed. The material from the Widnes Eastern Bypass and Queensway embankments would be re-used in the works where possible.

14.4 Relevant Legislation and Planning Policy

14.4.1 A summary of relevant legislation and policies relating to contaminated land is provided in Table 14.1.

Table 14.1 – Contamination Legislation and Policy

	Title	Relevance to the Project
European	Water Framework Directive (Ref. 1)	Protection, improvement and sustainable use of water resources for which a holistic approach is adopted in the consideration of water bodies within specific river basins
National	Environmental Protection Act (EPA) Part IIA (Ref. 2)	Provides a framework for the identification of statutory '*Contaminated Land*' and, where necessary, its remediation. The source-pathway-receptor (pollutant linkage) approach is adopted for assessment of 'unacceptable risk'.
	Planning Policy Statement (PPS) 23: Planning & Pollution Control (Ref. 3)	Annex 2 of PPS23 provides guidance on how the development of contaminated land is to be controlled through the planning process.
	The Water Resources Act (Ref. 4)	Sets out the responsibilities of the Environment Agency in relation to water pollution, resource management, flood defense, fisheries and in some areas, navigation. It sets out a framework for licensing and prosecution relating to water pollution (surface and groundwater).
	Groundwater Regulations (Ref. 5)	Sets out provisions for the discharge of listed substances to groundwater through a license process governed by the Environment Agency.
Regional	Regional Planning Guidance for the Northwest (RPG13) (Ref. 6)	The RPG develops a regional strategy within which local development and transport plans can be prepared. RPG13 focuses on environmental issues associated with derelict and contaminated land, air and water quality, waste management and radioactive waste.
Local	Halton Borough Council Contaminated Land Inspection Strategy (Ref. 7)	Local Authorities are required under Part IIA of the EPA (Ref. 2) to inspect land within their administrative boundaries and identify land at potential risk of being determined as 'Contaminated Land' and to rank them in order of priority for more detailed investigation. The HBC Contaminated Land Inspection Strategy sets out priority ranked sites within Runcorn and Widnes.
	Halton Borough Council Unitary Development Plan (UDP) – Chapter 4 Pollution & Risk (Ref. 8)	Policy PR6, PR7, PR13, PR14 and PR15 in Chapter 4 of the UDP relate to objectives to reduce the potential of various land uses to cause continuing harm and to improve the potential to create a safe, healthy and prosperous economy, environment and society.

14.4.2 A review of policy and legislation relating to waste management is considered within Chapter 13 (Waste and Materials) and to surface water in Chapter 8 (Surface Water Quality).

14.4.3 Part IIA (Ref. 2) and PPS23 (Ref. 3) are considered to be the principal tests for assessing the significance of contaminants identified during the site investigations.

14.4.4 Part IIA provides a framework for the identification of Statutory 'Contaminated Land' and, where necessary, its remediation. Part IIA was amended in 2006 and these changes are outlined in DEFRA Circular 01/2006 (Ref. 9). Under Part IIA Local Authorities are required to:

a. Cause their areas to be inspected to identify contaminated land;
b. Determine whether any particular site is contaminated land; and

c. Act as enforcing authority for all contaminated land which is not designated as a 'special site' (the Environment Agency are the enforcing authority for special sites).

14.4.5 Part IIA addresses 'unacceptable risk'. The approach is based upon the principles of risk assessment, using the concept of a contaminant, a receptor and a pathway, which combine to form a pollutant linkage. The presence of a significant pollutant linkage forms the basis of a formal determination that land is contaminated.

14.4.6 The Environmental Protection Act provides the statutory definition of Contaminated Land for the purposes of determining land where remedial action is required, this is as follows:

'Contaminated Land is any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:

Significant harm is being caused or there is a significant possibility of such harm being caused; or
Pollution of controlled waters is being, or is likely to be, caused.'

14.4.7 Annex 2 of PPS23 states that an ES should ensure that the likely significant environmental effects of the proposed development and the measures proposed to mitigate those effects are fully understood and are taken into account before development is allowed to proceed. PPS23 also states that it may not therefore provide comprehensive information about the existing condition of the land. Such information would be provided only to the extent that it is relevant to the environmental effects of the development itself or to the means by which the development is to be carried out. Therefore, an ES is no guarantee by itself that the potential for contamination at a site to affect the proposed development has been fully assessed.

14.4.8 Annex 2 of PPS23 also states that the standard of remediation to be achieved through the granting of planning permission for new development is the removal of unacceptable risk and making the site suitable for use. As a minimum, after carrying out the development and commencement of its use, the land should not be capable of being determined as statutory 'Contaminated Land' under Part IIA.

14.4.9 Chapter 4 of the UDP covers pollution and risk relating to contaminated land. The policy for land quality (PR6) states that development will not be permitted if it is likely to cause contamination of the soil or sub-soil on a development site or on surrounding land uses.

14.4.10 Policy PR7 states that development near to existing sources of pollution will not be permitted if it is likely that those existing sources of pollution will have an unacceptable effect on the proposed development and it is considered to be in the public interest that the interests of the existing sources of pollution should prevail over those of the proposed development. Exceptions may be permitted where proposals to substantially mitigate the effects of pollution are submitted.

14.4.11 The policy for vacant and derelict land (PR13) states that development and reclamation will not be permitted unless they are carried out to ensure the safety and health of people and the environment, the proposal is a suitable after use and the proposal complies with other relevant policies within the UDP.

14.4.12 The policy for contaminated land (PR14) states that assessments of the nature and degree of contamination are required and that remedial measures should be identified to deal with any hazard to safeguard future development and neighbouring land uses. The policy for groundwater (PR15) states that proposals that are likely to lead to an adverse impact on groundwater resources will not be permitted.

14.5 Assessment Methodology

Consultations

14.5.1 Consultations have been undertaken with the Environment Agency and Local Authority Contaminated Land Officer from Halton Borough Council as part of these investigations. Information on the dates and records of the minutes from the meetings are included in Appendix 14.2.

14.5.2 The investigations and subsequent assessments were undertaken in line with current best practice guidance and standards. A review of the main standards and guidance used in the investigation is outlined in Table 14.2.

Table 14.2 – Guidance and Standards

Source	Date	Title
British Standards Institute (BSI)	2001	BS10175 Investigation of Potentially Contaminated Sites – Code of Practice (Ref. 10)
British Standards Institute (BSI)	1999	BS5930 Code of Practice for Site Investigations (Ref.11)
CIRIA	2001	C552 Contaminated Land Risk Assessment – A Guide to Good Practice (Ref. 12)
Environment Agency	2005	Guidance on Requirements for Land Contamination Reports (Version 1) (Ref. 13)
Environment Agency	2004	CLR 11: Model Procedures for the Management of Contaminated Land (Ref. 14)
DEFRA	2006	Contaminated Land Advice Note (CLAN) 6/06 – Assessing Risks from Land Contamination – A Proportionate Approach. Soil Guideline Values the Way Forward (Ref. 15)
Highways Agency	2005 & 2006 amendments	Design Manual for Roads and Bridges (DMRB) (Ref. 16 and Ref. 17)

Desk Study Information

14.5.3 A review of published information obtained on historical site uses and ground conditions for the Project area and information obtained from previous investigations was undertaken. Information on site history was obtained from the following sources.

a. Historical Ordnance Survey (OS) Maps (1:2500 to 1:10,560 scale) and Envirocheck Reports from Landmark in Appendix 14.3 ;
b. Public Records Office at Kew;
c. Catalyst Museum in Widnes;
d. Halton Borough Council; and
e. Cheshire County Council Records Office.

14.5.4 Information on ground conditions from published sources was obtained from the British Geological Survey and Environment Agency and from previous reports. The previous reports were obtained from Halton Borough Council.

14.5.5 When there were amendments to the Project area, for instance the addition of toll plazas at St Michaels Golf Course, then the desk based information was extended to include such areas.

14.5.6 A desk top threat assessment was obtained for the Contamination Study Area to assess possible risks from unexploded ordnance. The desk top threat assessment is included in Appendix 14.4.

Site Investigations

14.5.7 In order to obtain information on the ground conditions, groundwater and ground gas/vapours to establish the baseline within the study area a series of site investigations were undertaken. The locations of the exploratory holes and geophysical transits were chosen in order to investigate ground conditions within the vicinity of the proposed route and areas of possible contamination highlighted from the historical information, reports from previous investigations and plans. Each phase of investigation took account of the information available at the time the investigation was designed.

14.5.8 Geophysical investigations were undertaken in 2002 to determine depth to bedrock within the estuary and beneath the saltmarshes. The findings of this investigation are located in Appendix 14.5.

14.5.9 The site investigations were undertaken in a number of phases between 2002 and 2007 as the Project was developed. Table 14.3 outlines the phases of site investigation that were undertaken.

14.5.10 The exploratory hole locations for the Phase 1 to 6 site investigations are shown on Figures 14.2 to 14.8 (Appendix 14.1). The factual site investigation reports are located in Appendix 14.6.

Table 14.3 – Phases of Site Investigation

Site Investigation Reference	Objective
Phase 1	**Land Based Site Investigation (2002)** To determine the ground and groundwater conditions in the areas of Widnes north of St Helens Canal and south of the Manchester Ship Canal in Runcorn to the junction with the Bridgewater Junction.
Phase 2	**Saltmarsh Site Investigation (2002)** To determine the ground and groundwater conditions beneath the saltmarsh areas.
Runcorn Sands Site Investigation (Phase 3)	**Runcorn Sands Site Investigation (2002)** To determine the ground and groundwater conditions at shallow depth within the intertidal area of the Estuary.
Phase 4	**Additional Site Investigation (2005)** To determine the route specific ground and groundwater conditions in the areas north of St Helens Canal, on Wigg Island and beneath the saltmarshes.
Phase 4A Catalyst Trade Park Site Investigation	**Additional Site Investigation (2006)** To determine the route specific ground and groundwater conditions for the Catalyst Trade Park.
Phase 5 Estuary Investigation	**Additional Site Investigation (2006)** To determine the route specific ground conditions within the River Mersey.
Phase 6	**Additional Site Investigation (2007)** To determine the route specific ground and groundwater conditions based on reference design between St Michaels Golf Course in Widnes and the M56 Junction 12 for areas added to the Project area by Halton Borough Council in 2006.

14.5.11 The following table provides an outline on the number and type of exploratory holes that were undertaken during each phase of site investigation.

Table 14.4 – Number and Type of Exploratory Holes

Phase	No. Light Cable Percussion Boreholes	No. Rotary Boreholes (as follow-on)	No. Window Samples	No. Trial Pits/Trenches
1 & 2	39	13	3	25
3	-	-	26	-
4	17	7	9	-
4A	8	-	8	-
5	5	5	2	-
6	89	8	35	-

14.5.12 A range of investigation techniques were used during the site investigations, these comprised cable percussion and rotary boreholes, window sampling and trial pitting with soil and water samples being obtained for chemical testing.

14.5.13 Due to the likelihood of encountering contamination within some parts of the Project area, investigation methods took into account the possible presence of soil and groundwater contamination.

14.5.14 Monitoring wells were installed into boreholes and window sampler holes to allow for groundwater and gas/vapour monitoring, these were installed to cover the range of horizons encountered. Up to 10 rounds of groundwater sampling and chemical testing were undertaken. Monitoring for free product was undertaken prior to obtaining groundwater samples. In addition to this specific sampling for free product was also carried out. Ground gas monitoring was undertaken to obtain information on parameters such as methane and carbon dioxide. Monitoring for volatile vapours using a photo-ionisation detector was undertaken on soil arisings from exploratory holes during the site works and as part of gas and groundwater monitoring.

14.5.15 Based on specific information obtained on the site history, radiological monitoring was undertaken on arisings from exploratory holes located at the Catalyst Trade Park in Widnes.

14.5.16 Soil and groundwater samples were sent to suitably accredited analytical laboratories for chemical testing where they were tested for a range of possible contaminants based on historical information, observations on ground conditions during the site works and the findings from previous rounds of investigation. The parameters tested can be summarised as follows.

a. Metals and metalloids;
b. Other inorganic contaminants such as sulphate, sulphide, asbestos, cyanide and ammonia/ammoniacal nitrogen;
c. Organic carbon and pH;
d. Volatile and semi-volatile organic compounds (VOCs and SVOCs);
e. Pesticides and herbicides;
f. Polychlorinated biphenyls (PCBs);
g. Polyaromatic hydrocarbons (PAHs); and
h. Petroleum hydrocarbons.

14.5.17 Chemical analysis results are included in Appendix 14.7.

Assessment Criteria - Generic

14.5.18 The assessment of contaminated land in the UK is based on a 'suitable for use' approach for a defined end-use and current guidance advocates using a tiered approach for assessing the risk from soil contamination starting with an initial screening exercise (using Generic Assessment Criteria (GAC) and referred to as Tier 1). These criteria are included in Appendix 14.8 The

purpose of the screening exercise is to identify areas of contamination above the generic assessment criteria where it may be necessary to undertake a site specific risk assessment (sometimes referred to as Tier 2 and 3) or to implement mitigation measures.

14.5.19 Guidance in the Design Manual for Roads and Bridges (DMRB) Volume 2 (Ref. 17) considers that appropriate generic guideline values that are based on a risk assessment model can be used as default values. This guidance indicates that for human health, the series of Soil Guideline Values (SGVs) published by DEFRA and the Environment Agency (Ref. 18) provide suitable default values for assessing contaminants.

14.5.20 The DMRB considers that for general fill, the limiting values for harm to human health should normally be based on the 'commercial/industrial' land use category of guideline values as there is a very low risk of exposure to the public from any contaminants in the fill. The exposure scenario for a commercial/industrial land use is based on the standard land uses outlined in CLR10 (Ref. 19), the other standard land uses being residential and allotments. For landscaping fills, considerations of phytotoxicity (toxicity to plants) will be important. The use of generic assessment criteria, as indicated in the DMRB, has been used to screen the contaminants encountered from site investigations.

14.5.21 To assess the results of the chemical testing the Project was divided into a series of areas based on the identified historical land uses. These are shown on Figure 14.1 (Appendix 14.1) and a summary of each area is provided below.

a. Areas A & B1 – St Michaels Golf Course and Ditton Junction;
b. Areas B2 & I1 – Gussion Transport and Anglo Blackwells;
c. Area C – Catalyst Trade Park (CTP) and Thermphos. This includes the Western and Northern part of Area C and the Northern part of Area I2 (former Railway Land);
d. Area D – Saltmarshes and River Mersey
e. Areas E to F – Astmoor Industrial Estate to Bridgewater Junction;
f. Areas G1 to G2 – Central Expressway (Weston Link Junction to M56 Junction 12); and
g. Area I2 – De-Linking of A533 and A557 Expressway road embankments;

14.5.22 The results of the chemical testing and monitoring were compared against generic assessment criteria derived from the sources listed in Table 14.5.

Table 14.5 – Assessment Criteria for Contamination Testing and Monitoring Results (continued overleaf)

Purpose	Receptor	Source of the Assessment Criteria
Contaminants in Soil	Human Health: GAC for site uses based on a Commercial/ Industrial Land Use as outlined in DMRB (Refs.16&17)	GAC derived using input parameters on contaminants from Soil Guideline Values (SGVs) and other similarly derived soil assessment criteria and default exposure criteria for Commercial/Industrial land use which were input into the Contaminated Land Exposure Assessment (CLEA) UK Model.
	Human Health: Construction Workers	Assessment criteria derived using input parameters for contaminants from Soil Guideline Values (SGVs) and other similarly derived soil assessment criteria and site specific exposure criteria which were input into the Contaminated Land Exposure Assessment (CLEA) UK Model.

Table 14.5 (continued) – Assessment Criteria for Contamination Testing and Monitoring Results

Purpose	Receptor	Source of the Assessment Criteria
Contaminants in Soil	Toxicity to Plants (Phytotoxicity) in Landscaping Areas	Ministry for Agriculture Fisheries and Food (MAFF) Soil Code (Ref. 20)
	Buried Concrete Foundations	BRE Special Digest 1 (Ref. 21) (Design Sulphate Class (DS) 1) used as Tier 1 screening value
	Buried Water Supply Pipes	Water Regulations Advisory Scheme (WRAS) Guidance on the Selection of Materials for Water Supply Pipes to be laid in Contaminated Land (Ref. 22).
Contaminants in Sediment on Saltmarshes and Estuary	Aquatic Organisms in the Estuary from	Interim UK Marine Special Areas of Conservation (SAC) Sediment Quality Guidelines (Ref. 23).
Contaminants in Groundwater and Soil Leachate	Controlled Waters	Environmental Quality Standards (EQS) for List I and II substances from the Dangerous Substances Directive (Ref. 24) Water Supply (Water Quality) Regulations (Ref. 25) referred to as UK Drinking Water Standards (DWS) The Surface Water (Abstraction for Drinking Water)(Classification) Regulations (SWDWS) (Ref. 26)
Ground Gas and Vapours	Human Health	CIRIA C665 Assessing Risks posed by Hazardous Ground Gas (Ref. 27) (Characteristic Situation (CS) 1 used as Tier 1 screening value) Health and Safety Executive Workplace Exposure Limits (Ref. 28)

Assessment Criteria – Project Specific

14.5.23 Soil Guideline Values (SGVs) have been derived by the Environment Agency and DEFRA for limited number of individual substances.

14.5.24 SGVs were intended as tools for local authorities to use in determining whether land may be contaminated on the basis that there is a significant possibility of significant harm being caused (SPOSH), in relation to human health effects (DEFRA, Ref. 15).

14.5.25 For contaminants where an SGV has not been published, it was necessary to derive GAC for a commercial/industrial land use. The information obtained on the contaminant properties for the GAC was also used to derive assessment criteria for construction workers. This was undertaken following the approach outlined in CLR9 (Ref. 29) and CLR10 (Ref. 19) and by inputting the data into the CLEA UK beta model (CLEA UK) (Ref. 30). CLEA UK has been developed by the Environment Agency and Department for the Environment, Food and Rural Affairs (DEFRA).

14.5.26 Separate GAC based on a commercial/industrial land use were derived for areas in Widnes and Runcorn. Commercial/industrial land use GAC were not derived for the saltmarshes and estuary in Area D because the approach viaducts and bridge will be raised on piers in this area. On this basis it was considered that there was no risk to site users.

14.5.27 Where contaminants exceed their respective GAC for a commercial/industrial land use, in accordance with guidance outlined in CLR7 (Ref. 31), a mean and maximum value test was undertaken for that part of the Project area (based on areas outlined in Section 14.3).

14.5.28 The mean value test involves determining a value, US_{95} (the upper 95th percentile bound), that is the true average concentration of a contaminant within a particular averaging area. This means that the concentration of the contaminant within that averaging area will be less than the US_{95} value with a 95% confidence level. The maximum value test is then carried out to determine if the maximum value in the data set represents a statistical outlier, which could indicate a potential hotspot of contamination.

14.5.29 The US_{95} value was derived using the one-sided non-parametric version of Chebyshev's Theorem and the results of this assessment were compared against GAC for a commercial/industrial land use.

14.5.30 Assessment criteria for soils were derived on a site specific basis for construction workers in all areas including the saltmarshes and estuary.

14.5.31 Project specific criteria were not derived for other factors such as sediments, water, plants in areas of landscaping, buried concrete foundations or plastic water supply pipes.

14.6 Baseline and Results of Investigations

Introduction

14.6.1 This section comprises a review of the published information obtained for the Project area followed by information on the historical site uses, landfills and waste management, ground conditions, the results of the soil and groundwater analysis, and the results of the ground gas and vapour monitoring for each area. This is considered on an area by area basis using the areas defined in Section 14.3.

14.6.2 The review of historical information is based on the historical OS maps. The information on landfills and waste management facilities is based on information from the Envirocheck Reports from Landmark.

14.6.3 Additional information from previous investigations and plans on site history and ground conditions was also considered.

Published Information on Ground Conditions

14.6.4 The published ground conditions for the Project area have been obtained from the 1:50,000 scale British Geological Survey (BGS) Drift (Ref. 32) and Solid (Ref. 33) editions, Sheet 97 (shown in Figures 14.9 and 14.10 in Appendix 14.1), which show the area to be underlain by Quaternary Drift deposits which overlie Triassic Sherwood Sandstone Group bedrock.

14.6.5 The general underlying stratigraphy based on published information for the Project area is outlined in Table 14.6.

Table 14.6 – General Stratigraphy for the Study Area

Strata Type	Group/Unit		Age	Period
Recent Deposits	Made Ground & Fill		Recent	Recent
Drift Deposits	Marine & Estuarine Alluvium Shirdley Hill Sand Glacial Till		Flandrian to Recent Flandrian Devensian	Quaternary
Solid Strata	Lower Keuper Marl Keuper Waterstones	Mercia Mudstone Group	Scythian	Triassic
	Upper Mottled Sandstone Pebble Beds	Sherwood Sandstone Group		

Solid Geology

14.6.6 The BGS solid geology map (Ref. 33) shown in Figure 14.10 (Appendix 14.1) shows that Area A to G is underlain by sandstone bedrock from the Upper Mottled Sandstone and Pebble Beds. Mudstones and siltstones of the Keuper Waterstones are shown at the Central Expressway in Area G. Mudstones of the Lower Keuper Marl are shown from the Lodge Lane Junction to M56 Junction 12 in Areas G and H in Runcorn.

14.6.7 The geological map shows the strata to have a general south easterly dip at a relatively shallow angle of approximately 15 degrees. There are two prominent faults within the Project area with further subsidiary faults to the south of the Project area.

14.6.8 A buried channel of the River Mersey is shown on the BGS map cut into the sandstone bedrock. This feature lies to the north of West Bank and is shown to present in parts of Areas A, B and C and is the result of glacial erosion.

Drift Deposits

14.6.9 The BGS drift geology map (Ref. 32) shown in Figure 14.9 (Appendix 14.1) shows Glacial Till (formerly known as Boulder Clay) overlying the bedrock across much of the Project area. The glacial till is described as comprising clay interbedded with discontinuous horizons of sand or sand and gravel. This is shown to form an extensive sheet, which varies in thickness from the north to south side of the river. North of the Mersey the glacial deposits are shown to be up to 40m thick although it is noted in the published information that they may be thicker still in glacially eroded channels in the bedrock.

14.6.10 The BGS map shows the glacial till is likely to be present near surface in Widnes in the northern part of Area A, beneath the northern part of Anglo Blackwells in Area B2 and beneath the Catalyst Trade Park in Area C. In Runcorn the BGS drift map indicates that the glacial till is likely to be present near surface beneath the former Wigg East Works (also known as the Kemet Works) on Wigg Island in Area D, and the area between the Astmoor Industrial Estate and Bridgewater Junction in Areas E and F.

14.6.11 To the south of the River Mersey the bedrock is shown as being typically overlain by 10m to 20m of glacial till.

14.6.12 Glacial sand and gravel are shown at the surface on the BGS drift geology map around M56 Junction 12 in Area H.

14.6.13 The glacial deposits are shown as being overlain by marine and estuarine alluvium on the BGS drift geology map. In the Project area in Widnes, alluvium is shown beneath Areas A to D on Widnes Warth saltmarsh, the existing Thermphos UK Ltd site and the southern part of Catalyst Trade Park, Gussion Transport and the southern part of Anglo Blackwells, Ditton Junction and St Michaels Golf Course (within Areas A to C). This alluvium in Widnes relates to a previous course of the River Mersey which flowed to the north of West Bank. . Alluvium is also shown beneath Astmoor saltmarsh in Area D in Runcorn.

Made Ground

14.6.14 Made ground is material that has been placed by man and can be divided into those composed of reworked natural soils and those composed of man-made materials. The BGS maps do not show made ground within the Project area. However, information from historical OS maps and previous investigations indicates extensive past industrial development in parts of Runcorn and Widnes and, therefore, the possibility of similarly extensive deposits of made ground.

14.6.15 The Halton Borough Council website (Ref. 34) provides information indicating that in the region of 10 million tonnes of a waste material known as 'galligu' was historically generated and tipped in Widnes. The galligu was disposed of in an often uncontrolled manner in the areas surrounding the factories, and was frequently used to level the land and to fill in ditches and watercourses.

14.6.16 Galligu is the term given to waste deposits generated by the Leblanc Process (patented by Nicolas Leblanc in 1791). The Leblanc Process was used extensively within Halton during the late 19th and early 20th century for the synthetic production of sodium carbonate, which was an important compound used on a large scale by the rapidly expanding alkali chemical industry.

14.6.17 The Leblanc process involved producing sulphuric acid for use in the salt cake manufacturing stage. Rather than using raw elemental sulphur, which was expensive, through the mid 1800s iron pyrites were used, this led to the liberation of arsenic vapour from the arsenopyrite within the mineral. This arsenic vapour sometimes found its way into the final sulphuric acid product. This meant that galligu waste deposits were created with elevated levels of arsenic. In addition to this, owing to impurities in the raw materials used in the Leblanc process, other heavy metals could also be found in the deposits together with sulphides and sulphates.

Groundwater Vulnerability

14.6.18 The Environment Agency 1:100,000 groundwater vulnerability map (Ref. 35) shown in Figure 14.11 (Appendix 14.1) shows much of the route alignment in Widnes is directly underlain by a minor aquifer with a major aquifer immediately to the north. Wigg Island in Area D is shown as being directly underlain by a minor aquifer as is the area around M56 Junction 12 in Area H. A major aquifer is shown near surface beneath the area at Astmoor Industrial Estate and Bridgewater Junction in Areas E and F. A non-aquifer is shown near surface from the Central Expressway to the Weston Link Junction in Area G. The major aquifer represents the Sherwood Sandstone and the minor and non-aquifers relate to drift geology.

Groundwater Source Protection Zones

14.6.19 The Environment Agency website (Ref. 36) shows that the area from St Michaels Golf Course to Catalyst Trade Park (Areas A to C) is located in a Zone 3 SPZ (total catchment), and the western most parts of the scheme at St Michaels Golf Course and Speke Road (Area A) are located in a Zone 2 SPZ (outer protection zone). The total and outer catchment zones identified relate to a series of abstraction boreholes in the sandstone bedrock to the north of the scheme, north of Widnes.

Groundwater Abstractions

14.6.20 Four groundwater abstraction boreholes have been identified from the Landmark Envirocheck reports within 500m of the proposed scheme which have extracted water for industrial use. Two abstraction licences relate to ICI Chemicals and Polymers Ltd and Ineos Chlor Ltd for abstracting groundwater from the Rocksavage Works in Runcorn and these are understood to still be current. The other two are in Widnes and are listed as having lapsed or been revoked.

14.6.21 The nearest groundwater abstraction identified from the Environment Agency website for public or potable water supplies is located 3km northwest of St Michael's Golf Course (Area A) near Upton in Widnes from the sandstone bedrock.

14.6.22 The information obtained indicates the major aquifer in the sandstone bedrock in parts of Widnes and Runcorn has been impacted by solvents derived from historical activities. Data from the wells monitored most recently by the Environment Agency (five wells monitored between 2004 and 2007 and located between 1km and 3km distance from the Project area) indicate that the most recent concentrations of trichloroethene in the sandstone aquifer are all below 2.2µg/l, this compares to the maximum concentrations of trichloroethene in Runcorn of 1,730µg/l recorded in 1997 and in Widnes of 5.77µg/l recorded in 2000.

14.6.23 There is also data available from three monitoring wells installed approximately 1km to the east of Area C. These wells were monitored by the Environment Agency for chlorinated solvents between 1993 and 2003. No chlorinated solvents were detected at two of these locations, but the third monitoring well recorded 1.9µg/l of chloroform during the only round of monitoring undertaken at that location in 1993.

14.6.24 There are no Environment Agency monitoring wells installed in the sandstone bedrock at less than 1km distance, or immediately down-gradient of the Project area.

Unexploded Ordnance

14.6.25 The desk top threat assessment considered the risk from unexploded ordnance (UXO) to be moderate in Area D on the saltmarshes and Estuary, and low elsewhere. No evidence of UXO was encountered during the site investigations. The desk top threat assessment is located in Appendix 14.4

Overview of the Ground Conditions Identified in the Project Area from the Phase 1 to 6 Site Investigations

14.6.26 The ground conditions encountered during the Phase 1 to 6 site investigations comprised made ground, alluvium, glacial deposits and bedrock. The alluvial materials were associated with the Estuary and the saltmarshes. Alluvium was also encountered underlying the made ground in parts of Areas A to C in Widnes. Underlying the made ground and/or alluvium were glacial deposits, these comprised predominately cohesive glacial clay with interbedded glacial sands and gravels, which in turn were underlain by Sandstone bedrock. Mudstone bedrock was encountered within the Runcorn area.

14.6.27 The made ground was highly variable in the Project area. There was widespread evidence of 'galligu' from Area A at St Michaels Golf Course to Area C at the Catalyst Trade Park. Waste from the alkali industry was also encountered in localised areas in the north of Widnes Warth saltmarsh in Area D and the Wigg Island Landfill in Area D.

14.6.28 Alluvial material associated with the River Mersey was located within the saltmarsh areas and as recent materials (Runcorn Sands) within the Mersey Estuary in Area D. The alluvium on the saltmarshes comprised cohesive sediment (clay or clay/silt) near surface overlying silty sand. The alluvium in the Estuary was also a silty sand.

14.6.29 Alluvium was also encountered in exploratory holes to the north of St Helens Canal extending northwards to the golf course across Areas A to C. The extent of alluvial material in this area is in broad agreement with that shown on the BGS drift geology map.

14.6.30 Glacial deposits were encountered across the majority of the study area. North of the St. Helens Canal and south of the Manchester Ship Canal, where the alluvium was absent, the glacial materials were found immediately underlying the made ground. Closer to the river estuary, the glacial material was encountered underlying the alluvial materials. The glacial deposits typically comprised the following:

a. Firm and stiff clay with varying amounts of granular constituents;
b. Medium dense to very dense silt; and
c. Medium dense to very dense sand and/or gravel.

14.6.31 Areas where glacial materials were noted to be absent in the Project area or only present intermittently were as follows:

a. Wigg Island (bedrock at relatively high elevation and directly underlying alluvium); and
b. Runcorn Sands – across the Estuary (alluvium directly onto bedrock).

14.6.32 The near surface bedrock in the Project area typically comprised very weak to moderately weak red sandstone with evidence of weathering at the interface between the drift deposits and solid strata. The weathered rock was generally encountered within the top 3m of bedrock, although it

was encountered to a maximum thickness of 15.9m in the north of Area E in Runcorn. Mudstone was encountered underlying the glacial deposits to the south of the estuary in Area G1.

14.6.33 The bedrock was typically encountered at shallower depths (<20 m bgl) south of the River Mersey and at greater depths to the north (between 20m and >40 m bgl). Outcrops of rock were noted to the west of the Project area in the Estuary at West Bank in Widnes and the southern bank of the Manchester Ship Canal in Runcorn.

14.6.34 The boreholes on the Widnes Warth saltmarsh in Area D indicate that the depth to rockhead increases from the edge of the saltmarsh northwards to the St Helens Canal and then continues to increase to the north into the Catalyst Trade Park in Area C. The base of the glacial deposits was not encountered at a depth of 53m bgl at the Ditton Junction in Area B1. Historical boreholes in Area C proved the rock at depths of between 40m and 48m bgl. This increase in depth to bedrock in Areas A to C is considered to be related to the buried glacial channel shown on published information.

14.6.35 Geological cross sections for the Project are shown on Figures 14.12 to 14.24 (Appendix 14.1) and the exploratory hole logs are located in Appendix 14.6. Conceptual ground models for Widnes and northern Runcorn based upon this information are shown on Figures 14.25 and 14.26 (Appendix 14.1) and described in Appendix 14.9.

Surface Water

14.6.36 A number of surface water features have been identified within the Project area comprising St Helens Canal, Stewards Brook and Bowers Brook in Widnes, and the Manchester Ship Canal, Bridgwater Canal, former Latchford Canal spur and Flood Brook in Runcorn (these are referred to in the Surface Water Quality Chapter). The largest surface water feature is the River Mersey. These surface water features are referred to below in the discussion on the information obtained from each area and are discussed in greater detail in Chapter 8 Surface Water Quality.

Groundwater

14.6.37 Shallow groundwater has been identified in the made ground, alluvium and glacial deposits. Groundwater is also present in the sandstone bedrock; this is considered to be separated from the shallow groundwater where glacial clay is present. Groundwater flow in the bedrock in the Project area appears to follow the rockhead profile northwards towards the buried glacial valley identified in Widnes. Groundwater flow in the alluvial deposits on both sides of the estuary is towards the River Mersey.

14.6.38 Figures 14.27 and 14.28 (Appendix 14.1) show the groundwater flow directions in the alluvium and sandstone respectively. The difference in groundwater flow directions and groundwater elevations indicates separate groundwater bodies.

14.6.39 The principal controls on groundwater levels within the Project area are considered to be:

a. Geological strata;
b. Groundwater abstraction by pumping;
c. Tidal influences; and
d. Infiltration and surface drainage.

14.6.40 Historical groundwater abstraction from the bedrock, particularly for industrial purposes in the Widnes area, is understood to have resulted in a substantial drawdown of the water table in this horizon. Since the decline of industrial activities and associated groundwater pumping,

groundwater levels have rebounded. It is possible that groundwater levels in the bedrock in Widnes were also affected by pumping associated with coal mining in areas to the north of Widnes.

14.6.41 This rebounding of groundwater levels in the bedrock has been identified from the groundwater monitoring undertaken as part of the investigations. These monitoring results show a trend of rising groundwater levels in the Sherwood Sandstone aquifer in the Widnes area, although no significant change in groundwater levels was apparent to the south of the Estuary.

14.6.42 Groundwater in the bedrock is considered to be in continuity with the Estuary where estuarine alluvium lies directly over the Sherwood Sandstone. Evidence of saline intrusion is apparent from the conductivity and chloride results for groundwater which show increased salinity closer to the Estuary. Saline intrusion was noted in both the shallow groundwater and in the groundwater in the bedrock beneath Widnes Warth saltmarsh, Astmoor saltmarsh and Wigg Island (Area D). Groundwater in the alluvium and bedrock beneath Widnes Warth and Astmoor Saltmarsh in Area D showed evidence of tidal influence. Monitoring did not show the tidal influence to extend beyond the St Helens Canal in Widnes.

14.6.43 A review of recent publications indicates that faulting of the Permo-Triassic sandstone has divided the aquifer into a series of interconnected blocks with restricted groundwater flow between the blocks. The broken rock associated with the fault zones is thought to provide highly transmissive zones of which control groundwater flow. The dominant fault orientation in the Project area is approximately north-south and this is thought to have allowed saline intrusion from the Mersey Estuary.

Baseline Information Obtained on Project Areas

14.6.44 The following provides a description of the baseline information obtained for the Project area using the Areas outlined in Section 14.3. Figures showing the distribution of selected contaminants and discussed in the following sections are included in Appendix 14.1 as Figures 14.29 to 14.40.

Areas A and B1

14.6.45 St Michaels Golf Course is a grassed area currently closed to the public due to contamination at the site. Area B1 comprises the Ditton Junction with associated highways. The A533 Queensway road is raised on embankment as it crosses over the Ditton Junction.

Areas A & B1 – Historical Land Uses

14.6.46 An overview of the main historical land uses in this area identified from the OS maps is as follows.

a. Fields with Stewards Brook flowing through site in an approximate north-northeast to south-southwest direction are shown on the 1849 OS map. Stewards Brook is shown as having been diverted from the 1937 OS maps onwards;
b. Liver Alkali Works is shown to the southwest of site on 1893 to 1896 OS maps;
c. A disused 'gasometer' is shown at the location of the Liver Alkali Works on 1908 OS map;
d. Areas of fill are shown on the OS maps between 1908 and 1987, initially in Area B1 and then progressing across Area A.;
e. Sludge beds are shown to the east of Stewards Brook on the 1937 OS map, and also on 1967/1968/1969 Composite OS map within Area A;
f. Works are shown on the 1958/1959 OS maps on the area of fill to the south of Area A/ east of Stewards Brook;

g. A 'Pit (carbonate of lime)' is shown on 1958/1959 OS maps towards the west of Area A;
h. A timber yard and depot are shown on 1958/1959 OS maps towards the west of Area A, and on the 1970/1977 OS maps in the western part of Area A;
i. A pond is shown towards the north of Area A on 1958/1959 OS maps. Additional ponds are shown on 1967/1968/1969 Composite OS map to the east and west of Stewards Brook;
j. A roundabout is shown from the 1964 OS map onwards at the current location of Ditton Junction.
k. A chemical works is shown on the 1967/1968/1969 composite OS map to the south of Area A, 'tanks' are shown towards northern boundary of this works;
l. Speke Road (A562) is shown along the northern site boundary of Area A from the 1967/1968/1969 Composite OS map onwards; and
m. The golf course is shown on 1984/1987/ 1990/1994 composite OS map in the western part of the site and in Area A from the 1993 OS map onwards.

Areas A & B1 – Information from Previous Investigations

14.6.47 Information from six site investigations previously undertaken in this area between 1980 and 2005 was obtained for review.

14.6.48 These investigations encountered made ground to between 3.8 and 8m below ground level (bgl), which included chemical waste, overlying glacial deposits. The base of the glacial deposits was not proven at a maximum depth of 15.2m bgl. Alluvium was also noted in a number of exploratory holes between the made ground and glacial deposits. Groundwater was reported within the alluvium, and locally within the made ground.

14.6.49 Elevated concentrations of metals, sulphate, chloride, ammoniacal nitrogen and high pH in soils and groundwater were reported within the made ground and alluvium.

Areas A & B1 – Landfills and Waste Management

14.6.50 The Envirocheck Report indicates that St Michaels Golf Course in Area A, extending to the boundary with Ditton Junction (Area B1), is a former registered landfill site with licenses having been held by Halton Borough Council and McKechnie Chemicals Ltd. The licenses for this site were surrendered in 1981 and 1979 respectively. The Envirocheck Report indicates the site was licensed to accept calcium sulphate, construction and demolition wastes, Leblanc waste (galligu), mine and quarry waste, distillation residues, industrial non-hazardous and inert waste, non-flammable waste, potentially combustible waste, industrial effluent treatment sludge and used filter materials. Information obtained from Halton Borough Council indicates this site was capped with clay.

14.6.51 The Envirocheck Report indicates the northern part of St Michaels Golf Course to the north of Area A is a recorded historical landfill site.

14.6.52 With the exception of the landfills at St Michaels Golf Course, the Envirocheck Reports do not show any recorded landfills within 500m of the Project area in Widnes.

14.6.53 A former special waste transfer station site was located to the west of the St Michaels Road (approximately 200m west of Area A). This site was operated by Cleanaway Ltd and the Envirocheck Report indicates the license was surrendered in September 2002.

Areas A & B1 – Surface Water

14.6.54 Stewards Brook flows in a southerly direction through St Michaels Golf Course in Area A. Information obtained from Halton Borough Council indicates the Brook is being affected by contamination from the northern part of the golf course, although in the Project area itself the Brook has been lined to prevent contaminants migrating into the watercourse.

Areas A & B1 – Ground conditions

14.6.55 This area was investigated during the Phase 4 and Phase 6 site investigations. Made Ground was present from ground level to depths of between 3.3m and 11m bgl (+9.16m to +2.4m AOD), with an average thickness of 6.2m. The full thickness was not proved at 11m bgl in BH70. Surface materials comprised grass and topsoil over clay (understood to be capping to the landfill) to between 0.4mbgl to 1.40m bgl. This clay capping layer was not encountered in BH75, WS26 and WS27.

14.6.56 The majority of made ground underlying St Michael's Golf Course in Area A was described as chemical waste, comprising soft to firm light blue grey and black mottled white sandy clay/silt (possible galligu) or black mottled red clayey sand and/or gravel. The gravel was typically sandstone, brick, coal, timber, ash, clinker, slag, concrete and glass, with organic material comprising roots and rootlets. The ground conditions confirm the information on the site history; the area was used as a tipping area for chemical waste prior to the golf course development.

14.6.57 Where the made ground was not identified as possible chemical waste, this material comprised very soft to firm (occasionally stiff) green brown and grey sandy gravelly clay or loose grey brown slightly sandy gravel. Gravel was described as comprising sandstone, coal and brick. Very soft to soft grey slightly sandy slightly gravelly silt which was possibly Pulverised Fuel Ash (PFA) was occasionally encountered within the main body of the made ground.

14.6.58 Alluvial deposits from 0.4m to 2.5m thick were encountered directly underlying the made ground within six exploratory holes in this area. The alluvium comprised grey and black slightly sandy slightly gravelly silt with occasional organic matter and medium dense grey brown silty sand.

14.6.59 In exploratory holes BH63, BH62, and BH76 (located alongside Speke Road and Ditton Junction) the glacial deposits were encountered as grey black slightly sandy slightly gravelly clay with a strong sulphur or hydrogen sulphide odour. The discolouration of the glacial deposits directly underlying the made ground is considered to be due to the effects of staining and leaching from the overlying chemical waste/galligu.

Areas A & B1 – Groundwater

14.6.60 Monitoring wells were installed into the made ground, alluvium and shallow glacial deposits in this area. Water levels monitored during Round 10 and during the Phase 6 site investigation were found to be between 6.39 and 11.17m AOD within made ground, between 7.71 and 8.57m AOD in alluvium, and between 6.27 and 9.40m AOD within the glacial deposits.

Areas A & B1 – Results of the Chemical Testing and Monitoring

14.6.61 The following results were obtained from the chemical testing and monitoring in this area.

Soil - Human Health for Site Users (Commercial/Industrial land use)

14.6.62 The GAC was exceeded for arsenic (1 sample), nickel (1 sample) and lead (6 samples) in the made ground. Figure 14.29 (Appendix 14.1) shows the locations where arsenic exceeds the

GAC value in soil. Arsenic has been shown as it is known to be associated with galligu. Concentrations exceeding the GAC were also obtained for barium and lead in a sample of alluvium tested from BH75. Asbestos was identified in made ground from BH75 and BH85.

14.6.63 The US_{95} values derived for lead exceeds the GAC value for a commercial/industrial land use. The results indicate a possible statistical outlier for nickel at St Michaels Golf Course.

Soil - Human Health for Construction workers

14.6.64 Local exceedances of the assessment criteria derived for construction workers were observed for metals notably arsenic, lead, nickel and barium, along with hydrocarbons and VOCs (trimethylbenzene and chloroform).

Soil - Phytotoxicity

14.6.65 Widespread exceedance of the guidance outlined in MAFF (Ref. 20) was obtained for copper, nickel and zinc in the made ground.

Soil - Buried Concrete

14.6.66 Concentrations of water soluble sulphate were obtained from the made ground, alluvium and shallow glacial clay which exceed the DS-1 level from BRE Special Digest 1 (Ref. 21). Figure 14.30 (Appendix 14.1) shows the locations where water soluble sulphate exceeds the DS-1 level.

Soil - Buried Water Supply Pipes

14.6.67 Concentrations of metals, hydrocarbons and PAHs were obtained from the made ground which exceed the WRAS (Ref. 22) threshold values.

Soil Leachate

14.6.68 Concentrations of metals (notably arsenic, lead, cadmium, chromium, copper and zinc) and PAHs were obtained from the made ground which exceed the water quality standards.

Groundwater

14.6.69 Monitoring wells were installed into the made ground, alluvium and shallow glacial deposits in this area. Concentrations of metals (notably arsenic, cadmium, copper, lead and zinc) were observed in the made ground and alluvium that exceed the water quality standards. Figure 14.31 (Appendix 14.1) shows the locations where arsenic was encountered above the EQS value. Concentrations of petroleum hydrocarbons that exceed the water quality standards were also obtained from five monitoring wells in made ground and alluvium. PAHs were identified in one sample of groundwater from made ground and ammonia was identified in groundwater within made ground and alluvium.

14.6.70 Localised exceedances of the water quality standards were observed for chlorinated solvents encountered in the made ground and alluvium in Area A, including 1,1,2,2-tetrachloroethane, tetrachloroethene and trichloroethene. The highest concentration encountered was 0.88mg/l of 1,1,2,2-tetrachloroethane from BH93. Figure 14.32 and 14.33 (Appendix 14.1) shows the locations where tetrachloroethene, and trichloroethene respectively exceed the EQS values.

Ground Gas and Vapours

14.6.71 The gas screening values derived for carbon dioxide and methane correspond with CS2 in CIRIA C665 (Ref. 27).

14.6.72 Local exceedances of the long term workplace exposure limits for volatile vapours were observed from the made ground in this area (Ref. 28).

Areas B2 and I1

14.6.73 This area is currently occupied by Gussion Transport and Widnes Tank Container Services (described as Gussion Transport hereafter), Anglo Blackwells and S. Evans and Sons Scrapyard.

Areas B2 & I1 – Historical Land Uses

14.6.74 An overview of the main historical land uses in this area identified from the OS maps is as follows.

a. The 1893 OS map shows this area was occupied by an Alkali & Sulphur Works located towards the west of the existing Gussion Transport site, with a Chemical Works occupying the centre and east of the Gussion Transport site. The existing S.Evans and Sons Scrapyard is shown as open land (possible area of fill). The area around the existing Ditton Junction is also shown as an area of possible fill. Railway lines are shown to the south of Area I1;
b. The 1907 OS map shows that the majority of the buildings previously shown on the site of the former Alkali & Sulphur Works and Chemical Works are no longer marked. The existing Anglo Blackwell site is shown as open land;
c. The 1927 OS map shows a Steel Alloy Works on the site of the former Chemical Works at the existing Gussion Transport site. Buildings are shown on the existing S.Evans & Sons Scrapyard site. The existing Anglo Blackwell site is shown as an area of fill;
d. The 1937 OS map shows the buildings at the existing S.Evans & Sons Scrapyard (marked on the 1927 map) to be an Engineering Works. Two rectangular buildings are shown at the existing Anglo Blackwell site, the area around these buildings is still shown as fill;
e. The 1958 and 1959 OS maps show all of the sites identified from the previous OS maps as Works. Additional buildings are shown at the existing Anglo Blackwell site; and
f. The 1988 OS map shows the area to be similar to the current land use. Many of the railway lines/sidings to the south of Area I1 and the existing freight rail line have been removed, although some are still present and this area is shown as a depot.

Areas B2 & I1 Information from Previous Investigations

14.6.75 Information from two previous site investigations undertaken in 1989 and 1994 were obtained for review from this area. These investigations encountered made ground in all exploratory holes, this included material described as chemical waste and galligu.

14.6.76 The 1989 investigation was undertaken at Gussion Transport and comprised two boreholes to 10m bgl to obtain geotechnical information for a workshop extension in the northwest corner of the site. No information on contamination testing was included in the information obtained.

14.6.77 The 1994 investigation was undertaken at Anglo Blackwells and encountered galligu towards the north of the site. Contaminants identified in the report on this previous investigation comprised petroleum hydrocarbons and metals.

14.6.78 Historical information obtained on the former High Speed Steel Alloys (HSSA) works which was located in Area B2 indicates the water supply for this works was obtained from a 250 foot deep borehole located within the centre of the site. The information obtained does not show the location of the well though historical OS maps indicate the centre of former HSSA site (shown as the Steel Alloy Works) would have been located towards the centre of the existing Gussion Transport site.

Areas B2 & I1 – Landfills and Waste Management

14.6.79 The Envirocheck Reports do not contain records of any landfills within 500m of this area other than St Michaels Golf Course in Area A.

Areas B2 & I1 – Surface Water

14.6.80 No surface water features are located in this area.

Areas B2 & I1 – Ground conditions

14.6.81 This area was investigated during Phase 6 site investigation. The ground conditions comprised made ground overlying alluvial and glacial deposits.

14.6.82 Made ground was encountered in all exploratory holes from ground level to between 1.6m and 4.9m bgl (+6.2m AOD and +2.8m AOD), with an average thickness of 3.2m.

14.6.83 The made ground was highly variable comprising the following:

a. loose to medium dense dark grey mottled black and brown very clayey very gravelly sand;
b. very soft to soft white grey slightly gravelly silt (possible galligu);
c. very loose light grey silty sandy gravel (possible galligu);
d. soft to firm dark grey and black slightly gravelly clay (possible galligu);
e. blue white and black slightly sandy slightly gravelly clay (possible chemical waste);
f. red brown slightly clayey slightly gravelly medium; and
g. coarse sand or soft brown and black very sandy slightly gravelly clay.

14.6.84 The gravel content comprised sandstone, ash, brick, slag, concrete, slate and clinker.

14.6.85 Cohesive alluvial material was encountered underlying the made ground in a number of exploratory holes (WS16A, WS22 and BH49) up to 2.6m thickness. This material comprised grey mottled black slightly sandy slightly gravelly slightly organic clay and clayey sand. In BH49 alluvium comprising organic clay with occasional plant fibres and plastic pseudofibrous peat was encountered between 2.5m and 4.5m bgl. The glacial deposits comprised interbedded firm, stiff and very stiff slightly sandy slightly gravelly clay and medium dense to dense slightly silty gravelly sand. The gravel constituents were described as mudstone, quartz and sandstone, with occasional cobbles of sandstone. The base of the glacial deposits was not encountered at a maximum depth of 26.2m bgl in BH54E. Archive boreholes show the base of the glacial deposits was encountered at 41.2m bgl (approximately -33m AOD) within the Gussion Transport site.

14.6.86 In eight exploratory holes located within the Gussion Transport site, the near surface glacial clay was observed to be stained from the overlying made ground/chemical waste materials. This was encountered as firm and stiff grey black slightly sandy slightly gravelly clay with strong sulphur or hydrogen sulphide odour noted at between 0.2m and 3m thickness.

Areas B2 & I1 – Groundwater

14.6.87 Monitoring wells were installed into the made ground, alluvium (WS22 only) and shallow glacial deposits in this area. Water levels monitored during the Phase 6 site investigation were found to be between 6.08 and 7.11m AOD within made ground, at 6.42m AOD in alluvium (WS22), and between 2.91 and 6.17m AOD within the glacial deposits.

Areas B2 & I1 – Results of the Chemical Testing and Monitoring

14.6.88 The following results were obtained from the chemical testing and monitoring.

Soil - Human Health for Site Users (Commercial/Industrial Land Use)

14.6.89 Localised exceedances of the GAC were obtained from the made ground for arsenic (1 sample), nickel (1 sample) and lead (3 samples), along with elevated concentrations of petroleum hydrocarbons in one exploratory hole (WS17). Figure 14.29 (Appendix 14.1) shows the locations where arsenic exceeds the GAC value in soil. Arsenic has been shown as it is known to be associated with galligu.

14.6.90 The US_{95} values derived for benzene exceed the GAC value for a commercial/industrial land use. No statistical outliers were identified.

Soil - Human Health for Construction Workers

14.6.91 Concentrations of metals, notably arsenic, lead, nickel, barium and vanadium, along with petroleum hydrocarbons were obtained from the made ground in localised areas which exceed the assessment criteria derived for construction workers. Local exceedances of the assessment criteria derived for construction workers for VOCs (including 1,2-dichloroethane, dichloromethane and naphthalene) were also observed.

Soil - Phytotoxicity

14.6.92 Widespread exceedances of the guidance outlined in MAFF (Ref. 20) were obtained for copper, nickel and zinc from the made ground.

Soil - Buried Concrete

14.6.93 Concentrations of water soluble sulphate were obtained from made ground and shallow glacial clay exceeding the DS-1 level from BRE Special Digest 1 (Ref. 21). Figure 14.30 (Appendix 14.1) shows the locations where water soluble sulphate exceeds the DS-1 level.

Soil - Buried Water Supply Pipes

14.6.94 Concentrations exceeding the WRAS threshold values (Ref. 22) were obtained for metals, hydrocarbons and PAHs.

Soil Leachate

14.6.95 Concentrations of metals (notably arsenic, cadmium, chromium, copper, zinc and vanadium) and SVOCs including PAHs were obtained from soils in this area exceeding the water quality standards.

Groundwater

14.6.96 Monitoring wells were installed into the made ground, alluvium and shallow glacial deposits in this area. Concentrations of metals (notably arsenic, cadmium, copper, selenium and zinc) were obtained from the made ground and alluvium which exceed the water quality standards. Figure 14.31 (Appendix 14.1) shows the locations where arsenic was encountered above the EQS value.

14.6.97 Concentrations of benzene, toluene, ethyl benzene and xylene were encountered in WS17 (installed in the made ground) along with petroleum hydrocarbons in WS17 and WS22 in made ground and alluvium respectively at concentrations that exceed the water quality standards. PAHs were identified in groundwater from the glacial deposits and ammonia was identified in groundwater within made ground, alluvium and glacial deposits.

14.6.98 Concentrations of chlorinated solvents including 1,1,2,2-tetrachloroethane, tetrachloroethene and trichloroethene were encountered in the made ground and alluvium exceeding the water quality standards. The highest concentration for chlorinated solvents was 0.92mg/l of 1,1,2,2-tetrachloroethane. Figure 14.32 and 14.33 (Appendix 14.1) shows the locations where tetrachloroethene, and trichloroethene respectively exceeds the EQS values.

14.6.99 Light non-aqueous phase liquid (LNAPL) was encountered floating on the groundwater at WS17, WS20, BH51 and BH54 at Gussion Transport during monitoring. These locations are shown in Figure 14.34 (Appendix 14.1). The LNAPL in WS17 was observed up to 0.36m thick. Chemical testing of the LNAPL from WS17 indicates this comprised predominantly of fatty acids and fatty acid methyl esters (FAME) along with trace levels of chlorinated solvents, benzene, toluene, xylene and MTBE. The FAME in the LNAPL from WS17 was considered by the laboratory as likely to have been produced by, or for an industrial process associated with food manufacture or the pharmaceutical industry.

Ground Gas and Vapours

14.6.100 The gas screening value derived for carbon dioxide corresponds with CS2 in CIRIA C665 (Ref. 27).

14.6.101 Concentrations of carbon dioxide above the long term workplace exposure limits were obtained from the existing Gussion Transport and Anglo Blackwell sites (Ref. 28).

14.6.102 Readings for volatile vapours obtained from WS17 at the existing Gussion Transport site were also found to exceed the long term workplace exposure limits.

Area C

14.6.103 The current land uses comprise the Fallon Brothers Scrapyard in the west of this area, with the A557 Expressway raised on embankments, then buildings associated mainly with light industrial use adjacent to Hutchinson Street and Victoria Road.

14.6.104 To the east of the Victoria Road is Catalyst Trade Park which comprises a series of light industrial units separated by hard landscaping (roads and car parking) and landscaping (predominately grass and gravel). Immediately to the east of the Catalyst Trade Park is Thermphos which produces speciality phosphates. The former ICI Muspratt site is located immediately to the east of Thermphos and Area C, this site is currently derelict. To the south of Area C is the St Helens Canal.

14.6.105 Within the Project area at the Thermphos site the land comprises predominantly grass cover, with Bowers Brook flowing in an easterly direction through an enclosed channel along the southern boundary. Bowers Brook then flows east along the southern side of Catalyst Trade Park to an outfall into the River Mersey at Spike Island.

Area C – Historical Land Uses

14.6.106 An overview of the main historical land uses in this area identified from the OS maps is as follows.

West of Victoria Road

a. The 1849 OS map shows this area was unoccupied at this time. A railway line, which is later recorded as the L & NW Railway Widnes Deviation, is shown along the northern boundary;
b. Between 1893 and 1971, the OS maps show that the area was occupied by a number of railway sidings and a goods station. Various residential and/or commercial properties are also shown along Hutchinson Street and Victoria Road;
c. A number of railway sidings appear to have been removed from the site before 1988, when historical maps show that the site was occupied by depot in the south and a scrap yard in the north (which extended eastwards to Victoria Road). A garage and small depot are shown to the north of Hutchinson Street; and
d. OS maps published in 1994 indicate that railway sidings were no longer present on the site. The 1999 Ordnance Survey Plan shows the existing A557 Widnes Bypass crossing the site on an embankment. Only the western end of the existing Fallon Brothers Scrapyard is shown (to the west of the A557) on this map.

East of Victoria Road

Catalyst Trade Park

14.6.107 An overview of the main historical land uses in this area identified from the OS maps is as follows.

a. Widnes Oil Works is shown adjacent to a swing bridge over St. Helens Canal on the 1849 OS map, replaced by a Resin Works on the 1893 OS map, a Manure Works on 1907 map, and an Alum Works on the 1927 OS map;
b. A Chemical Works with railway sidings is shown on the 1893 OS map across most of site. This is labelled as the Woodend Chemical Works on the 1907 OS map, and then the Gaskell Deacon Works (Chemical) on the 1927 OS map. The 1971 OS map shows the site as Chemical Works;
c. The configuration of buildings within the chemical works changed between the 1927 and 1958/1959 OS maps, where the large building in the centre of the site is shown to have been replaced by a number of smaller buildings;
d. A number of tanks are shown to the west of the site on the 1971 OS map;
e. Catalyst Trade Park shown in place of Chemical Works on the 1988 OS map;
f. Chemical Works are shown to north of site on OS maps from 1893 to 1988; and
g. Railway lines are shown on the 1893 OS map are in the approximate location of the existing A557 Expressway, which is first shown on the 1971 OS map.

Thermphos

14.6.108 A review of the historical OS maps shows the area has been associated with the manufacture of chemicals since the mid 19th Century, this is as follows.

a. The 1849 OS map shows a chemical works in the southern part of the existing Thermphos site with a number of east-west orientated railway lines shown;
b. The 1893 OS map shows the expansion of the chemical works at the current Thermphos site and a gasometer in the south west corner of this site surrounded by a possible area of fill. The current Thermphos site is labelled as the Muspratt Works (Chemical) with an increased number of tanks and buildings shown on the 1907 OS map where it is labelled as the Muspratt Works (No.1) (Chemical);
c. A significant number of buildings and tanks at the current Thermphos site are shown as having been cleared on the 1927 OS map;
d. Alkali Works are shown occupying the western part of the former ICI Muspratt site immediately to east of the current Thermphos site on the 1895 OS map;
e. This site is shown as the Muspratt Works No.2 on the 1928 OS map; and
f. The former Muspratt No.2 works site is shown to have largely been cleared on the 1982 OS map.

Area C – Information from Previous Investigations

Catalyst Trade Park

14.6.109 Historical information obtained from ICI (1996) indicates this was the former site of the ICI Widnes Experimental Site (WES), which formed part of the Gaskell Marsh group of works in Widnes. In 1855 Henry Deacon and Holbrook Gaskell entered into partnership to produce soda ash by the Leblanc process (forming the Gaskell Deacon company). ICI (1996) report the site was first used as a 'chemical dump (galligu)' between 1849 and 1865 before which it was a 'green field site'. In 1890 the Gaskell Deacon Company joined approximately forty other alkali manufacturers in forming the United Alkali Company and in 1891 the Central Laboratory or Hurter Laboratory was founded at the site.

14.6.110 ICI (1996) indicate that the Central Laboratory carried out investigations into a wide range of processes between 1891 and 1927, including into the Leblanc process, recovery of metals from ores, production of various gasses and acids for use during wartime, production of chlorine and chlorinated solvents, and the use of electrolytic methods in the preparation of various materials. Larger scale processes undertaken at the site between 1894 and 1960 included the manufacture of carbon tetrachloride, chloroform, acetic acid, formic acid, acetone, aluminium chloride, chlorinate rubber and sodium cyanide.

14.6.111 ICI (1996) indicate that work carried out between 1940 and 1945 included uranium extraction and metal production processes which eventually led to the production of the uranium rods used to fuel the first atomic reactor pile at Harwell.

14.6.112 Historical plans obtained for the former ICI WES show a works water well was located in the north west of Catalyst Trade Park adjacent to the existing Unit 3 (currently beneath an area of hard cover). Historical information obtained by ICI indicates this well extended 207m into the sandstone bedrock and that the well was covered/capped in 1960s, however, no records of how the well was capped were available.

14.6.113 Information was obtained from eight previous site investigations undertaken between 1990 and 2004 in this area. The ground conditions encountered comprised made ground over alluvium over glacial deposits, although the alluvium was noted to be absent towards the north of this site.

14.6.114 Visual and olfactory evidence of contamination was identified during several of these investigations. Soil testing recorded elevated concentrations of metals, pH, sulphate, phenols,

petroleum hydrocarbons, PAHs and VOCs (predominantly chlorinated solvents) in the made ground and underlying drift deposits. Groundwater was recorded in made ground and alluvium, chemical testing of the groundwater recorded elevated concentrations of metals, sulphate, petroleum hydrocarbons, VOCs, halocarbons, PAHs, and ammonia.

14.6.115 Information from three radiological investigations undertaken between 1990 and 1999 was also obtained. These investigations comprised walkover surveys and assessment of sediments in site drains. Levels at or above background were recorded in surface locations (one of which is now below the A557 Expressway) and within sediment in drains but these did not exceed the regulatory limits.

Thermphos and Former ICI Muspratt Site, Widnes

14.6.116 No previous information on the ground conditions was obtained for the Project Area at Thermphos, although information was obtained for the area to the east of this site (at the former ICI Muspratt Site).

Area C – Landfills and Waste Management

14.6.117 The Envirocheck Reports do not contain records of any landfills within 500m of this area.

Area C – Surface Water

14.6.118 Available information indicates the majority of Bowers Brook in Area C is located in a culvert along the southern edge of Area C. This culvert is brick lined adjacent to the Catalyst Trade Park. This is thought to have been constructed onto or within the fine grained alluvial deposits. Information also indicates that contaminated silt is likely to be present within Bowers Brook. This water course is considered to be in hydraulic connection with shallow groundwater which chemical testing shows is contaminated in Area C.

14.6.119 Testing on samples of water and sediment obtained from drains during previous investigations at Catalyst Trade Park in Area C encountered metals, solvents and radiological contaminants. It is understood these drains were connected to Bowers Brook.

Area C – Ground Conditions

14.6.120 This area was investigated during the Phase 1, Phase 4a and Phase 6 site investigations. A layer of made ground was encountered across the site directly from ground level to a level of between 0.7m bgl to 5.7m bgl (+7.5m AOD and +1.9m AOD), with an average thickness of 3.16m.

14.6.121 The majority of the made ground was essentially granular in nature (mainly encountered as a fine to coarse gravel). The made ground material was variable and contained the following constituents;

a. Very soft black slightly gravelly clay/silt;
b. Very loose to medium dense red brown and light grey to black mottled cream slightly silty locally slightly clayey gravelly fine to coarse sand;
c. Very soft to soft brown slightly sandy slightly gravelly clay;
d. Very loose to medium dense yellow brown and black clayey sand and gravel (possible chemical waste);
e. Very dense dark grey brown and black cobbles (possible galligu);
f. Soft to firm red brown and grey sandy slightly gravelly ashy clay;

g. Loose to medium dense red to dark brown and light grey to black slightly clayey sandy silty ashy gravel; and
h. Brown and black ashy sand and gravel.

14.6.122 The gravel content within the made ground was described as sandstone, ash, brick, concrete, concrete, limestone, wood, slate, clinker and metal with occasional cobbles.

14.6.123 Alluvium was generally encountered directly beneath the made ground, with glacial deposits directly underlying the alluvial material. This is consistent with the BGS drift map (Ref. 32). Material interpreted as alluvium was encountered in boreholes to depths of between 2.6m and 9.55m bgl (-0.22m AOD and -2.8m AOD) with an average thickness of 6.7m. This material comprised very soft to firm grey brown slightly sandy clay with frequent organic content, which was typically underlain by loose to medium dense slightly silty fine sand or loose to medium dense grey mottled black slightly sandy silt. There were instances where granular material and laminated clay were encountered at greater depths in Area C. However, from a review of the descriptions and an assessment of the levels at which these materials were present, these have been interpreted as glacial deposits (see paragraph 14.6.125 below).

14.6.124 Alluvium was also encountered in the western part of Area C underlying the made ground in BH48, BH95 and BH96 at between 1.5m and 1.7m thickness.

14.6.125 The glacial deposits were encountered to levels of between +2.2m AOD and -21.8m AOD (the full thickness not being proved). The base of the glacial deposits was encountered in BH43 in the north eastern corner of Area C at 48.9m bgl (-39.44m AOD). The glacial deposits consisted of firm to very stiff (occasionally soft) red brown slightly sandy slightly gravelly clay with interbedded medium to dense brown slightly silty or clayey slightly gravelly fine and medium sand. Gravel constituents were described as angular to subangular fine and medium of sandstone and coal. Some of the descriptions for these materials include laminated clays, these have been interpreted as glacial deposits based on a review of the levels at which these materials were encountered.

Area C – Groundwater

14.6.126 Monitoring wells were installed into the made ground, alluvium and shallow glacial deposits in this area. Water levels monitored during Round 10 and during the Phase 6 site investigation were found between 5.18 and 6.89m AOD within made ground, between 3.85 and 6.27m AOD in alluvium, between 2.50 and 6.93m AOD within the glacial deposits, and at 1.70m AOD in the sandstone bedrock at BH43 in the north-eastern corner of Area C.

Area C – Results of the Chemical Testing and Monitoring

14.6.127 The following results were obtained from the chemical testing and monitoring.

Soil - Human Health for Site Users (Commercial/Industrial Land Use)

14.6.128 Exceedances of the GAC were obtained for arsenic (9 samples) and lead (20 samples) from the made ground at Catalyst Trade Park. Figure 14.29 (Appendix 14.1) shows the locations where arsenic exceeds the GAC value in soil. Arsenic has been shown as it is known to be associated with galligu. Observed concentrations of hexachlorobutadiene and hexachloroethane were also found to exceed the GAC values from the made ground in one exploratory hole (WS11A).

14.6.129 Localised exceedances of the GAC for arsenic (1 sample), lead (2 samples) and hexachlorobutadiene (1 sample) were obtained from samples of alluvium at the Catalyst Trade Park.

14.6.130 The US_{95} values derived for arsenic and lead exceed the GAC values for a commercial/industrial land use. Statistical outliers were identified for benzene, hexachlorobutadiene and hexachloroethane at the Catalyst Trade Park.

Soil - Human Health for Construction Workers

14.6.131 Concentrations of metals, notably arsenic, lead, nickel and barium, along with petroleum hydrocarbons were obtained from the made ground in this area which exceed the assessment criteria derived for construction workers. Concentrations of VOCs were also obtained from soil samples which exceed the assessment criteria, these included the following: chloroform, 1,1,1-trichloroethane, carbon tetrachloride, 1,2-dichloroethane, 1,1,2,2, tetrachloroethane, trichloroethene, tetrachloroethene, 1,1,2-trichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, vinyl chloride, 1,2,3-trichloropropane, trans-1,2-dichloroethane, tetrachlorothane and hexachlorobutadiene.

14.6.132 Figure 14.35 to 14.37 (Appendix 14.1) shows the locations where tetrachloroethene, trichloroethene and carbon tetrachloride were encountered above the lower analytical limit of detection in soil.

14.6.133 Local exceedances of the assessment criteria for construction workers for arsenic were also obtained from made ground in Area C which could represent a risk to construction workers from acute (short term) ingestion.

Soil - Phytotoxicity

14.6.134 Exceedances of the MAFF guideline values (Ref. 20) for copper, nickel and zinc were obtained from the made ground in Area C.

Soil - Buried Concrete

14.6.135 Concentrations of water soluble sulphate were obtained from the made ground and alluvium which exceed the DS-1 level from BRE Special Digest 1 (Ref. 21). Figure 14.30 (Appendix 14.1) shows the locations where water soluble sulphate exceeds the DS-1 level.

Soil - Buried Water Supply Pipes

14.6.136 Concentrations of metals, hydrocarbons and PAHs were obtained from the made ground in Area C which exceed the WRAS threshold values (Ref. 22).

Soil Leachate

14.6.137 Local exceedances of the water quality standards for metals (notably arsenic, lead, chromium, copper, nickel and zinc) and petroleum hydrocarbons were obtained from soils in this area.

Groundwater

14.6.138 Monitoring wells were installed into the made ground, alluvium and shallow glacial deposits in this area. Widespread concentrations of metals (notably arsenic, cadmium, copper, mercury, vanadium and zinc) were obtained from groundwater in the made ground and alluvium that exceeded the water quality standards. Figure 14.31 (Appendix 14.1) shows the locations where arsenic was encountered above the EQS value.

14.6.139 Concentrations of chloride and ammonia that exceed the water quality standards were obtained from groundwater in the made ground, alluvium and glacial deposits.

14.6.140 Benzene, toluene, ethyl benzene and xylene were encountered in localised areas from groundwater in the made ground, alluvium and upper glacial sand at Catalyst Trade Park along with petroleum hydrocarbons in these horizons exceeding the water quality standards. Local exceedances of the water quality standards for PAHs and SVOCs were obtained in the alluvium.

14.6.141 Concentrations of organochlorine pesticides were observed above the lower analytical detection limit from groundwater on and adjacent to Area C. Heptachlor and chlordane in BH56 (alluvium) exceeded the DWS. The highest concentrations of total pesticides was obtained in five monitoring wells from the made ground and alluvium. Acid herbicides were also encountered above the lower analytical detection limit, but only pentachlorophenol in BH55 exceeded the EQS.

14.6.142 Concentrations of a wide range of chlorinated solvents were encountered in groundwater in the made ground, alluvium and glacial sands exceeding the EQS and DWS. The highest concentrations were carbon tetrachloride (260mg/l) and tetrachlorethene (240mg/l) from WS11A and 1,1,2,2-tetrachloroethane (240mg/l) from BH107 which were both installed into the alluvium. The concentrations of these contaminants were significantly lower in the monitoring well (BH55) installed into the alluvium down-gradient of Catalyst Trade Park on Spike Island although they were still detectable and exceeded water quality criteria. Chlorinated solvents were not detected on the saltmarshes.

14.6.143 Figures 14.32, 14.33 and 14.38 (Appendix 14.1) shows the locations where carbon tetrachloride, tetrachloroethene, and trichloroethene respectively exceeds the EQS values.

14.6.144 Evidence of cis-1,2-dichloroethene was obtained above the lower analytical detection limit in 27 no. monitoring wells within this area, this compound can be produced by anaerobic biodegradation from the reductive dechlorination of trichloroethene suggesting natural attenuation is occurring.

14.6.145 As high concentrations of chlorinated solvents can indicate the presence of free product as a dense non-aqueous phase liquid (DNAPL) an assessment (based on the results of the chemical testing and compound solubility) was undertaken. The results of this assessment indicated possible DNAPL in six monitoring wells in the alluvium, two in the made ground and one in the upper glacial sand on and adjacent to the Catalyst Trade Park. Figure 14.39 (Appendix 14.1) shows the location of possible DNAPL in groundwater.

14.6.146 Due to the density of DNAPLs when compared to water, these contaminants will tend to sink within the water column. These contaminants do not necessarily follow the groundwater flow direction and can also penetrate low permeability materials such as clay. The results of the chemical testing indicate that DNAPL is likely to have penetrated the cohesive saltmarsh deposits and the near surface glacial clay, having migrated into the upper glacial sand layer at Catalyst Trade Park. The information obtained indicates that chlorinated solvents, including possible DNAPL, in the alluvium is at present likely to have migrated outside of the Project area and this is likely to be in a south westerly direction. No evidence of DNAPL has been obtained from monitoring wells installed at Thermphos or on Widnes Warth.

Ground Gas and Vapours

14.6.147 The gas screening value derived for carbon dioxide corresponds with CS2 in CIRIA C665 (Ref. 27).

14.6.148 Concentrations of carbon dioxide above the long term workplace exposure limits were obtained from the made ground and alluvium in Area C (Ref. 28).

14.6.149 Widespread exceedances of the long term workplace exposure limits for volatile vapours were observed in soils obtained from the southern part of Catalyst Trade Park and Thermphos. These were the highest readings obtained in the Project area. Local exceedances were observed between the northern part of Catalyst Trade Park and Fallon Brothers Scrapyard.

Radiological

14.6.150 Radiological screening was undertaken on soil arisings from all exploratory holes at the Catalyst Trade Park. Readings exceeding twice background were encountered from the radiological screening in made ground at the following two locations.

a. Made ground at approximately 1m bgl in the inspection pit for WS10 during the Phase 4A investigation; and
b. Grey ashy material located immediately beneath limestone gravel surface cover approximately 10m northwest of BH105 during the Phase 6 investigation. No elevated readings were obtained from BH105 itself.

14.6.151 All of the readings obtained were less than ten times background levels.

Area D

14.6.152 This area comprises Widnes Warth and Astmoor Saltmarshes separated by the River Mersey. To the south of Astmoor Saltmarsh is Wigg Island including an area of fill associated with the Wigg Island Landfill. In the south of this area is the Manchester Ship Canal.

Area D – Historical Land Uses

14.6.153 An overview of the main historical land uses in this area identified from the OS maps is as follows.

Widnes Warth

a. The 1893 to 1927 OS maps show a building in the northwest corner of Widnes Warth, otherwise the area is shown as saltmarshes;
b. An area of fill is shown to the east of this building from the 1927 OS map onwards at the location of the proposed northern abutment (immediately adjacent to the St Helens Canal). An area of fill is also shown adjacent to the St Helens Canal to the east of the route alignment (and east of Bowers Brook) from the 1895 OS map onwards; and
c. The Bowers Brook channel on Widnes Warth appears on the 1982 OS map although none of the 1:10,000 scale maps dating back to the 1960's show this area.

Astmoor Saltmarsh and Wigg Island

14.6.154 Wigg Island Landfill forms part of the Wigg Island Community Park. No developments are currently located within Area D to the north of Manchester Ship Canal.

a. This area is shown as predominantly saltmarsh on the 1881/1882 OS maps;
b. The Latchford Canal is shown on all of the OS maps obtained from 1881/1882 to 1994, but the majority of this Canal is shown as having been replaced by the Manchester Ship

Canal from the 1899 OS map onwards. The 1908 OS map shows the remaining spur of the Latchford Canal as being disused;

c. The Old Quay works (copper and alkali) is shown on the 1881/1882 OS map to the west of Area D, towards the west of Wigg Island. This is shown as the Wigg Works (Alkali) on the 1899 OS map, with a small area of tipping marked to the east of the works. The 1928, 1954, 1962 and 1963 OS maps show the area of tipping to have extended gradually to the east, but not as yet into the Project area. The 1982 OS map shows the Wigg Works to have been replaced by a warehouse;
d. Tipping is shown on the area of land between the Latchford Canal spur and the Manchester Ship Canal on the 1899 OS map. This area is later shown to have been developed on the 1938 OS map. On the 1954 OS map this development is shown as the Kemet Chemical Factory. On the 1962/1963 OS map, an outfall is shown in the Project area extending from the site of the Kemet Factory, over the Latchford Canal and into a drain on Astmoor Saltmarsh. The Kemet Factory is no longer shown from the 1982 OS map onwards;
e. The area to the east of the Kemet Chemical Factory known as Randles Island is shown as developed on the 1962/1963 OS map. The development is shown as disused on the 1982 OS map. Information from historical sources indicates that Randle Island was developed in the First World War and was also active in the Second World War; and
f. The 1982 OS map shows a 'refuse tip' in the Project area to the south of Astmoor Saltmarsh (at the Wigg Island Community Park). Part of the Latchford Canal spur to the east of the Project area appears to have been infilled. The 1994 OS map shows trees at the former refuse tip and Kemet Factory within the Project area. The area of the former works at Randles Island is shown as an area of tipping with a series of possible lagoons near to the Manchester Ship Canal.

Area D – Information from Previous Investigations

14.6.155 Information was obtained from five previous site investigations undertaken in this area between 1993 and 2000. These investigations on the Wigg Island Landfill recorded topsoil over clay fill, which contained a wide range of waste materials including wood, brick, ash, clinker, plastic and occasional 'chemical waste pockets'. It was noted that the 'boundary between the made and natural ground was often difficult to distinguish as leaching of contaminants into natural ground has almost certainly occurred'.

14.6.156 Where natural material was present it was described as alluvial silty fine sands or soft silty clay. Sandstone bedrock was observed at depths ranging from 6.0m to 17.6m bgl. Groundwater was noted to be present within the alluvium and the waste material (as seepages), although the groundwater level in the alluvium rose to within the waste material over time.

14.6.157 Investigations within the former Kemet Works site reported made ground up to 5.8m bgl, this was described as sandy clay with gravels of brick and concrete, over glacial clay. The sandstone bedrock was noted to be present at 10.50m bgl.

14.6.158 Contamination testing recorded elevated concentrations of metals, phenol, sulphide and sulphur in shallow soils together with high concentrations of metals, cyanide and sulphate in waste materials (described as chemical wastes). In groundwater, elevated concentrations of metals were noted in two of the monitoring wells installed in this area.

14.6.159 Surface water samples taken from the former Latchford Canal to the north of the former Kemet Works were found to be acidic (minimum pH of 2.75). It was considered likely in the previous reports that other contaminants existed in the silt within this water body. Samples of a water seep entering a surface water ditch to the north of this site (north east of the Project area) were recorded as alkaline; pH 10.95 and pH 11.12. The pH from water samples from this ditch was

reported to range between 9.15 and 11.36, with one of the samples also reported as having elevated concentrations of arsenic, cadmium and chromium.

Area D – Landfills and Waste Management

14.6.160 The Envirocheck reports obtained for this area shows all of Wigg Island and Astmoor Saltmarsh to be landfill. From what is known from other sources such as OS maps, this is considered not to be the case.

14.6.161 The Wigg Island Landfill in Area D is listed in the HBC Contaminated Land Strategy (2001) as being part of the Wigg Works Tip which was operated by ICI for inert process solids. The Contaminated Land Inspection Strategy also lists the area to west of the route alignment in Area D (towards the west of Wigg Island Community Park) as having been tipped with "heavy chemicals" between 1869 and 1960.

14.6.162 The Envirocheck Report records for the Wigg Works Tip to the west of the Project indicate this operated between 1869 and 1960 and deposited waste included inert and industrial waste.

14.6.163 The Envirocheck Report has records for an historical landfill site within the Project area shown immediately south of the former Kemet Works on the banks of the Manchester Ship Canal. From other historical information it is considered unlikely that there is a landfill at this location and the information probably relates to either Wigg Island Landfill or Randle Island Landfill. The records provided indicate this site operated between 1869 and 1960 and deposited material included industrial waste. Another entry in the Envirocheck Report for this location indicates the landfill was licensed to ICI Ltd Mond Division for 'waste produced on-site'. The status of the landfill is shown as 'record superseded'. The records indicate the maximum input rate was greater than 250,000 tonnes per year and the authorised waste comprised the following:

a. Construction demolition wastes;
b. Mainly calcium sulphate;
c. Mercury contaminated waste;
d. Polyvinyl Chloride;
e. Razorite;
f. Sludge containing 5% vermiculite foam;
g. Spent catalyst (including chromium oxide);
h. Sulphur bearing debris and filter cake; and
i. Traces of chemical contamination from own operations.

14.6.164 The Randle Island Landfill is located approximately 500m east of Area D on Wigg Island in Runcorn. The Envirocheck Report indicates this is an active site operated by Ineos Chlor which is licensed to accept Special Waste (hazardous waste). Information on the EA website indicates the Randle Island Landfill site accepts treated hazardous wastes arising from the chemical manufacturing process. The EA website also indicates the hazardous waste permit is pending although this site is currently operating under a waste management license.

Area D – Surface Water

14.6.165 Available information indicates the St Helens Canal in the north of Area D was constructed on embankment onto the cohesive alluvium (shallow saltmarsh deposits). Given the age of this part of the Canal it is likely that some form of lining, such as puddle clay, would have been used on the base and sides of the Canal. Therefore, the St Helens Canal may not be in continuity with shallow groundwater.

14.6.166 The Manchester Ship Canal is located in the south of Area D and was cut through glacial deposits into the Sherwood Sandstone. Groundwater in bedrock is likely to be in hydraulic continuity with the Manchester Ship Canal. The spur to the former Latchford Canal in Area D on Wigg Island has been impacted by contamination arising from the former Wigg East Works. Remedial measures have been implemented in the past for the Latchford Canal including removing sediments and the construction of a leachate treatment system.

Area D – Ground Conditions

14.6.167 This area was investigated during the Phase 2, Phase 4 and Phase 5 site investigations.

Widnes Warth

14.6.168 The ground conditions comprise recent estuarine alluvium associated with the River Mersey. The alluvium (comprising clays overlying sands) rests upon glacial deposits, which is in turn underlain at depth by sandstone. Localised made ground was encountered in the north western part of Widnes Warth.

14.6.169 The made ground is not representative of the surrounding natural strata, but indicates the likely remnants of historic land use in a limited area adjacent to the St Helens Canal, where the saltmarshes have been raised locally. The made ground was encountered to +5.3m AOD in BH40.

14.6.170 The recent alluvium was proved in all the boreholes undertaken on the saltmarshes and was encountered in boreholes to depths of between 8.1m and 13.3m bgl (-2.8m AOD and -7.8m AOD), with an average thickness of 10.9m. The alluvial material comprised very soft to firm grey brown slightly sandy organic clay underlain by loose to medium dense grey brown slightly silty fine and medium sand.

14.6.171 Directly beneath the recent alluvium glacial deposits were encountered comprising firm to very stiff brown thinly laminated slightly gravelly sandy clay with interbedded loose to medium dense brown slightly gravelly silty medium and coarse sand and proved to level of between 3.7m and 29.9m bgl (-9.3m AOD and -32.7m AOD) generally increasing from south to north, away from the estuary.

14.6.172 Bedrock was encountered in three boreholes directly underlying the glacial deposits and comprised weak red thinly to thickly laminated fine and medium grained sandstone, proved to a maximum level of between -16m AOD and -39.1m AOD. A 4.9m thick layer of weathered sandstone was encountered in BH35 near the edge of the saltmarshes. The base of the sandstone was not proved.

Mersey Estuary

14.6.173 The ground conditions comprised recent estuarine alluvium associated with the River Mersey. The alluvium (comprising silty slightly gravelly sand) was found to rest directly on the Sandstone (bedrock was proved during the Phase 5 investigation within the route alignment). The exploratory holes within the Estuary cover a wider area than other parts of the Project area due to the potential mobility of the sediments.

14.6.174 Recent alluvium was recovered in all the boreholes undertaken in the estuary and was encountered to levels of between -4.4m AOD and -8.4m AOD, with an average thickness of 9.3m. The alluvial material comprised very loose to dense dark grey slightly silty slightly gravelly fine and medium sand. The gravel content was described as subangular and subrounded fine and medium of sandstone with occasional shell fragments and organic fragments of wood, coal

and silt within the upper sand. Very loose dark grey and black sandy slightly gravelly silt was encountered from ground level to 3m bgl within BH58. Rare pockets, up to 25 mm in size, of black organic silt and layers of soft and very stiff red brown slightly sandy slightly gravelly clay (possible glacial deposits) were also encountered within the main body of alluvial sand.

14.6.175 Bedrock was encountered in all five boreholes undertaken within the estuary during the Phase 5 site investigation, directly underlying the alluvium. The bedrock was initially encountered as highly and completely weathered material comprising weakly cemented very dense red brown locally silty fine and medium sand. The weathered bedrock graded into competent bedrock which comprised very weak to weak, occasionally moderately weak, red brown medium to thickly bedded fine to coarse grained sandstone. Fracturing was predominately sub-horizontal tight to open, rough and generally clean with occasional clay and sand infill. The depth to the sandstone increased towards the northern channel within the estuary.

Astmoor Saltmarsh and Wigg Island

14.6.176 The ground conditions comprised made ground (where present) overlying recent alluvium, which was underlain by glacial deposits. Bedrock was found to directly underlie the glacial deposits at relatively shallow depths.

14.6.177 The made ground material was associated with the raised ground at the Wigg Island Landfill, and was encountered to levels of +6.4m AOD and +5.3m AOD, with a thickness of between 0.5m and 8.3m.

14.6.178 The alluvial material was encountered in all the boreholes undertaken on the saltmarshes (except BH20 and BH31) to depths of between 6.1m and 8.8m bgl (-0.7m AOD and -2.96m AOD), with an average thickness of 7.6m. The alluvial material comprised very soft to soft grey brown slightly sandy organic clay underlain by loose to medium dense grey brown slightly silty fine and medium sand.

14.6.179 Glacial deposits were encountered in BH33 and BH34 as a stiff to very stiff brown locally laminated slightly gravelly sandy clay to depths of between 8.6m and 9.5m bgl (-2.9m AOD and -3.7m AOD), and a thickness of 1.3m to 1.6m. Glacial deposits were not present in BH15, BH17 or BH32. Within BH20 and BH31, located in the south of Wigg Island (near to the Manchester Ship Canal), glacial deposits were encountered directly underlying the made ground to a level of +5.0m AOD and +3.2m AOD, with an average thickness of 7 metres. The glacial deposits were encountered as stiff brown sandy slightly gravelly clay. Dense red clayey fine sand was encountered at the base of the glacial deposits from +3.2m to +1.0m AOD within BH20.

14.6.180 Bedrock was encountered in all boreholes, directly underlying the alluvium or glacial deposits and was initially described as very weak red brown sandstone, recovered as red brown medium and coarse sand. The sandstone was encountered as very weak to moderately weak thinly to thickly laminated red sandstone at depth. The sandstone was proved between +0.8m AOD to maximum of -27.2m AOD (BH34). In each of the boreholes the sandstone was initially recovered as sand with a thickness of between 3.3m to 11.5m, indicating the top of the bedrock is highly to completely weathered.

Area D – Groundwater

14.6.181 Monitoring wells in this area were installed into the alluvium, glacial sand and bedrock on the saltmarshes. Four monitoring wells were installed at the north eastern end of the Wigg Island Landfill. Two of these wells were installed in boreholes commenced from the top of the landfill, one of these wells was installed into the made ground and the other into bedrock. The remaining two wells were placed in boreholes commenced from the lower slope of the landfill, and these were installed into the alluvium. Water levels monitored during Round 10 were found to be between 1.75 and 4.74m AOD in alluvium, 3.08m AOD within the glacial deposits, and between 1.73 and 3.67m AOD in the sandstone bedrock.

14.6.182 The monitoring well installed into the made ground in the Wigg Island Landfill has been dry during every monitoring and sampling round, although other investigations have encountered groundwater within this material in the landfill.

Area D – Results of the Chemical Testing and Monitoring

14.6.183 The following results were obtained from the chemical testing and monitoring.

Soil - Human Health for Site Users (Commercial/Industrial Land Use)

14.6.184 A comparison of the soil test results against the commercial/industrial land use GAC has not been undertaken in this area as the approach viaduct will be raised on piers.

Soil - Human Health for Construction workers

14.6.185 Concentrations of arsenic, lead and barium were obtained from the cohesive sediments which exceed the assessment criteria derived for construction workers.

14.6.186 Concentrations of arsenic were also obtained from two samples (made ground and alluvium) in Area C which could represent a risk to construction workers by acute ingestion.

Soil - Buried Concrete

14.6.187 Concentrations of water soluble sulphate were obtained from made ground and alluvium which exceed the DS-1 level from BRE Special Digest 1 (Ref. 21).

Sediment Quality Criteria - Saltmarshes

14.6.188 Widespread exceedances of the Interim Sediment Quality Guidelines (ISQG) (Ref. 23) for metals, notably arsenic, cadmium, chromium, copper, lead, mercury and zinc, were obtained from exploratory hole locations associated with the shallow cohesive alluvial sediments. Figure 14.40 (Appendix 14.1) shows the locations where arsenic exceeds the ISQG values. Widespread exceedances of the probable effect limits were obtained for metals in cohesive sediments on the saltmarshes. Concentrations of PAHs above the probable effect limits were obtained from the cohesive alluvium tested.

14.6.189 Although there are no sediment quality criteria for ammonium it was recorded in the made ground and alluvium within the Project area at the site of the Wigg Island Landfill. These were the highest results obtained from the Project area.

14.6.190 Localised exceedances of the interim sediment quality guidelines for organochlorine pesticides and PCBs were obtained from the cohesive sediments on Widnes Warth.

Sediment Quality Criteria - Intertidal Zone in the Mersey Estuary

14.6.191 Widespread exceedances of the interim sediment quality guidelines for metals were obtained from chemical testing in the intertidal zone, notably concentrations of arsenic, lead mercury and zinc exceeded the higher probable effect limit for sediments in localised areas. Concentrations of PAHs were also obtained from chemical testing that exceeded the interim sediment quality guidelines, but not their respective higher probable effect limits.

Assessment of Sediment Concentrations in the Estuary from Scouring

14.6.192 An assessment of the potential effect from scouring was undertaken based on a number of different depths of sediments being scoured (up to 6m depth). This assessment was undertaken on the metals and PAHs which were identified as exceeding the interim sediment quality guidelines. The 95th percentile contaminant concentrations (mean value test from CLR7 (Ref. 31) for each scour zone were calculated and compared to the results derived for the mobile sediment zone.

14.6.193 The results of this assessment indicate that generally the concentrations of contaminants within estuary sediments would not change. The exceptions are the results for arsenic which show a possible small increase in concentration in sediments, and PAHs where a possible slight decrease in concentrations may occur. It should be noted that scouring of deeper sediments and sediment release around the towers in the estuary would be a one off event.

Soil Leachate

14.6.194 Concentrations of metals, notably arsenic, lead, chromium, copper, and zinc along with hydrocarbons exceeding the water quality standards were obtained from made ground and alluvium on saltmarshes in Area D. Concentrations of PAHs including naphthalene that exceeded the water quality standards were also obtained from the made ground on the Wigg Island Landfill along with phthalates in BH32.

Groundwater

14.6.195 Monitoring wells in this area were installed into the made ground, alluvium, glacial sand and bedrock on the saltmarshes. One monitoring well was installed into the made ground on top of the Wigg Island Landfill, this monitoring well has been dry during every monitoring and from the sampling round. Previous investigations have encountered groundwater within this landfill.

14.6.196 Localised exceedances of the water quality standards for metals (notably arsenic, zinc, copper and mercury) were obtained in alluvium and bedrock in monitoring wells installed onto the saltmarshes. Figure 14.31 (Appendix 14.1) shows the locations where arsenic was encountered above the EQS value. Concentrations of chloride and conductivity obtained from the alluvium and bedrock were indicative of the presence of a saline intrusion from the adjacent River Mersey. Total cyanide and ammonium were recorded in groundwater from the alluvium underlying the Wigg Island Landfill, along with slightly elevated concentrations of naphthalene, which exceeded the water quality standards.

14.6.197 Alkaline pH was obtained from groundwater in the alluvium in WS2 beneath the Wigg Island Landfill exceeding the water quality standards.

14.6.198 A sample of water was obtained from a spring on the Astmoor saltmarsh, near to the Wigg Island Landfill. This was located on the bank of a surface water drainage channel. Exceedances of the water quality standards for lead, ammonia, total cyanide and alkaline pH were obtained from this sample.

Ground Gas and Vapours

14.6.199 Concentrations of carbon dioxide above the long term workplace exposure limit were obtained from alluvium and bedrock on Widnes Warth and Astmoor saltmarsh (Ref. 28).

14.6.200 A local exceedance of the long term workplace exposure limit for hydrogen sulphide and volatile vapours were obtained from samples of made ground on the Wigg Island Landfill.

14.6.201 No buildings are proposed in this area; therefore, no assessment for ground gas protection measures has been undertaken.

Areas E & F

14.6.202 Area E comprises an industrial estate and access roads associated with the Astmoor Industrial Estate. The Bridgewater Junction in Area F currently comprises a grade separated junction.

Areas E & F – Historical Land Uses

14.6.203 An overview of the main historical land uses in this area identified from the OS maps is as follows.

a. The 1881/1882 OS map shows this area to be open fields. Marsh Farm was located to the east of the Project area within the area of the existing Astmoor Industrial Estate. The Astmoor Tannery is first shown within the Project area along the north bank of the Bridgewater Canal east of the Bridgewater Junction;
b. The 1928 OS maps shows the building at Astmoor Tannery to have expanded northwards;
c. The 1938 OS map shows a filter bed north of Marsh Farm in the area of the Astmoor Industrial Estate. Buildings (possible houses) are shown east of Marsh Farm;
d. The 1962 and 1963 OS maps show Halton Brook flowing northwest from the filter beds identified in the area of the Astmoor Industrial Estate and towards the Manchester Ship Canal;
e. The 1982 OS map shows the Astmoor Industrial Estate along with the Bridgewater Junction (the existing carriageway west of the Bridgewater Junction is not shown as having been constructed at this stage). The former Astmoor Tannery and Marsh Farm are no longer shown; and
f. The 1994 OS map shows further development at the Astmoor Industrial Estate. The A533 Daresbury Expressway is shown to the west of the Bridgewater Junction.

Areas E & F – Information from Previous Investigations

14.6.204 A ground investigation was completed in this area in 1984. The investigation encountered made ground over glacial sand and glacial clay. Bedrock was not proved. No contamination testing was undertaken as part of this investigation.

Areas E & F – Landfills and Waste Management

14.6.205 The Envirocheck Report has records of a registered waste transfer site and a waste treatment or disposal site on Astmoor Industrial Estate; licenses for both sites are shown as being lapsed/cancelled. The waste transfer site was located immediately north of the Project area and the Daresbury Expressway on Chadwick Road. This license holder was Autochem Ltd and the authorised wastes were solvents. The waste treatment or disposal site was located west of the Project on Davy Road and the authorised waste comprised plastics only.

Areas E & F – Surface Water

14.6.206 The Manchester Ship Canal is located immediately to the north of Area E. The Bridgewater Canal is located is located in Area F below the Bridgewater Junction.

Areas E & F – Ground Conditions

14.6.207 This area was investigated during the Phase 1 and Phase 6 site investigations. The ground conditions encountered comprised made ground overlying glacial deposits, which in turn was underlain by sandstone bedrock.

14.6.208 A layer of made ground was encountered from ground level to a level of between 0.4m to 5m bgl (+35m AOD to +10.5m AOD), with an average thickness of 1.6m. The made ground material comprised soft, firm and stiff red and orange brown sandy slightly gravelly clay, loose grey brown slightly sandy clayey gravel, dense grey brown slightly sandy gravelly cobbles, loose red silty fine and medium sand or dark brown sandy gravelly silt. Gravel content comprised sandstone, coal, concrete, shale, mudstone, rare brick and occasional organic matter.

14.6.209 Directly underlying the made ground, were glacial deposits. The base of the glacial deposits was between 2.3m and 16.5m bgl (+32.7m AOD and -5.9m AOD). The glacial deposits comprised stiff and very stiff (occasionally firm) brown slightly sandy slightly gravelly clay underlain by dense and very dense red clayey slightly gravelly sand with occasional bands of stiff brown very sandy clay. The gravel content was described as sub-angular to sub-rounded fine to coarse of sandstone and coal and occasional mudstone and limestone. A layer of thinly laminated light brown silt was encountered within the glacial deposits in BH116.

14.6.210 The bedrock was encountered in all of the boreholes undertaken within the Astmoor area (except BH27 and BH28) and comprised very weak to weak sandstone, which extended to -27.9m AOD in BHRC30. A very weak red brown mudstone overlying a moderately strong thinly laminated red brown siltstone was encountered in BH29 from +32.7m AOD to +29m AOD.

14.6.211 The upper surface of the bedrock was found to be highly weathered and recorded in the boreholes as very dense orange brown slightly silty/clayey slightly gravelly fine and medium sand. The intact bedrock was encountered as very weak to weak (locally moderately weak) red brown, grey and green thinly laminated fine and medium grained sandstone.

Areas E & F – Groundwater

14.6.212 Monitoring wells were installed into the glacial deposits and sandstone bedrock. Water levels monitored during Round 10 and during the Phase 6 site investigation were found at 21.24m AOD within made ground at BH116, at 25.00m AOD in alluvium at BH120, at 23.50m AOD within the glacial deposits at BH119, and between 3.24 and 6.75m AOD in the sandstone bedrock.

Areas E & F – Results of the Chemical Testing and Monitoring

14.6.213 The following results were obtained from the chemical testing and monitoring.

Soil - Human Health for Site Users (Commercial/Industrial Land Use)

14.6.214 No exceedances of the assessment criteria were noted. Asbestos was encountered in made ground from BH114 at the Bridgewater Junction.

Soil - Human Health for Construction Workers

14.6.215 Localised exceedances of the assessment criteria derived for construction workers for lead and PAHs were obtained from the made ground in this area.

Soil - Phytotoxicity

14.6.216 None of the samples tested exceed the assessment criteria for phytotoxicity in this area.

Soil - Buried Concrete

14.6.217 No concentrations of water soluble sulphate exceeding the DS-1 level from BRE Special Digest 1 (Ref. 21) were recorded.

Soil - Buried Water Supply Pipes

14.6.218 An assessment for buried water supply pipes was not undertaken in this area as no buildings such as offices or toll plazas are proposed.

Soil Leachate

14.6.219 Concentrations of metals (notably arsenic, cadmium, chromium, copper, zinc and vanadium) and SVOCs including PAHs were obtained from soils in this area exceeding the water quality standards.

Groundwater

14.6.220 Monitoring wells were installed into the glacial deposits and the sandstone bedrock.

14.6.221 When compared to the water standards, concentrations of antimony, chromium, copper, iron and mercury were noted in localised areas in both the glacial deposits and bedrock in this area. Ammonia was also identified in groundwater in the sandstone bedrock at one location.

Ground Gas

14.6.222 Concentrations of carbon dioxide were obtained from both the glacial deposits and bedrock, exceeding the long term workplace exposure limit (Ref. 28).

14.6.223 No buildings are proposed in this area; therefore, an assessment for ground gas protection measures has not been undertaken.

Area G

14.6.224 This existing land use in this area is highways.

Area G – Historical Land Uses

14.6.225 An overview of the main historical land uses identified in this area identified from the OS maps is as follows.

a. A review of the historical OS maps up to and including 1962 shows the area to be fields; and

b. The existing road network is first shown on the 1974 OS map (1:2,500) with the adjacent housing developments at Beechwood and Southgate shown from the 1980 OS maps onwards.

Area G – Information from Previous Investigations

14.6.226 No previous site investigations have been obtained for this area.

Area G – Landfills and Waste Management

14.6.227 The Envirocheck Reports do not contain records of any landfills within 500m of this area.

Area G – Surface Water

14.6.228 No surface water features are located close to this area.

Area G1 – Ground conditions

14.6.229 This area was investigated during the Phase 6 site investigation. The ground conditions comprised glacial deposits overlying interbedded sandstone and mudstone. Made ground was encountered in BH126 located close to the bridge abutment on the verge of the A5126 (possible abutment backfill material).

14.6.230 Made ground was also encountered in BH124 and BH126 from ground level to 0.5m and 2m bgl respectively, comprising road construction to 0.6m bgl and grey slightly gravelly silt. The gravel was found to be fine and medium ash, brick and limestone.

14.6.231 Glacial deposits were encountered across this area from ground level to a depth of between 2.05m to 11.5m bgl (+62.8m AOD and +54.1m AOD). The glacial deposits comprised firm, stiff and very stiff orange brown slightly sandy, slightly gravelly clay. The gravel comprised sub-angular to sub-rounded fine to coarse sandstone, occasional mudstone and limestone. A 1.1m thick layer of medium dense orange brown clayey slightly gravelly sand was encountered in BH122 at 1.9m bgl.

14.6.232 Bedrock was encountered at the base of each of the six boreholes undertaken at the Lodge Lane Junction and proved to a maximum depth of 26m bgl (+40.3m AOD) in BHRC123. The bedrock was initially recovered as very stiff red brown slightly sandy gravelly clay; the gravel was described as fine to coarse and comprising of sandstone and mudstone.

14.6.233 Where bedrock was recovered, the strata comprised very weak to moderately weak red brown fine grained sandstone with frequent laminae of red brown mudstone or very weak to weak thinly laminated grey green and purple brown mudstone/siltstone with very closely to medium spaced subhorizontal discontinuities.

Area G2 – Ground conditions

14.6.234 The ground conditions comprised made ground overlying glacial deposits, which in turn was underlain by weathered sandstone.

14.6.235 Made ground was encountered in each of the boreholes from ground level to a depth of between 1.7m and 2.3m bgl (+56.7m AOD and +51.7m AOD), with an average thickness of 2.4m. The made ground material was fairly consistent and comprised soft, firm and stiff brown and black sandy gravelly clay or red brown and black clayey very gravelly sand. The gravel was described as sandstone and mudstone with occasional cobbles of concrete.

14.6.236 Directly underlying the made ground were glacial deposits to a depth of between 4.55m and 10m bgl (+51.9m AOD to +45.8m AOD), although the base was not proven at 10m bgl in BH127 and BH128. The glacial deposits comprised firm to stiff (becoming very stiff at depth) red brown slightly sandy slightly gravelly clay.

14.6.237 Weathered bedrock was encountered in three of the five boreholes undertaken within this area directly underlying the glacial deposits. The rock was recovered as very dense red brown slightly sandy gravel with occasional cobbles of sandstone.

Area G – Groundwater

14.6.238 Monitoring wells were installed into the made ground, glacial deposits and sandstone bedrock. Water levels monitored during the Phase 6 site investigation were found to be 55.60m AOD within the glacial deposits at BH122, and between 53.27 and 56.16m AOD in the sandstone bedrock. The wells installed in made ground and three of the wells installed in glacial deposits were found to be dry.

Area G – Results of the Chemical Testing and Monitoring

14.6.239 The following results were obtained from the chemical testing and monitoring.

Soil - Human Health for Site Users (Commercial/Industrial Land Use)

14.6.240 One exceedance of the GAC for lead was obtained from made ground in BH127 at the Weston Link Junction. No other samples tested exceeded the GAC for a commercial/industrial land use.

14.6.241 None of the US_{95} values exceeds the GAC values for a commercial/industrial land use, although a statistical outlier was identified for lead.

Soil - Human Health for Construction Workers

14.6.242 Localised exceedances of the assessment criteria derived for construction workers for arsenic and lead were obtained from the made ground in BH127.

Soil - Phytotoxicity

14.6.243 One sample tested (from BH127) exceeded the assessment criteria for phytotoxicity in this area for copper and zinc.

Soil - Buried Concrete

14.6.244 One sample of made ground from BH126 at 1.0m bgl recorded a concentration of water soluble sulphate above the DS-1 level from BRE Special Digest 1 (Ref. 21).

Soil - Buried Water Supply Pipes

14.6.245 An assessment for buried water supply pipes was not undertaken in this area as no buildings such as offices or toll plazas are proposed.

Groundwater

14.6.246 Some exceedances of the DWS for metals, notably copper, nickel and zinc were obtained from the glacial deposits and sandstone bedrock.

Ground Gas and Vapours

14.6.247 Exceedances of the long term workplace exposure limits (Ref. 28) were observed for carbon dioxide from made ground in BH127 and carbon dioxide and methane from glacial deposits in BH131A. The highest concentrations of carbon dioxide and methane were obtained from BH131A during the Phase 6 site investigation.

14.6.248 No buildings are proposed in this area; therefore, no assessment for ground gas protection measures has been undertaken.

Area H

14.6.249 This area comprises the highways and a roundabout associated from M56 Junction 12.

Area H – Historical Land Uses

14.6.250 An overview of the main historical land uses in this area identified from the OS maps is as follows.

a. A review of the historical OS maps up to and including 1962 shows the majority of the Project area to be fields; and
b. The existing road network is first shown on the 1974 OS map (1:2,500) with the adjacent housing developments at Beechwood and Southgate shown from the 1980 OS maps onwards.

Area H – Information from Previous Investigations

14.6.251 No previous site investigations have been obtained for this area.

Area H - Landfills and Waste Management

14.6.252 The Envirocheck Report has records of a landfill approximately 100m to the west of this area. This is shown as “No.3 Lagoon” although no other information was provided. Additional lagoons are shown to the west of the Weaver Navigation, approximately 250m from the Project area, which were operated by ICI Chemicals & Polymers Ltd. No information was located to indicate whether the licenses for these sites have been surrendered.

Area H – Surface Water

14.6.253 The Flood Brook is flows through Area H in a westerly direction towards the Weaver Navigation. This Brook is situated at a lower elevation than the existing highways.

Area H – Ground Conditions

14.6.254 This area was investigated during the Phase 6 site investigation. The ground conditions encountered within this area comprised made ground overlying glacial deposits, which in turn is underlain by weathered mudstone.

14.6.255 Made ground was encountered in each of the boreholes from ground level to a depth of between 0.3m and 3.7m bgl (+30.9mAOD and +21m AOD), with an average thickness of 1.8 metres. The made ground material comprised firm to stiff red dark brown and grey slightly sandy slightly gravelly clay or very dense red brown clayey gravelly sand. The gravel sized

constituents were described as mudstone, coal, concrete, brick and clinker. Sand, gravel and clay fill was encountered in BH134 and BH135A.

14.6.256 Directly underlying the made ground were glacial deposits to depths of between 7.9m and 10.5m bgl (+21.2m AOD to +16.4m AOD), with an average thickness of 7.8m. The glacial deposits comprised interbedded firm to stiff (occasionally soft, becoming very stiff at depth) red brown slightly sandy slightly gravelly clay and medium dense (occasionally loose) orange brown clayey slightly gravelly sand. Gravel is subangular to sub-rounded fine to coarse of mixed lithologies including sandstone and mudstone.

14.6.257 Material identified as possible mudstone bedrock was identified at 9.5m and 7.9m bgl in BH134 and BH135 respectively.

Area H – Groundwater

14.6.258 Monitoring wells were installed into the glacial deposits in this area. These wells were found to be dry during monitoring works undertaken as part of the Phase 6 site investigation, therefore, no groundwater samples were obtained for analysis.

Area H – Results of the Chemical Testing and Monitoring

14.6.259 The following results were obtained from the chemical testing and monitoring.

Soil - Human Health for Site Users (Commercial/Industrial Land Use)

14.6.260 None of the samples tested exceeded the GAC for a commercial/industrial land use.

Soil - Human Health for Construction workers

14.6.261 Concentrations of lead, chromium, vanadium (BH133) and methyl phenol (BH135) were obtained from the made ground which exceeded the assessment criteria derived for construction workers.

Soil - Phytotoxicity

14.6.262 None of the samples tested exceeded the assessment criteria for phytotoxicity.

Soil - Buried Concrete

14.6.263 No concentrations of water soluble sulphate were obtained above the DS-1 level from BRE Special Digest 1 (Ref. 21).

Soil - Buried Water Supply Pipes

14.6.264 An assessment for buried water supply pipes was not undertaken in this area as no buildings such as offices or toll plazas are proposed.

Soil Leachate

14.6.265 One exceedance of the water quality standards for petroleum hydrocarbon (gasoline range organics) was obtained from the made ground in BH132. As this exploratory hole is located adjacent to highways, it is possible these contaminants could have arisen from a fuel spill, although no visual or olfactory evidence of contamination was encountered in BH132 during the site investigation.

Groundwater

14.6.266 Monitoring wells in this area were dry; therefore, no samples have been obtained for chemical testing.

Ground Gas and Vapours

14.6.267 No concentrations of ground gas were observed in this area that exceed the long term workplace exposure limits (Ref. 28).

14.6.268 No buildings are proposed in this area; therefore, no assessment for ground gas protection measures has been undertaken.

Area I2 (de-linking)

14.6.269 This area comprises highway embankments associated with the A533 and A557 Expressways in Widnes. It is proposed these would be excavated and re-used where possible as part of the works. Therefore, chemical testing results for this area have been compared to the assessment criteria derived for construction workers.

14.6.270 This area was investigated during the Phase 6 site investigation. The results of this assessment indicate that locally elevated concentrations of arsenic and lead, hydrocarbons (aliphatic and aromatic, C10-12 and C12-16 fractions), naphthalene, benzo(a)pyrene, benzene, toluene, isopropylbenzene, 4-isopropyltoluene and a range of chlorinated solvents were obtained from the embankments which exceed the assessment criteria derived for construction workers.

Summary of Existing Levels of Contamination

14.6.271 This section provides a summary of the information obtained on contaminants in soils and groundwater which represent 'sources' of contamination used within the conceptual site model.

a. Concentrations of soil contaminants have been obtained from the made ground and alluvium which exceed the assessment criteria derived for a commercial/industrial land use in Area A to C in Widnes. Exceedances of the GAC for commercial/industrial land use was highly localised in Runcorn (lead in BH127);
b. Widespread exceedances of the assessment criteria derived for construction workers were encountered in the made ground and alluvium in Widnes and the cohesive alluvium on the saltmarshes. Only localised exceedances of assessment criteria for construction workers were encountered in Runcorn, associated with the made ground;
c. Concentrations of soil contamination exceeding the assessment criteria for phytotoxic metals and for buried drinking water supply pipes have also been encountered in samples of made ground in Widnes. Only one sample exceeded the assessment criteria for phytotoxic metals in made ground in Runcorn (BH127 at the Weston Link Junction);
d. Concentrations of metals, PCBs and organochlorine pesticides have been encountered in the cohesive alluvium on the saltmarshes that exceed the sediment quality guidelines. Concentrations of metals/metalloids and PAHs were encountered in sediments within the estuary that exceed the sediment quality guidelines;
e. Widespread exceedances of the water quality standards for metals/metalloids were recorded in Widnes within shallow groundwater. Concentrations of metals/metalloids in groundwater in the bedrock were low. Widespread exceedances of the water quality standards for ammonium were encountered across the Project area;
f. Stewards Brook is understood to be lined where it crosses the site area through the southern part of St Michaels Golf Course (Area A). Therefore, it is unlikely that

contaminants would be migrating into the Brook at present. There is evidence that the brook has been impacted by contamination, though this is thought to originate from the northern part of the golf course outside the Project area. Contamination has been identified in groundwater within the made ground and alluvium at St Michaels Golf. As the contamination source in Area A extends beyond the Project area the impact on the alluvium (minor aquifer) is likely to extend off-site;

g. The St Helens Canal is likely to be founded in the cohesive alluvium and dates from a time when canals were frequently lined. On this basis, it is considered unlikely that contaminants in shallow groundwater would be migrating directly into the St Helens Canal;

h. Floating product as LNAPL has been identified in shallow groundwater in the made ground at the Gussion Transport site in Areas B2 and I1. Elevated concentrations of hydrocarbons, PAHs, some VOCs and SVOCs were obtained from soils tested in this area. The groundwater tested contained elevated concentrations of hydrocarbons, and some SVOCs and VOCs (including several chlorinated solvents, benzene, toluene and xylenes). LNAPL would provide a source for dissolved phase contamination in groundwater;

i. The information obtained indicates a former works water well (extending into the bedrock) was located in Area B2. The location of this well has not been confirmed although historical maps indicate this is likely to have been at the Gussion Transport site;

j. A wide range of chlorinated solvents have been identified in soil and groundwater samples tested from the made ground, alluvium and glacial deposits from chemical testing in Area C. The highest concentrations of solvents were obtained from the southern part of Catalyst Trade Park;

k. The concentrations of chlorinated solvents in groundwater within made ground, alluvium and the upper glacial sand are indicative of possible DNAPL in the southern part of Catalyst Trade Park in Area C. Evidence of possible DNAPL was encountered in the south west part of the Catalyst Trade Park and it is likely this has migrated off-site. DNAPL would provide a source for dissolved phase contamination in groundwater. No evidence was noted for the migration of possible DNAPL or dissolved phase chlorinated solvents along the proposed route to the south east onto Widnes Warth;

l. The results from shallow monitoring wells down-gradient of the Catalyst Trade Park indicate a rapid decrease in dissolved solvent concentrations, although the results from BH55 on Spike Island still exceed water quality standards;

m. Solvents did not exceed the water quality standards in the monitoring wells installed into the made ground and glacial sands nearest to the likely location of the former works water well at Catalyst Trade Park (north of Unit 3);

n. Previous investigations encountered solvents (and radiological material) in the drains at Catalyst Trade Park. It is understood the drains at this site connect to Bowers Brook. Evidence of chlorinated solvents has been obtained in the outfall of Bowers Brook at Spike Island;

o. In Runcorn, exceedances of the water quality standards for phenol and ammonia were obtained from the alluvial deposits beneath Wigg Island Landfill. Exceedances of the standards for phthalates were obtained from the groundwater in the glacial deposits from Area D on Astmoor saltmarsh and Area F at the Bridgewater Junction. Localised exceedances of the water quality standards for iron and arsenic were obtained on Astmoor saltmarsh from the alluvium and Sherwood Sandstone, with exceedances for zinc in groundwater at the Lodge Lane Junction in the glacial deposits;

p. Approach viaduct piers would be located at the eastern end of the Wigg Island Landfill. No groundwater has been encountered in BH18A which was installed into the fill material on top of the Wigg Island Landfill. However, information obtained from historical investigations undertaken in other parts of the Wigg Island Landfill indicates that perched groundwater has been encountered within the made ground;

q. Exceedances of the water quality standards for ammonia and sulphate were recorded in samples of groundwater obtained from monitoring wells installed into the alluvium on the eastern slope of the Wigg Island Landfill;

r. A spring with an associated white precipitate was identified on Astmoor Saltmarsh. This spring is located on the southern bank of a surface water drainage channel, to the north of the Wigg Island Landfill. Chemical testing of the spring water encountered elevated concentrations of ammonia, cyanide and an alkaline pH;

s. There was evidence that the groundwater beneath Wigg Island Landfill has been impacted as ammonia and slightly elevated concentrations of arsenic have been recorded. Elevated concentrations of arsenic have also been recorded in monitoring wells on Astmoor saltmarsh, downgradient of the Wigg Island Landfill;

t. Gas screening values from Areas A, B and C correspond to CS2 from CIRIA C665 (Ref. 27).

u. Carbon dioxide has been detected in Widnes (made ground, alluvium, glacial deposits and bedrock) and in localised areas in Runcorn (made ground, glacial deposits and bedrock) which exceed the workplace exposure limits; and

v. The highest concentrations of volatile vapours were detected in soils (made ground, alluvium and glacial deposits) in the southern part of Area C at Catalyst Trade Park and Thermphos. Volatile vapours were also detected in Areas A, B and the northern part of Area C in the made ground and near surface glacial deposits although at significantly lower levels.

14.7 Effect Assessment

14.7.1 The initial stage of the effect assessment comprised a risk assessment to qualitatively assess the significance of contamination using a source-pathway-receptor model. For a risk to exist at least one plausible pollutant linkage between each component of the model needs to be present. The aim of the risk assessment has been to identify, on a qualitative basis, the extent to which linkages may be operating at present and those which could be introduced during the construction and operation stages of the Project. This assessment was used to identify which of these are likely to be significant effects.

14.7.2 This risk assessment has been prepared on the basis of the conceptual site model which is included in Appendix 14.9 and summarised on Figures 14.41 to 14.44 (Appendix 14.1). The figures show Source – Pathway – Receptor linkages and these are referenced to the risk assessment tables 14.11 to 14.20.

14.7.3 The conceptual model is based on the following information and is summarised below.

a. Current land use;
b. Historical land uses;
c. Ground conditions;
d. Hydrogeology and water abstractions;
e. Contaminants in soil, leachate and groundwater;
f. Ground gas and volatile vapours;
g. UXO and radiation; and
h. Construction proposals.

14.7.4 The sources of contamination have been outlined in Section 14.6 and summarised in paragraph 14.6.271. The contaminants identified represent the existing conditions and this baseline will be present even if the Project does not proceed.

14.7.5 Table 14.7 outlines the potential pathways and receptors that could exist at present or during the Construction and Operation Stage. The construction proposals used within the conceptual model are listed in paragraph 14.7.6.

Table 14.7 – Summary of Potential Pathways and Receptors

Receptors	Pathways
Human health – Ground workers, visitors, local residents, trespassers, site users, site workers (toll booths or offices), maintenance workers and landscaping contractors	Soil/dust ingestion, inhalation or dermal contact, inhalation of gas and/or vapours, migration of contaminated water into excavations or surface waters, ingestion or dermal contact with water from contaminated water supply pipes
Controlled waters - Groundwater and surface water	Vertical migration to groundwater
	Migration of groundwater off-site or to surface water, surface water run-off
	Creation of vertical pathways as a result of development, e.g. piling, drainage, placement of embankments, service runs, removal of foundations
Buildings and buried services	Contact with aggressive ground conditions Damage to buried services and tainting of water supplies Gas and/or vapour ingress into buildings
Flora in areas of soft landscaping	Plant uptake
Flora and fauna on the salt marshes and in the Estuary	Direct contact

14.7.6 In addition to the information on construction proposals relating to ground conditions outlined in Section 14.3 of this Chapter, which was obtained from the Construction Methods Report (MG_REP_EIA_010), the following were also considered as part of the conceptual site model.

a. The ground improvement for embankments on made ground or alluvium would be vibro-concrete columns founded on the glacial clay with a load transfer platform. Verbal consultation with ground improvement specialists indicates vibro-concrete columns are unlikely to penetrate more than 200mm to 300mm into the underlying firm to stiff glacial clay;
b. Foundations for larger structures will require piles where there are significant depths of made ground or alluvium;
c. Structures to the south of the Estuary will be founded on rock.
d. On Widnes Warth the piles for the five approach viaduct piers closest to the river will be founded on rock, thereafter piles for all structures to the north will be founded in the glacial clay;
e. Excavations for services and pile caps and replacement piles such as continuous flight auger (CFA) and bored and cast in place methods would produce arisings;
f. Only limited areas of cutting will be required in Widnes and no extensive excavations for site preparation will be required. A site strip would not be undertaken prior to construction;
g. Post-construction the site will comprise a road with landscaped embankments. Toll plazas and office buildings will be located on embankment fill in Widnes. It is assumed that a nominal thickness of topsoil (at least 200mm to 300mm) would be introduced over fill material in areas of landscaping, though in some areas this may need to be deeper; and
h. Pedestrian access for the toll booths would be from overhead walkways.

Qualitative Risk Assessment

14.7.7 The risk assessment is based on the guidance provided in CIRIA Report C552 – Contaminated Land Risk Assessment – A Guide to Good Practice (Ref. 12) and has been undertaken on a qualitative basis, which means that both scale and probability are considered. Scenarios have been assessed for the Do-Nothing, Construction and Operational Stages.

14.7.8 The following descriptions on the classification of probability, consequence and risks are provided in CIRIA C552 (Ref. 12).

Classification of Consequence

Table 14.8 – Classification of Consequence

CIRIA C552 Classification	Examples of Criteria Threshold
Severe	Short term (acute) risk to human health likely to result in 'significant harm' as defined in EPA, 1990 Part IIA. Short term risk of pollution of sensitive water course. Catastrophic damage to buildings/property. A short term risk to a particular eco-system or organism forming part of such eco-system.
Medium	Chronic damage to human health ('significant harm'). Pollution of sensitive water resources. A significant change in a particular eco-system or organism forming part of such eco-system. Significant damage to plants, buildings, structures and services.
Mild	Pollution of non-sensitive water resources. Damage to sensitive buildings, structures, services or the environment
Minor	Harm, although not necessarily significant which may result in financial loss or expenditure to resolve. Easily repairable effects of damage to buildings structures and services.

Classification of Probability

Table 14.9 – Classification of Probability

CIRIA C552 Classification	Examples of Criteria Threshold
High Likelihood	There is a pollutant linkage and an event that either appears 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 a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur
Low Likelihood	There is a pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and it is less likely in the shorter term
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term

Comparison of Consequence against Probability

Table 14.10 – Comparison of Consequence against Probability

		Consequence			
		Severe	*Medium*	*Mild*	*Minor*
Probability	*High Likelihood*	Very high risk	High risk	Moderate risk	Moderate/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

14.7.9 A description of the classified risks and likely action is outlined below:

Very High Risk

14.7.10 There is a high probability that severe harm could arise to the designated receptor from an identified hazard or there is evidence that severe harm to a designated receptor is currently happening. The risk, if realised is likely to result in substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.

High Risk

14.7.11 Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.

Moderate Risk

14.7.12 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, or if any harm were to occur, it is likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and determine the potential liability. Some remedial works may be required in the longer term.

Low Risk

14.7.13 It is possible that harm could arise to a designated receptor from an identified hazard but is likely that this harm, if realised, would at worst normally be mild.

Very Low Risk

14.7.14 There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

14.7.15 It is important to note that the Moderate* risk category is not contained in CIRIA C552 (Ref. 12). However, it has been included on the basis of the definitions provided for a 'likely probability' and 'medium consequence'. This probability would mean that it is probable that an event will occur, i.e. a significant possibility. A 'medium consequence' could involve chronic damage to human health, pollution of sensitive water resources, a significant change in a particular eco-system or organism forming part of such eco-system, significant damage to plants, buildings, structures and services, i.e. 'significant harm'. Other moderate risks involve either a 'low probability' or a 'mild consequence' and, therefore, have not been considered to represent a 'Significant Possibility of Significant Harm'.

14.7.16 Based on the definitions provided in CIRIA C552 (Ref. 12), Moderate*, High and Very High risks are considered to have the potential to meet the requirements outlined in Part IIA (Ref. 2) for 'Significant Harm' or a 'Significant Possibility of Significant Harm'.

14.7.17 The risk assessment considered whether a source-pathway-receptor linkage was likely to be present. The degree of risk was then assessed through analysis of the consequence of the effect and the probability of the effect based on guidance outlined in CIRIA C552 (Ref. 12). The risk assessment assumes that no mitigation measures are introduced.

Identification and Assessment of Effects

14.7.18 The following information has been considered in addition to risk as part of the effect assessment.

a. status of the effect (positive or negative);
b. duration of the effect(short/medium/long term);
c. permanent or temporary;
d. direct or indirect; and
e. significance (significant or not significant).

14.7.19 There are no formal guidance documents detailing specific assessment criteria of effects with regard to contaminated land. However, conclusions can be drawn on the significance of each effect through reference to relevant EIA legislation and guidance, professional judgment, evaluation against the effect assessment criteria detailed below and the outcome of the contaminated land risk assessment. For the purpose of the assessment the receptors outlined in Table 14.7 have been considered as receptors.

Status of the Effect

14.7.20 The status of the effects were assessed by considering whether the Project would have a positive or negative effect on the receptor.

Duration or Timescale of the Effect

14.7.21 In assessing the effect the likely length of the effect has been considered. These have been summarised under the following timescales:

a. Short Term – 0-40 months;
b. Medium Term – 40 months-10 years; and
c. Long Term – 10+ years.

Permanent or Temporary

14.7.22 In assessing whether an effect is permanent, the effect will be regarded as one which is not reversible and will last for the lifespan of the Project and beyond.

14.7.23 A temporary effect will be one that is reversible or where it ceases to be an issue at some point during the Project.

Direct or Indirect

14.7.24 Direct effects are considered to arise from the Project. For the purposes of this particular assessment an indirect effect is one which is not considered to arise directly from the Project or one which is already present and may continue after the Project has been constructed.

Significance of the Effect

14.7.25 Where a moderate*, high or very high risk classification was identified from the Qualitative Risk Assessment then these are considered to represent significant effects in terms of the project and may require mitigation. The definition of high and very high risk from CIRIA C552 (Ref. 12) is as follows

a. *Very High Risk* – There is a high probability that severe harm could arise to the receptor from an identified hazard or there is evidence that severe harm to a receptor is currently happening. The risk, if realised is likely to result in substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required; and

b. *High Risk* – Harm is likely to arise to a receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.

14.7.26 As explained above no definition is provided in CIRIA C552 (Ref. 12) for the Moderate* risk but the reasons for its inclusion are discussed at paragraph 14.7.15 above. All other outcomes (moderate to very low risk classification) from the Qualitative Risk Assessment are not considered to be significant effects, although mitigation measures may still be required.

14.7.27 Tables 14.11 to 14.20 shows the findings of the risk assessment and identifies the effects that are considered to be significant in respect of the Construction Areas identified in the CMR as specifically applied in this Chapter. Each source – pathway – receptor linkage has been assigned a reference number, prefixed by either 'W' for Widnes or 'R' for Runcorn. It should be noted that the reference numbers are area specific and therefore are not intended to be consecutive through the tables.

Table 14.11 – Risk and Effect Assessment for Risks Common to Areas A, B, C and I1 in Widnes (continued overleaf)

WIDNES							
All Areas – Risks Common to Areas A, B, C, I1 in Widnes							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Site users, off-site residents	W1	Low	Medium	Moderate/Low	Not Significant
		Human Health Construction or service maintenance workers	W2	High	Medium	High	Significant
	Contaminated water supplies from buried services	Human Health	W3	Likely	Medium	Moderate*	Significant
	Leaching and vertical migration of contaminants into groundwater including along existing buried foundations	Shallow Groundwater	W4	High	Medium	High	Significant
		Groundwater in Bedrock	W5	Low	Medium	Moderate/Low	Not Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater	W10	High	Medium	High	Significant
		Groundwater in Bedrock	W11	Low	Medium	Moderate/Low	Not Significant
	Migration of contaminants along buried drains or services	Off-site shallow groundwater or surface water	W16	Likely	Medium	Moderate*	Significant
	Migration of contaminants through groundwater to surface watercourses	River Mersey	W17	Low	Medium	Moderate/Low	Not Significant
	Direct Contact	Integrity of buried plastic services	W21	Likely	Mild	Moderate/Low	Not Significant
	Plant uptake	Planting/soft landscaping	W23	Likely	Mild	Moderate/Low	Not Significant
Gas and vapours from made ground, free product, and natural soils	Migration of ground gas into buildings	Human Health Site users or site visitors	W25	Likely	Medium	Moderate	Not Significant
	Migration of ground gas into excavations	Human Health People entering excavations	W28	Likely	Severe	High	Significant
UXO	Direct Contact – Urban Areas	Human Health	W30	Unlikely	Severe	Moderate/Low	Not Significant
Construction Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Construction/ground workers	W32	High	Severe	Very High	Significant
		Human Health Site visitors, trespassers	W33	Likely	Severe	High	Significant
		Human Health Local residents	W34	Likely	Medium	Moderate*	Significant

Table 14.11 (continued) – Risk and Effect Assessment for Risks Common to Areas A, B, C and I1 in Widnes (continued overleaf)

WIDNES							
All Areas – Risks Common to Areas A, B, C, I1 in Widnes							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Construction Stage							
Contaminants on Site	Contaminated water supplies from new buried services	Human Health	W35	No Pathway			Not Significant
	Leaching and vertical migration of contaminants between groundwater horizons	Shallow Groundwater	W36	High	Medium	High	Significant
		Bedrock	W37	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminants due to installation of piled foundations	Shallow Groundwater	W42	Unlikely	Medium	Low	Not Significant
	Vertical migration of contaminants in areas where existing foundations are removed	Shallow Groundwater	W45	High	Medium	High	Significant
	Vertical migration between horizons during installation of vibro-concrete columns	Shallow Groundwater	W46	Low	Medium	Moderate/Low	Not Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater	W48	High	Medium	High	Significant
		Bedrock	W49	Low	Medium	Moderate/Low	Not Significant
	Off-site migration of contaminated groundwater due to placing embankment (without ground improvement)	Shallow Groundwater	W54	Low	Medium	Moderate/Low	Not Significant
		Bedrock	W55	Unlikely	Medium	Low	Not Significant
	Migration of contaminants along buried drains or services	Off-site groundwater or surface water	W56	Likely	Severe	High	Significant
	Migration of contaminants through groundwater to surface watercourses	River Mersey	W57	Low	Medium	Moderate/Low	Not Significant

Table 14.11 (continued) – Risk and Effect Assessment for Risks Common to Areas A, B, C and I1 in Widnes (continued overleaf)

WIDNES							
All Areas – Risks Common to Areas A, B, C, I1 in Widnes							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Construction Stage							
Contaminants on Site	Direct Contact	Integrity of new buried plastic services	W65	No Pathway			Not Significant
		New Foundations	W66	High	Mild	Moderate	Not Significant
	Plant uptake	Planting/soft landscaping	W67	No Pathway			Not Significant
Gas and vapours from made ground and natural soils	Migration of ground gas into excavations	Human Health People entering excavations	W70	Likely	Severe	High	Significant
	Migration of ground gas to adjacent areas outside excavations	Human Health (site users, site visitors, local residents, workers and trespassers)	W72	Unlikely	Medium	Low	Not Significant
UXO	Direct Contact ground works in urban areas	Human Health	W75	Unlikely	Severe	Moderate/Low	Not Significant
Operational Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Site Users/Workers in toll booths or offices	W77	Low	Medium	Moderate/Low	Not Significant
		Human Health Service Maintenance Workers	W78	High	Medium	High	Significant
		Human Health Local Residents	W79	Unlikely	Medium	Low	Not Significant
		Human Health Road Users	W80	No Pathway			Not Significant
	Contaminated water supplies from new buried services	Human Health	W81	High	Medium	High	Significant
	Leaching and vertical migration of contaminants between groundwater horizons	Shallow Groundwater	W82	High	Medium	High	Significant
		Groundwater in Bedrock	W83	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminants due to piled foundations	Shallow Groundwater	W88	Unlikely	Medium	Low	Not Significant
	Vertical migration between horizons in areas of vibro-concrete columns	Shallow Groundwater	W92	Unlikely	Medium	Low	Not Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater	W94	High	Medium	High	Significant
		Bedrock	W95	Low	Medium	Moderate/Low	Not Significant

Table 14.11 (continued) – Risk and Effect Assessment for Risks Common to Areas A, B, C and I1 in Widnes

WIDNES							
All Areas – Risks Common to Areas A, B, C, I1 in Widnes							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Operational Stage							
Contaminants on Site	Off-site migration of contaminated groundwater due to placing embankment	Shallow Groundwater	W100	Low	Medium	Moderate/Low	Not Significant
		Bedrock	W101	Unlikely	Medium	Low	Not Significant
	Migration of contaminants along buried drains or services	Off-site groundwater or surface water	W102	Likely	Severe	High	Significant
	Migration of contaminants through groundwater to surface watercourses	River Mersey	W103	Low	Medium	Moderate/Low	Not Significant
	Direct Contact	Integrity of buried plastic services	W107	High	Mild	Moderate/Low	Not Significant
		New Foundations	W108	High	Mild	Moderate	Not Significant
	Plant uptake	Planting/soft landscaping with nominal thickness of topsoil	W109	Low	Mild	Low	Not Significant
Gas and vapours from made ground, free product, and natural soils	Migration of ground gas	Human Health site users within offices or toll booths	W112	Likely	Medium	Moderate*	Significant
	Migration of ground gas to adjacent areas outside excavations	Human Health Site and Road users	W114	No Pathway			Not Significant
	Migration of ground gas to adjacent sites	Human Health Local residents	W115	Unlikely	Medium	Low	Not Significant
	Migration of ground gas into excavations	Human Health People entering excavations	W116	Likely	Severe	High	Significant
UXO	Direct Contact	Human Health Site or road users	W118	No Pathway			Not Significant
		Human Health Workers from excavations	W119	Unlikely	Severe	Moderate/Low	Not Significant

*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual effect, as shown in Figures 14.41 to 14.44 (Appendix 14.1).

Table 14.12 – Risk and Effect Assessment for Areas A and B1 in Widnes

WIDNES							
Effects Specific to Particular Areas							
Area A – St. Michaels Golf Course **Area B1 – Ditton Junction**							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Migration of contaminants through groundwater to surface watercourses	Stewards Brook	W18	Low	Medium	Moderate/Low	Not Significant
Construction Stage							
Contaminants on Site	Vertical migration of contaminants due to installation of piled foundations	Groundwater in Bedrock outside CTP	W43	Unlikely	Medium	Low	Not Significant
	Migration of contaminants through groundwater to surface watercourses	Stewards Brook	W58	High	Severe	Very High	Significant
	Migration of contaminants through surface water run-off to surface watercourses	Stewards Brook	W62	Likely	Medium	Moderate*	Significant
Operational Stage							
Contaminants on Site	Vertical migration of contaminants due to piled foundations	Groundwater in bedrock outside CTP	W89	Unlikely	Medium	Low	Not Significant
	Vertical migration of contaminants in areas where existing foundations are removed in Area B1	Shallow Groundwater	W91	High	Medium	High	Significant
	Migration of contaminants through groundwater to surface watercourses	Stewards Brook	W104	High	Medium	High	Significant
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual effect, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

Table 14.13 – Risk and Effect Assessment for Areas B2 and I1 in Widnes (continued overleaf)

WIDNES							
Effects Specific to Particular Areas							
Area B2 - Gussion Transport, Anglo Blackwells and S.Evans & Sons Scrapyard **Area I1 – Gussion Transport**							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Vertical Migration of contaminated groundwater along disused water wells	Groundwater in Bedrock beneath Gussion	W7	Likely	Medium	Moderate*	Significant
	Vertical Migration of Free Product along disused water wells	Groundwater in Bedrock beneath Gussion	W9	Likely	Medium	Moderate*	Significant
	Off-site migration of LNAPL	Shallow Groundwater adjacent to Gussion	W12	Likely	Medium	Moderate*	Significant
	Transfer of contaminants from LNAPL to groundwater	Shallow groundwater beneath Gussion	W14	High	Medium	High	Significant
	Direct Contact	Buried foundations	W22	High	Mild	Moderate	Not Significant
Gas and vapours from made ground, free product, and natural soils	Migration of volatile vapours into buildings (localised areas only)	Human Health Site users or site visitors	W26	Likely	Medium	Moderate*	Significant
		Human Health Adjacent site users	W27	Low	Medium	Moderate/Low	Not Significant
	Migration of volatile vapours into excavations (localised areas only)	Human Health People entering excavations	W29	Likely	Severe	High	Significant
Construction Stage							
Contaminants on Site	Vertical Migration of contaminated groundwater along disused water wells	Groundwater in Bedrock beneath Gussion	W39	Likely	Medium	Moderate*	Significant
	Vertical Migration of Free Product along disused water wells	Groundwater in Bedrock beneath Gussion	W41	Likely	Medium	Moderate*	Significant
	Vertical migration of contaminants due to installation of piled foundations	Groundwater in Bedrock outside CTP	W43	Unlikely	Medium	Low	Not Significant
	Off-site migration of LNAPL	Shallow Groundwater adjacent to Gussion	W50	Likely	Medium	Moderate*	Significant
	Transfer of contaminants from LNAPL to groundwater	Shallow groundwater beneath Gussion	W52	High	Medium	High	Significant

Table 14.13 (continued) – Risk and Effect Assessment for Areas B2 and I1 in Widnes

WIDNES							
Effects Specific to Particular Areas							
Area B2 - Gussion Transport, Anglo Blackwells and S.Evans & Sons Scrapyard Area I1 – Gussion Transport							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Construction Stage							
Gas and vapours from made ground and natural soils	Migration of volatile vapours into excavations	Human Health People entering excavations	W71	High	Severe	Very High	Significant
	Migration of volatile vapours to adjacent areas outside excavations	Human Health (site users, site visitors, local residents, workers and trespassers)	W73	Likely	Medium	Moderate	Not Significant
	Migration of gas or vapours into buildings off-site	Human Health	W74	Low	Medium	Moderate	Not Significant
Operational Stage							
Contaminants on Site	Vertical Migration of contaminated groundwater along disused water wells	Groundwater in Bedrock beneath Gussion	W85	Likely	Medium	Moderate*	Significant
	Vertical Migration of Free Product along disused water wells	Groundwater in Bedrock beneath Gussion	W87	Likely	Medium	Moderate*	Significant
	Vertical migration of contaminants due to piled foundations	Groundwater in bedrock outside CTP	W89	Unlikely	Medium	Low	Not Significant
	Vertical migration of contaminants in areas where existing foundations are removed	Shallow Groundwater	W91	High	Medium	High	Significant
	Off-site migration of LNAPL	Shallow Groundwater adjacent to Gussion	W96	Likely	Medium	Moderate*	Significant
	Transfer of contaminants from LNAPL to groundwater	Shallow groundwater beneath Gussion	W98	High	Medium	High	Significant
Gas and vapours from made ground, free product, and natural soils	Migration of volatile vapours	Human Health site users within offices or toll booths	W113	Likely	Medium	Moderate*	Significant
	Migration of volatile vapours into excavations	Human Health People entering excavations	W117	Likely	Severe	High	Significant
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual impact, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

Table 14.14 – Risk and Effect Assessment for Area C in Widnes (continued overleaf)

WIDNES							
Effects Specific to Particular Areas							
Area C – Freight Line to Thermphos							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Vertical Migration of contaminated groundwater along disused water wells	Groundwater in Bedrock beneath CTP	W6	Low	Medium	Moderate/Low	Not Significant
	Vertical Migration of Free Product along disused water wells	Groundwater in Bedrock beneath CTP	W8	Low	Medium	Moderate/Low	Not Significant
	Off-site migration of DNAPL	Shallow Groundwater adjacent to CTP	W13	High	Medium	High	Significant
	Transfer of contaminants from DNAPL groundwater	Shallow groundwater beneath CTP	W15	High	Medium	High	Significant
	Migration of contaminants through groundwater to surface watercourses	Bowers Brook	W19	High	Medium	High	Significant
		St Helens Canal	W20	Unlikely	Medium	Low	Not Significant
	Direct Contact	Buried foundations	W22	High	Mild	Moderate	Not Significant
Gas and vapours from made ground, free product, and natural soils	Migration of volatile vapours into buildings (localised areas only)	Human Health Site users or site visitors	W26	Likely	Medium	Moderate*	Significant
		Human Health Adjacent site users	W27	Low	Medium	Moderate/Low	Not Significant
	Migration of volatile vapours into excavations (localised areas only)	Human Health People entering excavations	W29	Likely	Severe	High	Significant
Construction Stage							
Contaminants on Site	Vertical Migration of contaminated groundwater along disused water wells	Groundwater in Bedrock beneath CTP	W38	Low	Medium	Moderate/Low	Not Significant
	Vertical Migration of Free Product along disused water wells	Groundwater in Bedrock beneath CTP	W40	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminants due to installation of piled foundations	Groundwater in Bedrock beneath CTP	W44	Low	Medium	Moderate/Low	Not Significant

Table 14.14 (continued) – Risk and Effect Assessment for Area C in Widnes (continued overleaf)

WIDNES							
Effects Specific to Particular Areas							
Area C – Freight Line to Thermphos							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Construction Stage							
Contaminants on Site	Vertical migration between horizons during installation of vibro-concrete columns	Shallow Groundwater beneath CTP (DNAPL)	W47	Low	Medium	Moderate/Low	Not Significant
	Off-site migration of DNAPL	Shallow Groundwater adjacent to CTP	W51	High	Medium	High	Significant
	Transfer of contaminants from DNAPL groundwater	Shallow groundwater beneath CTP	W53	High	Medium	High	Significant
	Migration of contaminants through groundwater to surface watercourses	Bowers Brook	W59	High	Severe	Very High	Significant
		St Helens Canal	W60	Unlikely	Medium	Low	Not Significant
	Migration of contaminants through surface water run-off to surface watercourses	River Mersey	W61	Likely	Medium	Moderate*	Significant
		Bowers Brook	W63	Likely	Medium	Moderate*	Significant
		St Helens Canal	W64	Likely	Medium	Moderate*	Significant
Gas and vapours from made ground and natural soils	Migration of volatile vapours into excavations	Human Health People entering excavations	W71	High	Severe	Very High	Significant
	Migration of volatile vapours to adjacent areas outside excavations	Human Health (site users, site visitors, local residents, workers and trespassers)	W73	Likely	Medium	Moderate	Not Significant
	Migration of vapours into buildings off-site	Human Health	W74	Low	Medium	Moderate	Not Significant
Operational Stage							
Contaminants on Site	Vertical Migration of contaminated groundwater along disused water wells	Groundwater in Bedrock beneath CTP	W84	Low	Medium	Moderate/Low	Not Significant
	Vertical Migration of Free Product along disused water wells	Groundwater in Bedrock beneath CTP	W86	Low	Medium	Moderate/Low	Not Significant

Table 14.14 (continued) – Risk and Effect Assessment for Area C in Widnes

WIDNES							
Effects Specific to Particular Areas							
Area C – Freight Line to Thermphos							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Operational Stage							
Contaminants on Site	Vertical migration of contaminants due to piled foundations	Groundwater in bedrock beneath CTP	W90	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminants in areas where existing foundations are removed	Shallow Groundwater	W91	High	Medium	High	Significant
	Vertical migration between horizons in areas of vibro-concrete columns	Shallow Groundwater beneath CTP (DNAPL)	W93	Unlikely	Medium	Low	Not Significant
	Off-site migration of DNAPL	Shallow Groundwater adjacent to CTP	W97	High	Medium	High	Significant
	Transfer of contaminants from DNAPL groundwater	Shallow groundwater beneath CTP	W99	High	Medium	High	Significant
	Migration of contaminants through groundwater to surface watercourses	Bowers Brook	W105	High	Medium	High	Significant
		St Helens Canal	W106	Unlikely	Medium	Low	Not Significant
Gas and vapours from made ground, free product, and natural soils	Migration of volatile vapours	Human Health site users within offices or toll booths	W113	Likely	Medium	Moderate*	Significant
	Migration of volatile vapours or ground gas to adjacent sites	Human Health Local residents	W115	Unlikely	Medium	Low	Not Significant
	Migration of volatile vapours into excavations	Human Health People entering excavations	W117	Likely	Severe	High	Significant
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual effect, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

Table 14.15 – Risk and Effect Assessment for Area I2 in Widnes

WIDNES							
Effects Specific to Particular Areas							
Area I2 – De-linking Works							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Site users, off-site residents	W1	Low	Medium	Moderate/Low	Not Significant
		Human Health Construction or service maintenance workers	W2	High	Medium	High	Significant
Construction Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Construction/ground workers	W32	High	Severe	Very High	Significant
		Human Health Site visitors, trespassers	W33	Likely	Severe	High	Significant
		Human Health Local residents	W34	Likely	Medium	Moderate*	Significant
	Migration of contaminants through surface water run-off to surface watercourses	River Mersey	W61	Likely	Medium	Moderate*	Significant
Operational Stage							
No risks have been assessed for the Operation Stage in Area I2 because the embankments would have been removed and any existing underlying contamination would be addressed as part of future development and, therefore, would not be part of the Project.							
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual effect, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

Table 14.16 – Risk and Effect Assessment for Area D (excluding Wigg Island) in the Mersey Estuary (continued overleaf)

MERSEY ESTUARY							
Area D – River Mersey, Widnes Warth Saltmarsh and Astmoor Saltmarsh							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Site users, off-site residents	W1	Low	Medium	Moderate/Low	Not Significant
	Leaching and vertical migration of contaminants into groundwater including along existing buried foundations*	Shallow Groundwater	W4	High	Medium	High	Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater	W10	High	Medium	High	Significant
	Direct Contact	Flora and Fauna on Saltmarshes or Estuary	W24 & R23	Low	Medium	Moderate/Low	Not Significant
UXO	Direct Contact – Salt Marshes	Human Health	W31 & R31	Unlikely	Severe	Moderate/Low	Not Significant

Table 14.16 (continued) – Risk and Effect Assessment for Area D (excluding Wigg Island) in the Mersey Estuary (continued overleaf)

MERSEY ESTUARY							
Area D – River Mersey, Widnes Warth Saltmarsh and Astmoor Saltmarsh							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Construction Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Construction/ground workers	W32	High	Severe	Very High	Significant
		Human Health Site visitors, trespassers	W33	Likely	Severe	High	Significant
		Human Health Local residents	W34	Likely	Medium	Moderate*	Significant
	Leaching and vertical migration of contaminants between groundwater horizons*	Shallow Groundwater	W36	High	Medium	High	Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater	W48	High	Medium	High	Significant
	Migration of contaminants through surface water run-off to surface watercourses	River Mersey	W61	Likely	Medium	Moderate*	Significant
		St Helens Canal	W64	Likely	Medium	Moderate*	Significant
	Direct Contact	Flora and Fauna on Saltmarshes or Estuary	W68 & R61	Low	Medium	Moderate/Low	Not Significant
	Scour/Erosion around Piers releasing contaminants	Saltmarsh or Estuary	W69 & R62	Low	Medium	Moderate/Low	Not Significant
Gas and vapours from made ground and natural soils	Migration of ground gas into excavations	Human Health People entering excavations	W70	Likely	Severe	High	Significant
UXO	Direct Contact ground works on saltmarshes	Human Health	W76	Low	Severe	Moderate	Not Significant
Operational Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Service Maintenance Workers	W78	High	Medium	High	Significant
	Leaching and vertical migration of contaminants between groundwater horizons*	Shallow Groundwater	W82	High	Medium	High	Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater	W94	High	Medium	High	Significant
	Direct Contact	Flora and Fauna on Saltmarshes or Estuary	W110 & R95	Low	Medium	Moderate/Low	Not Significant
** - It should be noted that a small area of made ground over the saltmarsh deposits was observed at Widnes Warth.*							

Table 14.16 (continued) – Risk and Effect Assessment for Area D (excluding Wigg Island) in the Mersey Estuary

MERSEY ESTUARY							
Area D – River Mersey, Widnes Warth Saltmarsh and Astmoor Saltmarsh							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Operational Stage							
Contaminants on Site	Scour/Erosion around Piers releasing contaminants	Saltmarsh or Estuary	W111 & R96	Low	Medium	Moderate/Low	Not Significant
Gas and vapours from made ground and natural soils	Migration of ground gas into excavations	Human Health People entering excavations	W116	Likely	Severe	High	Significant
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual effect, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

Table 14.17 – Risk and Effect Assessment for Area D (Wigg Island) in the Mersey Estuary (continued overleaf)

MERSEY ESTUARY							
Area D – Wigg Island							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Residents/Visitors to Wigg Island	R1	Low	Medium	Moderate/Low	Not Significant
		Human Health Construction or service maintenance workers at Wigg Island	R3	Likely	Severe	High	Significant
	Leaching and vertical migration of contaminants between made ground and shallow groundwater including along existing buried foundations	Shallow groundwater beneath Wigg Island	R6	Likely	Medium	Moderate*	Significant
	Vertical migration of contaminated groundwater to bedrock	Groundwater in Bedrock beneath Wigg Island	R9	Likely	Medium	Moderate*	Significant
	Off-site migration of contaminated groundwater	Made Ground	R10	Low	Mild	Low	Not Significant
		Alluvium	R11	Likely	Medium	Moderate*	Significant
		Glacial Deposits	R12	Low	Mild	Low	Not Significant
		Bedrock	R13	Likely	Medium	Moderate*	Significant
	Migration of contaminants through groundwater to surface watercourses	River Mersey	R15	Low	Medium	Moderate/Low	Not Significant
		Canals	R16	Low	Medium	Moderate/Low	Not Significant

Table 14.17 (continued) – Risk and Effect Assessment for Area D (Wigg Island) in the Mersey Estuary (continued overleaf)

MERSEY ESTUARY							
Area D – Wigg Island							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Direct Contact	Buried Foundations at Wigg Island	R21	Unlikely (none encountered or shown on historical OS maps)	Mild	Low	Not Significant
	Plant uptake	Planting/soft landscaping	R22	Likely	Mild	Moderate/Low	Not Significant
Gas and vapours from made ground and natural soils	Migration of ground gas into excavations at Wigg Island	Human Health People entering excavations	R26	Likely	Severe	High	Significant
	Migration of volatile vapours into excavations at Wigg Island		R27	Likely	Severe	High	Significant
Construction Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Visitors to Wigg Island	R32	Low	Medium	Moderate/Low	Not Significant
		Human Health Site visitors, trespassers at Wigg Island	R35	Likely	Severe	High	Significant
		Human Health Construction workers at Wigg Island	R37	High	Severe	Very High	Significant
	Leaching and vertical migration of contaminants between made ground and shallow groundwater	Groundwater beneath Wigg Island	R41	High	Medium	High	Significant
	Vertical migration of contaminants due to installation of piled foundations	Groundwater beneath Wigg Island	R43	Likely	Medium	Moderate*	Significant
	Vertical migration in areas where existing foundations are removed	Groundwater beneath Wigg Island	R45	Unlikely (none encountered or shown on historical OS maps)	Medium	Low	Not Significant
	Vertical migration of contaminated groundwater to bedrock	Groundwater in Bedrock beneath Wigg Island	R47	Likely	Medium	Moderate*	Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater beneath Wigg Island	R48	Likely	Medium	Moderate*	Significant
		Groundwater in Bedrock beneath Wigg Island	R50	Likely	Medium	Moderate*	Significant

Table 14.17 (continued) – Risk and Effect Assessment for Area D (Wigg Island) in the Mersey Estuary (continued overleaf)

MERSEY ESTUARY							
Area D – Wigg Island							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Construction Stage							
Contaminants on Site	Migration of contaminants through groundwater to surface watercourses	River Mersey	R53	Low	Medium	Moderate/Low	Not Significant
		Canals	R54	Low	Medium	Moderate/Low	Not Significant
	Migration of contaminants through surface water run-off to surface watercourses	River Mersey	R55	Likely	Medium	Moderate*	Significant
		Canals	R56	Likely	Medium	Moderate*	Significant
	Direct Contact	New Foundations at Wigg Island	R59	High	Mild	Moderate	Not Significant
	Plant uptake	Planting/soft landscaping	R60	No Pathway			Not Significant
Gas and vapours from made ground and natural soils	Migration of ground gas into excavations at Wigg Island	Human Health People entering excavations	R65	Likely	Severe	High	Significant
	Migration of volatile vapours into excavations at Wigg Island		R66	High	Severe	Very High	Significant
Operational Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Service Maintenance Workers at Wigg Island	R72	High	Severe	Very High	Significant
	Leaching and vertical migration of contaminants between made ground and shallow groundwater	Shallow Groundwater beneath Wigg Island	R78	Likely	Medium	Moderate*	Significant
	Vertical migration of contaminants due to piled foundations	Groundwater beneath Wigg Island	R80	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminated groundwater to bedrock	Groundwater in Bedrock beneath Wigg Island	R83	Likely	Medium	Moderate*	Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater beneath Wigg Island	R84	Likely	Medium	Moderate*	Significant
		Groundwater in bedrock beneath Wigg Island	R86	Likely	Medium	Moderate*	Significant

Table 14.17 (continued) – Risk and Effect Assessment for Area D (Wigg Island) in the Mersey Estuary

MERSEY ESTUARY							
Area D – Wigg Island							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Operational Stage							
Contaminants on Site	Migration of contaminants through groundwater to surface watercourses	River Mersey	R89	Low	Medium	Moderate/Low	Not Significant
		Canals	R90	Low	Medium	Moderate/Low	Not Significant
	Direct Contact	Foundations at Wigg Island	R93	High	Mild	Moderate	Not Significant
	Plant uptake	Planting/soft landscaping with nominal topsoil	R94	Low	Mild	Low	Not Significant
Gas and vapours from made ground and natural soils	Migration of ground gas into excavations at Wigg Island	Human Health People entering excavations	R99	High	Severe	Very High	Significant
	Migration of volatile vapours into excavations at Wigg Island		R100	High	Severe	Very High	Significant
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual impact, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

Table 14.18 – Risk and Effect Assessment for Risks Common to Areas E, F, G and H in Runcorn (continued overleaf)

RUNCORN							
All Areas – Risks Common to Areas E, F, G, H in Runcorn							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Residents/visitors, workers outside Wigg Island	R2	Unlikely	Medium	Low	Not Significant
		Human Health Construction or service maintenance workers outside Wigg Island	R4	Low	Medium	Moderate/Low	Not Significant
	Contaminated water supplies from buried services	Human Health	R5	Low	Medium	Moderate/Low	Not Significant
	Leaching and vertical migration of contaminants between made ground and shallow groundwater including along existing buried foundations	Groundwater outside Wigg Island	R7	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminated groundwater to bedrock	Groundwater in Bedrock outside Wigg Island	R8	Low	Medium	Moderate/Low	Not Significant

Table 14.18 (continued) – Risk and Effect Assessment for Risks Common to Areas E, F, G and H in Runcorn (continued overleaf)

RUNCORN							
All Areas – Risks Common to Areas E, F, G, H in Runcorn							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Off-site migration of contaminated groundwater	Glacial Deposits	R12	Low	Mild	Low	Not Significant
		Bedrock	R13	Low	Medium	Moderate/Low	Not Significant
	Migration of contaminants along buried drains or services	Off-site groundwater or surface water	R14	Low	Medium	Moderate/Low	Not Significant
	Direct Contact	Integrity of buried plastic services	R19	Likely	Mild	Moderate/Low	Not Significant
		Buried Foundations outside Wigg Island	R20	Likely	Mild	Moderate/Low	Not Significant
	Plant uptake	Planting/soft landscaping	R22	Likely	Mild	Moderate/Low	Not Significant
Gas and vapours from made ground and natural soils	Migration of ground gas into buildings	Human Health (site users or site visitors)	R24	Low	Medium	Moderate/Low	Not Significant
	Migration of volatile vapours into buildings		R25	Unlikely	Medium	Low	Not Significant
	Migration of ground gas into excavations outside Wigg Island	Human Health People entering excavations	R28	Low	Severe	Moderate	Not Significant
	Migration of volatile vapours into excavations outside Wigg Island	Human Health People entering excavations	R29	Unlikely	Severe	Moderate/Low	Not Significant
UXO	Direct Contact – Urban Areas	Human Health	R30	Unlikely	Severe	Moderate/Low	Not Significant
Construction Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Residents/Visitors outside Wigg Island	R33	Unlikely	Medium	Low	Not Significant
		Human Health Local Workers	R34	Low	Medium	Moderate/Low	Not Significant
		Human Health Site visitors, trespassers outside Wigg Island	R36	Unlikely	Medium	Low	Not Significant
		Human Health Construction workers outside Wigg Island	R38	Low	Medium	Moderate/Low	Not Significant
	Contaminated water supplies from new buried services	Human Health	R39	No Pathway			Not Significant

Table 14.18 (continued) – Risk and Effect Assessment for Risks Common to Areas E, F, G, H in Runcorn (continued overleaf)

RUNCORN							
All Areas – Risks Common to Areas E, F, G, H in Runcorn							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Construction Stage							
Contaminants on Site	Leaching and vertical migration of contaminants between made ground and shallow groundwater	Groundwater outside Wigg Island	R40	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminants due to installation of piled foundations	Groundwater outside Wigg Island	R42	Low	Medium	Moderate/Low	Not Significant
	Vertical migration in areas where existing foundations are removed	Groundwater outside Wigg Island	R44	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminated groundwater to bedrock	Groundwater in Bedrock outside Wigg Island	R46	Low	Medium	Moderate/Low	Not Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater outside Wigg Island	R49	Low	Mild	Low	Not Significant
		Groundwater in Bedrock outside Wigg Island	R51	Low	Medium	Moderate/Low	Not Significant
	Migration of contaminants along buried drains or services	Off-site groundwater or surface water	R52	Low	Medium	Moderate/Low	Not Significant
	Direct Contact	Integrity of new buried plastic services	R57	No Pathway			Not Significant
		New Foundations outside Wigg Island	R58	Low	Medium	Moderate/Low	Not Significant
	Plant uptake	Planting/soft landscaping	R60	No Pathway			Not Significant
Gas and vapours from made ground and natural soils	Migration off-site of ground gas into buildings	Human Health Site users or visitors	R63	Low	Medium	Moderate/Low	Not Significant
	Migration off-site of volatile vapours into buildings		R64	Unlikely	Medium	Low	Not Significant
	Migration of ground gas into excavations outside Wigg Island	Human Health People entering excavations	R67	Unlikely	Severe	Moderate/Low	Not Significant
	Migration of volatile vapours into excavations outside Wigg Island		R68	Unlikely	Severe	Moderate/Low	Not Significant
UXO	Direct Contact ground works in urban areas	Human Health	R69	Unlikely	Severe	Moderate/Low	Not Significant

Table 14.18 (continued) – Risk and Effect Assessment for Risks Common to Areas E, F, G, H in Runcorn (continued overleaf)

RUNCORN							
All Areas – Risks Common to Areas E, F, G, H in Runcorn							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Operational Stage							
Contaminants on Site	Ingestion Inhalation Dermal Contact	Human Health Site Users/Workers	R71	No Pathway (No toll booths or offices)			Not Significant
		Human Health Service Maintenance Workers outside Wigg Island	R73	Low	Medium	Moderate/Low	Not Significant
		Human Health Local Residents or Workers	R74	Unlikely	Medium	Low	Not Significant
		Human Health Road User	R75	No Pathway			Not Significant
	Contaminated water supplies from new buried services	Human Health	R76	Unlikely	Medium	Moderate/Low	Not Significant
	Leaching and vertical migration of contaminants between made ground and shallow groundwater	Shallow Groundwater outside Wigg Island	R77	Low	Medium	Moderate/Low	Not Significant
	Vertical migration of contaminants due to piled foundations	Groundwater outside Wigg Island	R79	Unlikely	Medium	Low	Not Significant
	Vertical migration in areas where existing foundations are removed	Groundwater	R81	Unlikely (none encountered or shown on historical OS maps)	Medium	Low	Not Significant
	Vertical migration of contaminated groundwater to bedrock	Groundwater in Bedrock outside Wigg Island	R82	Low	Medium	Moderate/Low	Not Significant
	Off-site migration of contaminated groundwater	Shallow Groundwater outside Wigg Island	R85	Low	Mild	Low	Not Significant
		Groundwater in Bedrock outside Wigg Island	R87	Low	Medium	Moderate/Low	Not Significant
	Migration of contaminants along buried drains or services	Off-site groundwater or surface water	R88	Low	Medium	Moderate/Low	Not Significant
	Direct Contact	Integrity of buried plastic services	R91	Likely	Mild	Moderate/Low	Not Significant
		Foundations outside Wigg Island	R92	Low	Medium	Moderate/Low	Not Significant
	Plant uptake	Planting/soft landscaping with nominal topsoil	R94	Low	Mild	Low	Not Significant

Table 14.18 (continued) – Risk and Effect Assessment for Risks Common to Areas E, F, G, H in Runcorn

RUNCORN							
All Areas – Risks Common to Areas E, F, G, H in Runcorn							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Operational Stage							
Gas and vapours from made ground and natural soils	Migration of ground gas or volatile vapours	Human Health Local residents	R97	Unlikely	Medium	Low	Not Significant
	Migration of ground gas or volatile vapours	Human Health Road users	R98	No pathway			Not Significant
	Migration of ground gas into excavations outside Wigg Island	Human Health People entering excavations	R101	Unlikely	Severe	Moderate/Low	Not Significant
	Migration of volatile vapours into excavations outside Wigg Island		R102	Unlikely	Severe	Moderate/Low	Not Significant
UXO	Direct Contact	Human Health Site or road users	R103	No Pathway			Not Significant
		Human Health Workers from excavations	R104	Unlikely	Severe	Moderate/Low	Not Significant
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual effect, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

Table 14.19 – Risk and Effect Assessment for Areas E and F in Runcorn (continued overleaf)

RUNCORN							
Effects Specific to Particular Areas							
Area E - Astmoor Industrial Estate **Area F - Bridgewater Junction**							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Do Nothing Scenario							
Contaminants on Site	Off-site migration of contaminated groundwater	Made Ground	R10	Low	Mild	Low	Not Significant
	Migration of contaminants through groundwater to surface watercourses	Manchester Ship Canal	R17	Low	Medium	Moderate/Low	Not Significant
		Bridgewater Canal	R18	Unlikely	Medium	Low	Not Significant
Construction Stage							
Contaminants on Site	Migration of contaminants through groundwater to surface watercourses	Canals	R54	Low	Medium	Moderate/Low	Not Significant
	Migration of contaminants through surface water run-off to surface watercourses	Canals	R56	Likely	Medium	Moderate*	Significant

Table 14.19 (continued) – Risk and Effect Assessment for Areas E and F in Runcorn

RUNCORN							
Effects Specific to Particular Areas							
Area E - Astmoor Industrial Estate Area F - Bridgewater Junction							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Effect**
Operational Stage							
Contaminants on Site	Migration of contaminants through groundwater to surface watercourses	Canals	R90	Low	Medium	Moderate/Low	Not Significant
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual effect, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

Table 14.20 – Risk and Impact Assessment for Areas G and H in Runcorn

RUNCORN							
Effects Specific to Particular Areas							
Area G – Lodge Lane Junction to Weston Link Junction Area H – M56 Junction 12							
Source	**Pathway**	**Receptor**	**SPR No.*[1]**	**Probability**	**Consequence**	**Risk Classification**	**Significance of Impact**
There are no specific risks in these areas beyond those discussed in Table 14.19 above.							
*[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual effect, as shown in Figures 14.41 to 14.44 (Appendix 14.1).							

14.7.28 Tables 14.21 to 14.29 summarise the significant effects identified during the construction and operation stages. The relevant source-pathway-receptor linkages identified above are shown in the 'Effect' column on each table. At this stage in the process, these effects are based on no mitigation measures being introduced.

14.7.29 All of the significant effects identified at the site have been assessed as being negative impacts.

Effect Assessment Summary Tables

14.7.30 Table 14.21 shows the significant effects which are considered to be present during the Construction and Operation Stages in Areas A, B, C and I1 in Widnes.

Table 14.21 – Summary of Potentially Significant Effects Common to Areas in Widnes (Areas A to C and I1) during Construction and Operation Stages (continued overleaf)

WIDNES			
All Areas – Effects Common to Areas A, B, C, I1 in Widnes			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Ingestion, inhalation, and dermal contact with contaminants (W32)	Human health (construction workers)	Temporary, Short Term, Direct	Significant
Ingestion, inhalation, and dermal contact with contaminants (W33)	Human health (site visitors & trespassers)	Temporary, Short Term, Direct	Significant

Table 14.21 (continued) – Summary of Potentially Significant Effects Common to Areas in Widnes (Areas A to C and I1) during Construction and Operation Stages (continued overleaf)

WIDNES			
All Areas – Effects Common to Areas A, B, C, I1 in Widnes			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Ingestion, inhalation, and dermal contact with contaminants (W34)	Human health (local residents)	Temporary, Short Term, Direct	Significant
Contamination of groundwater from continued leaching and vertical migration of contaminants (W36)	Shallow groundwater	Temporary, Long Term, Indirect	Significant
Vertical migration of contaminants in areas where existing foundations are removed beneath Area B1 (W45)	Shallow groundwater	Temporary, Long Term, Direct	Significant
Continued off-site migration of contaminated groundwater (W48)	Shallow Groundwater	Temporary, Long Term, Indirect	Significant
Migration of contaminants off-site along buried drains or services (W56)	Off-site groundwater or surface water	Temporary, Long Term, Direct and Indirect	Significant
Migration of ground gas into excavations (W70)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant
Operation Stage			
Ingestion, inhalation, and dermal contact with contaminants (W78)	Human health (service & maintenance workers)	Temporary, Short Term, Direct	Significant
Contaminated water supplies from new buried services (W81)	Human health	Temporary, Long Term, Direct	Significant
Contamination of groundwater from continued leaching and vertical migration of contaminants (W82)	Shallow groundwater	Temporary, Long Term, Indirect	Significant
Continued off-site migration of contaminated groundwater (W94)	Shallow groundwater	Temporary, Long Term, Indirect	Significant
Migration of contaminants along buried drains or services (W102)	Off-site groundwater or surface water	Temporary, Long Term, Direct and Indirect	Significant
Migration of ground gas (W112)	Human health (site users within offices or toll booths)	Temporary, Long Term, Direct	Significant

Table 14.21 (continued) – Summary of Potentially Significant Effects Common to Areas in Widnes (Areas A to C and I1) during Construction and Operation Stages

WIDNES			
All Areas – Effects Common to Areas A, B, C, I1 in Widnes			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Operation Stage			
Migration of ground gas into excavations (W116)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant

14.7.31 Table 14.22 shows the significant effects identified for Areas A and B1 (St Michaels Golf Course and Ditton Junction) in Widnes.

Table 14.22 – Summary of Potentially Significant Effects for Areas A and B1 during Construction and Operation Stages

WIDNES			
Effects Specific to Particular Areas			
Area A – St. Michaels Golf Course **Area B1 –Ditton Junction**			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Migration of contaminants through groundwater to surface watercourses (W58)	Stewards Brook	Temporary, Long Term, Direct	Significant
Migration of contaminants through surface water run-off to surface watercourses (W62)	Stewards Brook	Temporary, Short Term, Direct	Significant
Operation Stage			
Vertical migration of contaminants in areas where existing foundations are removed beneath Area B1(W91)	Shallow groundwater	Temporary, Long Term, Direct	Significant
Migration of contaminants through groundwater to surface watercourses (W104)	Stewards Brook	Temporary, Long Term, Direct	Significant

14.7.32 Table 14.23 shows the significant effects identified for Area B2 and I1 (Gussion Transport, Anglo Blackwells and S.Evans & Sons Scrapyard).

Table 14.23 – Summary of Potentially Significant Effects for Areas B2 and I1 during Construction and Operation Stages

WIDNES			
Effects Specific to Particular Areas			
Area B2 - Gussion Transport, Anglo Blackwells and S.Evans & Sons Scrapyard **Area I1 – Gussion Transport**			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Vertical migration of contaminated groundwater along disused water wells (W39)	Groundwater in bedrock beneath Gussion	Temporary, Long Term, Direct	Significant
Vertical migration of free product along disused water wells (W41)	Groundwater in bedrock beneath Gussion	Temporary, Long Term, Direct	Significant
Continued off-site migration of LNAPL (W50)	Shallow groundwater adjacent to Gussion	Temporary, Long Term, Indirect	Significant
Continued transfer of contaminants from LNAPL to groundwater (W52)	Shallow groundwater beneath Gussion	Temporary, Long Term, Indirect	Significant
Migration of volatile vapours into excavations (W71)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant
Operation Stage			
Vertical migration of contaminated groundwater along disused water wells (W85)	Groundwater in bedrock beneath Gussion	Temporary, Long Term, Direct	Significant
Vertical migration of free product along disused water wells (W87)	Groundwater in bedrock beneath Gussion	Temporary, Long Term, Direct	Significant
Vertical migration of contaminants in areas where existing foundations are removed (W91)	Shallow groundwater	Temporary, Long Term, Direct	Significant
Continued off-site migration of LNAPL (W96)	Shallow groundwater adjacent to Gussion	Temporary, Long Term, Indirect	Significant
Continued transfer of contaminants from LNAPL to groundwater (W98)	Shallow groundwater beneath Gussion	Temporary, Long Term, Indirect	Significant
Migration of volatile vapours (W113)	Human health (site users within offices or toll booths)	Temporary, Long Term, Direct	Significant
Migration of volatile vapours into excavations (W117)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant

14.7.33 Table 14.24 shows the significant effects identified for Area C (Catalyst Trade Park and Thermphos).

Table 14.24 – Summary of Potentially Significant Effects for Area C during Construction and Operation Stages (continued overleaf)

WIDNES			
Effects Specific to Particular Areas			
Area C – Freight Line to Thermphos			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Continued off-site migration of DNAPL (W51)	Shallow groundwater adjacent to CTP	Temporary, Long Term, Indirect	Significant
Continued transfer of contaminants from DNAPL to groundwater (W53)	Shallow groundwater beneath CTP	Temporary, Long Term, Indirect	Significant
Migration of contaminants through groundwater to surface watercourses (W59)	Bowers Brook	Temporary, Long Term, Direct and Indirect	Significant
Migration of contaminants through surface water run-off to surface watercourses (W61)	River Mersey	Temporary, Short Term, Direct	Significant
Migration of contaminants through surface water run-off to surface watercourses (W63)	Bowers Brook	Temporary, Short Term, Direct	Significant
Migration of contaminants through surface water run-off to surface watercourses (W64)	St. Helens Canal	Temporary, Short Term, Direct	Significant
Migration of volatile vapours into excavations (W71)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant
Operation Stage			
Vertical migration of contaminants in areas where existing foundations are removed (W91)	Shallow groundwater	Temporary, Long Term, Direct	Significant
Continued off-site migration of DNAPL (W97)	Shallow groundwater adjacent to CTP	Temporary, Long Term, Indirect	Significant
Continued transfer of contaminants from DNAPL to groundwater (W99)	Shallow groundwater beneath CTP	Temporary, Long Term, Indirect	Significant
Migration of contaminants through groundwater to surface watercourses (W105)	Bowers Brook	Temporary, Long Term, Direct and Indirect	Significant

Table 14.24 (continued) – Summary of Potentially Significant Effects for Area C during Construction and Operation Stages

WIDNES			
Effects Specific to Particular Areas			
Area C – Freight Line to Thermphos			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Operation Stage			
Migration of volatile vapours (W113)	Human health (site users within offices or toll booths)	Temporary, Long Term, Direct	Significant
Migration of volatile vapours into excavations (W117)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant

14.7.34 Table 14.25 shows the significant effects for Area I2 (de linking of A533 and A557 Expressway embankments).

Table 14.25 – Summary of Potentially Significant Effects for Area I2 during Construction and Operation Stages

WIDNES			
Effects Specific to Particular Areas			
Area I2 – De-linking Works			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Ingestion, inhalation, and dermal contact with contaminants (W32)	Human health (construction workers)	Temporary, Short Term, Direct	Significant
Ingestion, inhalation, and dermal contact with contaminants (W33)	Human health (site visitors & trespassers)	Temporary, Short Term, Direct	Significant
Ingestion, inhalation, and dermal contact with contaminants (W34)	Human health (local residents)	Temporary, Short Term, Direct	Significant
Migration of contaminants through surface water run-off to surface watercourses (W61)	River Mersey	Temporary, Short Term, Direct	Significant
Operation Stage			
No significant effects have been assessed for the Operation Stage in Area I2 because the embankments would have been removed and any existing underlying contamination would be addressed as part of future development and, therefore, would not be part of the Project.			

Mersey Estuary

14.7.35 The following significant effects have been identified for Area D (Mersey Estuary and saltmarshes).

Table 14.26 – Summary of Potentially Significant Effects for Area D (Excluding Wigg Island) during Construction and Operation Stages

MERSEY ESTUARY			
Area D – River Mersey, Widnes Warth Saltmarsh and Astmoor Saltmarsh			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Ingestion, inhalation, and dermal contact with contaminants (W32)	Human health (construction workers)	Temporary, Short Term, Direct	Significant
Ingestion, inhalation, and dermal contact with contaminants (W33)	Human health (site visitors & trespassers)	Temporary, Short Term, Direct	Significant
Ingestion, inhalation, and dermal contact with contaminants (W34)	Human health (local residents)	Temporary, Short Term, Direct	Significant
Contamination of groundwater from continued leaching and vertical migration of contaminants (W36)*	Shallow groundwater	Temporary, Long Term, Indirect	Significant
Continued off-site migration of contaminated groundwater (W48)	Shallow Groundwater	Temporary, Long Term, Indirect	Significant
Migration of contaminants through surface water run-off to surface watercourses (W61)	River Mersey	Temporary, Short Term, Direct	Significant
Migration of contaminants through surface water run-off to surface watercourses (W64)	St Helens Canal	Temporary, Short Term, Direct	Significant
Migration of ground gas into excavations (W70)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant
Operation Stage			
Ingestion, inhalation, and dermal contact with contaminants (W78)	Human health (maintenance workers)	Temporary, Short Term, Direct	Significant
Contamination of groundwater from continued leaching and vertical migration of contaminants (W82)*	Shallow groundwater	Temporary, Long Term, Indirect	Significant
Continued off-site migration of contaminated groundwater (W94)	Shallow groundwater	Temporary, Long Term, Indirect	Significant
Migration of ground gas into excavations (W116)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant
** - It should be noted that a small area of made ground over the saltmarsh deposits was observed at Widnes Warth.*			

14.7.36 Table 14.27 shows the significant effects identified for Area D (Wigg Island) in Runcorn.

Table 14.27 – Summary of Potentially Significant Effects for Area D (Wigg Island) during Construction and Operation Stages (continued overleaf)

MERSEY ESTUARY			
Area D – Wigg Island			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Ingestion, inhalation, and dermal contact with contaminants (R35)	Human health (site visitors, trespassers at Wigg Island)	Temporary, Short Term, Direct	Significant
Ingestion, inhalation, and dermal contact with contaminants (R37)	Human health (construction workers at Wigg Island)	Temporary, Short Term, Direct	Significant
Contamination of groundwater from continued leaching and vertical migration of contaminants between made ground and shallow groundwater (R41)	Groundwater beneath Wigg Island	Temporary, Long Term, Indirect	Significant
Vertical migration of contaminants due to installation of piled foundations (R43)	Groundwater beneath Wigg Island	Temporary, Long Term, Direct	Significant
Continued vertical migration of contaminated groundwater to bedrock (R47)	Groundwater in bedrock beneath Wigg Island	Temporary, Long Term, Indirect	Significant
Continued off-site migration of contaminated groundwater (R48)	Shallow groundwater beneath Wigg Island	Temporary, Long Term, Indirect	Significant
Continued off-site migration of contaminated groundwater (R50)	Groundwater in bedrock beneath Wigg Island	Temporary, Long Term, Indirect	Significant
Migration of contaminants through surface water run-off to surface watercourses (R55)	River Mersey	Temporary, Short Term, Direct	Significant
Migration of contaminants through surface water run-off to surface watercourses (R56)	Canals	Temporary, Short Term, Direct	Significant
Migration of ground gas into excavations at Wigg Island (R65)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant

Table 14.27 (continued) – Summary of Potentially Significant Effects for Area D (Wigg Island) during Construction and Operation Stages

MERSEY ESTUARY			
Area D – Wigg Island			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Migration of volatile vapours into excavations at Wigg Island (R66)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant
Operation Stage			
Ingestion, inhalation, and dermal contact with contaminants (R72)	Human health (service maintenance workers at Wigg Island)	Temporary, Short Term, Direct	Significant
Contamination of groundwater from continued leaching and vertical migration of contaminants between made ground and shallow groundwater (R78)	Shallow groundwater beneath Wigg Island	Temporary, Long Term, Direct	Significant
Continued vertical migration of contaminated groundwater to bedrock (R83)	Groundwater in bedrock beneath Wigg Island	Temporary, Long Term, Indirect	Significant
Continued off-site migration of contaminated groundwater (R84)	Shallow groundwater beneath Wigg Island	Temporary, Long Term, Indirect	Significant
Continued off-site migration of contaminated groundwater (R86)	Groundwater in bedrock beneath Wigg Island	Temporary, Long Term, Indirect	Significant
Migration of ground gas into excavations at Wigg Island (R99)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant
Migration of volatile vapours into excavations at Wigg Island (R100)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant

Runcorn

14.7.37 Table 14.28 shows the significant effects for Areas E and F (Astmoor Industrial Estate and Bridgewater Junction) in Runcorn. No specific significant effects have been identified for the Operation Stage for these areas. These areas are not considered to share any other common significant effects with other parts of Runcorn.

Table 14.28 – Summary of Potentially Significant Effects for Areas E and F during Construction and Operation Stages

RUNCORN			
Area E - Astmoor Industrial Estate **Area F - Bridgewater Junction**			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
Migration of contaminants through surface water run-off to surface watercourses (R56)	Canals	Temporary, Short Term, Direct	Significant
Operation Stage			
No significant effects have been identified for the Operation Stage in Area E and F.			

14.7.38 No significant effects were identified for Areas G and H (Lodge Lane and Weston Link Junctions) in Runcorn. These areas are not considered to share any other common significant effects with other parts of Runcorn.

Table 14.29 – Summary of Potentially Significant Effects for Areas G and H during Construction and Operation Stages

Runcorn			
Area G – Lodge Lane Junction to Weston Link Junction **Area H – M56 Junction 12**			
Effect	**Receptor**	**Nature of Effect**	**Significance**
Construction Stage			
No significant effects have been identified for the Construction Stage in Areas G or H.			
Operation Stage			
No significant effects have been identified for the Operation Stage in Areas G or H.			

14.8 Mitigation, Compensation, Enhancement and Monitoring

14.8.1 The potential risks and effects of the proposed scheme have been assessed without mitigation. This section discusses measures to mitigate the identified risks and effects, which means remediation and other associated activities such as specific monitoring in this case. Importantly, this section is not a prescriptive set of remediation and/or mitigation measures but a discussion of what could/should be achieved by the deployment of appropriate methodologies. These elements must be secured by the submission of further data and any requirements for the approval of mitigation and remediation strategies before works commence.

14.8.2 The mitigation measures are discussed as follows:

a. A Preliminary Remediation Options Appraisal undertaken for soil and groundwater contamination is set out;
b. Potential mitigation measures to address significant effects identified in Section 14.7 above; and
c. Areas where mitigation measures will need to be considered during the three stages of the works, these are discussed for each of the following:
    i. Detailed Design;
    ii. Construction; and
    iii. Operation.

14.8.3 A review of the Preliminary Remediation Options Appraisal is included from paragraph 14.8.6 to 14.8.26. This was undertaken to identify possible mitigation measures for contaminants in soil and groundwater in the Project Area.

14.8.4 Mitigation measures to address the significant effects identified in Tables 14.21 to 14.29 are outlined from paragraph 14.8.28 to 14.8.49.

14.8.5 Paragraphs 14.8.50 to 14.8.117 provide an overview where mitigation measures will need to be considered during the detailed design, construction and operation stages to address the risks identified in Tables 14.11 to 14.20 in Section 14.7. The assessment of significant effects has been based on the concept of a Significant Possibility of Significant Harm. There are still potential effects that whilst not identified as significant effects would still need to be addressed as part of the works. Mitigation measures have also been considered for these effects.

Preliminary Remediation Options Appraisal for Soil and Water Contamination

14.8.6 A Preliminary Remediation Options Appraisal has been carried out to establish viable techniques that could be used for the remediation of soil and groundwater contamination identified in the Project area. The ultimate choice of method would be the subject of approval prior to the implementation of the relevant works.

14.8.7 Section 78A(7) of Part IIA of the Environmental Protection Act 1990 defines remediation as:

"(a) the doing of anything for the purpose of assessing the condition of -

(i) the contaminated land in question; or
(ii) any controlled waters affected by that land; or
(iii) any land adjoining or adjacent to that land;

(b) the doing of any works, the carrying out of any operations or the taking of any steps in relation to any such land for the purpose –

(i) of preventing or minimising, or remedying or mitigating the effects of, by reason of which the contaminated land is such land; or
(ii) of restoring the land or waters to their former state; or

(c) the making of subsequent inspections from time to time for the purpose of keeping under review the condition of the land or waters".

14.8.8 DEFRA Circular 01/2006 (Ref. 9) gives extensive guidance on contaminated land with respect to UK legislation, including Part IIA of the Environmental Protection Act (Ref. 2), as updated by further pieces of legislation. Chapter 3 of Annex 3 of the Circular gives specific guidance on the remediation of contaminated land and describes in full the process of remediation and the considerations that should be made in determining when remediation is required and to what standard. This includes the implementation of phased remediation works, the reasonableness of remediation (incorporating the seriousness of harm or of pollution to controlled waters), and the practicability, durability and effectiveness of remediation together with the need to consider adverse environmental impacts and probability of success.

14.8.9 Chapter 3 of Environment Agency CLR11 (Ref. 14) provides guidance on undertaking a detailed Remediation Options Appraisal. This process requires that consideration is given to each individual or combination of pollutant linkages that have been demonstrated through the undertaking of a detailed risk assessment process, to present a risk to potential receptors.

14.8.10 The Preliminary Remediation Options Appraisal examines remediation techniques currently available in the UK to determine their potential applicability to the ground conditions and the pollutant linkages that have been identified within the Project area, should they be required. A detailed Remediation Options Appraisal, as defined within CLR11, will be undertaken following the completion of a detailed risk assessment.

14.8.11 The preliminary appraisal was undertaken by compiling a database of remediation technologies. This database was compiled following an investigation of remediation techniques using the following sources of information:

a. Halton Borough Council (previous remediation projects within study area);
b. Environment Agency;
c. Remediation contractors – as part of a consultation process;
d. Contaminated Land: Applications in Real Environments (CL:AIRE) ;
e. Publicly available case studies and technology information sources; and
f. Academic journals on subject of contaminated land and remediation technologies.

14.8.12 The appraisal looked at three different types of remediation techniques, namely:

a. Engineering solutions, such as containment walls, landfilling and soil capping layers;
b. Ex-situ works, such as landfarming and groundwater treatment; and
c. In-situ works, such as bioremediation or permeable reactive barriers.

14.8.13 All of the techniques investigated were sub-divided into the following categories, as used by the Environment Agency (Ref. 37):

a. Civil Engineering Methods;
b. Biological Methods;
c. Chemical Methods;
d. Physical Methods;
e. Stabilisation & Solidification Methods; and
f. Thermal Methods.

14.8.14 Each treatment option was then assessed against the following criteria to aid comparison with other remediation techniques:

a. Contaminant types and phase that can be treated;
b. Ground conditions in which the technique is capable of operating;
c. Treatment time;
d. Complexity;
e. Advantages and disadvantages of the technique; and
f. Relevance to the site specific issues identified within the project area.

14.8.15 The following sections detail the findings at each stage of the appraisal.

Consultation Process for Remedial Measures

14.8.16 Consultation was undertaken as part of the Preliminary Remediation Options Appraisal in order to obtain an understanding of the likely requirements for remediation from the regulators and details on techniques that have been applied within the Project area previously.

14.8.17 This consultation process involved the Environment Agency, Halton Borough Council and a range of remediation contractors.

14.8.18 The consultation process noted that the following techniques have previously been implemented in the Halton area adjacent to the Project area:

a. Excavation and removal of contaminants;
b. Soil stabilisation (with various proprietary additives);
c. In-situ bioremediation; and
d. Capping (of both contaminated land and of landfills).

14.8.19 Remedial works that are known to be currently under consideration for use in the Halton area adjacent to the Project area comprise:

a. Capping; and
b. Permeable Reactive Barriers.

Results of Preliminary Remediation Options Appraisal

14.8.20 Following the preliminary appraisal, each remediation technology was assigned a category classification based upon potential for use, with Category A technologies having the greatest potential for use, and Category C technologies having the least potential for use within the Project area.

Category A Technologies

14.8.21 These techniques have a good potential for use based on the types of contaminants assessed as present and their extent across the Project area, and upon the complexity, cost effectiveness and reliability of the technique. Category A techniques comprise:

a. Soil Stabilisation/Solidification, either ex-situ or in-situ depending upon application / presence of a relevant pollutant linkage;
b. Cement based techniques including with the addition of additives;
c. Activated Carbon Technology coupled with cement stabilisation;
d. Capping – through the use of soil stabilisation/solidification, clay or concrete;

e. Permeable Reactive Barriers (PRBs), in particular redox PRBs (to dechlorinate chlorinated hydrocarbons) and biological based PRBs (to remove metals, phosphate and nitrate from groundwater, and which, with additions, could also treat organic contaminants);
f. Re-use on-site, for example, within road embankments;
g. Source Removal and Monitored Natural Attenuation (MNA);
h. Pre-hydrated High Density Bentonite – used as barrier walls, capping layers or landfill liner;
i. Gravity separation – for the separation of oil/water/sediment phases from liquid waste streams;
j. Enhanced bioremediation – using oxygen or hydrogen releasing compounds in areas of organic contamination;
k. Pump & treat – using pumps to bring contaminated groundwater to the surface for treatment and eventual disposal to sewer or ground;
l. Solvent Extraction – use of solvents with product recovery systems and soil washing plant to increase rate of desorption of residual product from soil to groundwater;
m. Dual Phase Vacuum Extraction – application of high vacuum to air/water interface to abstract vapours, LNAPL and contaminated groundwater;
n. Soil Washing – using specialist plant to screen and wash contaminated soils. Can reduce volumes of waste being removed from site, and produce suitable engineering fill materials. Can be coupled with other technologies to improve performance depending upon soil and contaminant types;
o. Use of piles (rotary bored cast in-situ piles or Vibro-concrete columns (VCC's);
p. Use of lightweight fill materials for embankments to minimise requirement for piled foundations; and
q. Use of PVD/Wick drains and groundwater treatment systems to increase rate of settlement beneath embankment and minimise requirement for piled foundations.

14.8.22 In addition to the above, the following techniques have been identified as having good potential for use but over which the certainty of use may be limited by restrictions of use, either in terms of practicality, effectiveness, reliability, treatable contaminants or availability in the UK. These remediation techniques comprise:

a. Steel sheet pile walls with sealed clutches – to contain contaminants on-site and prevent off-site migration;
b. Bored or excavated slurry walls;
c. Sorption based PRBs – increased costs due to the need for long term media replacement; and
d. Hydraulic containment / flow path management – long term implications due to the need for ongoing maintenance.

14.8.23 In addition to the above, the following techniques have been identified as having potential for use, but only in limited areas for a limited range of contaminants:

a. Chemical Oxidation – either in-situ or ex-situ, primarily for the treatment of organic contaminants;
b. Bioremediation of groundwater – either in-situ or ex-situ;
c. Bioremediation of soils - either in-situ or ex-situ;
d. Low Temperature Thermal Desorption - either in-situ or ex-situ;
e. Steam or Heated Air Injection;
f. Air sparging; and
g. Soil Vapour Extraction.

Category B Technologies

14.8.24 These are techniques that have been identified as having potential for use as a supplementary technology or with a lesser degree of certainty or applicability. Category B comprises:

a. Precipitation based PRBs;
b. Ozone sparging;
c. Air stripping;
d. Ultra Violet Oxidation;
e. Magnetic separation;
f. Hydraulic Fracturing;
g. Electrokinetics; and
h. Use of granular trench to dewater embankments and adjacent ground.

14.8.25 In addition to the above, the following techniques have potential for use in some areas but are unlikely to be utilised due to practicability, complexity, effectiveness, reliability, availability and /or range of treatable contaminants. These techniques comprise:

a. Cement & asphaltic emulsion based stabilisation/solidification;
b. Ion exchange; and
c. Electrochemical separation.

Category C Technologies

14.8.26 These are techniques that have been identified as having very little potential for use and are unlikely to be utilised due to practicability, complexity, effectiveness, reliability, availability and/or range of treatable contaminants. Category C techniques comprise:

a. High temperature Incineration;
b. Phytoremediation;
c. Excavation and disposal, due to the increase cost and lack of sustainability; and
d. Use of piled foundations (including Stone Columns) for embankments.

Potential Mitigation Measures

14.8.27 This section provides an overview of the potential measures that can be utilised to mitigate the significant impacts identified in Tables 14.21 to 14.29 above. This overview also considers the findings of the Preliminary Remediation Options Appraisal.

Removal/treatment of contaminated soils, including Galligu and other chemical wastes

14.8.28 The Preliminary Remediation Options Appraisal indicates there are a wide range of methods available to treat inorganic and organic contaminants identified in soils within the Project area.

14.8.29 For the treatment of Galligu and chemical wastes, soil stabilisation/solidification techniques have been used extensively in the HBC area as it has been widely accepted as a remediation technique capable of mitigating the risks posed by Galligu and other forms of chemical waste, with the obvious exception of excavation & off-site disposal. Off-site disposal of contaminated material has become less favourable over the last decade due to increased environmental concerns over sustainability and significant increasing landfill costs.

14.8.30 Different variations of stabilisation/solidification using lime, cement, and various additives have been trialled extensively by HBC and the region is subject to substantial research by CL:AIRE as part or the PASSiFy programme, aimed at documenting the use of stabilisation/solidification

techniques and obtaining long term performance data so that the efficacy of the various techniques can be verified.

14.8.31 The most significant drawback with stabilisation/solidification techniques is that the contaminant mass is not actively treated to reduce the net mass of contamination in the soil. The process does result in a net decrease in contaminant concentration but only because the net volume of soil is increased with the addition of the cement and various additives. There are environmental impacts associated with stabilisation/solidification, particularly due to the use of large volumes of cement and the environmental effects associated with the extraction and manufacture of this material. There is extensive guidance issued by the Environment Agency on the use of stabilisation/solidification and the re-use of stabilisation/solidification treated soils.

14.8.32 Other techniques that have the potential to be effective treatment techniques for Galligu and chemical waste soils include high temperature incineration and re-use of soil within the embankment, although both of these options carry extensive costs, have potential environmental impacts (in particular high energy requirements and emissions to atmosphere) and require extensive regulatory liaison for approval.

14.8.33 Re-use of soil within embankments, including treated soils, is likely to require an appropriate exemption from the Waste Management Licensing Regulations (Ref. 38), a Waste Management Licence (WML) or Pollution Prevention and Control (PPC) permit (Ref. 39) from the Environment Agency. Re-use of soils, assuming the risks were acceptable, would offset the need for disposal off site and / or the import of materials, and would be a potentially beneficial environmental impact.

Contaminated Groundwater

14.8.34 The Preliminary Remediation Options Appraisal indicates there are a wide range of methods available to treat inorganic and organic contaminants identified in groundwater within the Project area. These range from groundwater containment systems using sheet piles or bentonite slurry walls through groundwater control systems (such as PRBs and flow path management techniques) in-situ dosing treatments (including enhanced bioremediation and chemical oxidation) a wide range of ex-situ treatment techniques (that can be designed to address specific contaminants and site conditions) to monitored natural attenuation.

14.8.35 Consideration will need to given to the possibility of migration of contaminated groundwater in the Project area. This will apply in two cases. First, the possibility of contaminants migrating out of the Project area and secondly that areas remediated as part of the Works could be effected by sources of contamination outside the Project area.

14.8.36 Any mitigation measures that rely on containment will have to be considered in the context of the wider groundwater flow regime to ensure that they do not interrupt groundwater flows or cause contaminants to migrate to other areas, potentially not currently affected by contamination.

14.8.37 Treatment of contaminated groundwater can require long time periods and, if this is requested, it will need to be taken into account in programming the works. It is possible that mitigation measures for groundwater contamination will need to be built into the works so that they can continue to operate after completion.

14.8.38 The environmental impacts of these techniques vary widely. Monitored natural attenuation has a very low environmental impact as long as there are no adverse impacts from allowing contamination to remain in place. Environmental impacts associated with other techniques produce emissions and require energy use during disposal and/or destruction of recovered

contaminants and during installation and operation of treatment facilities or containment measures. In particular, in this respect the destruction of certain contaminants present on site may involve incineration. The use of cement and bentonite in barriers can have environmental impacts related to the extraction and manufacture of these materials.

14.8.39 Water pumped from excavations for bridge piers and towers (such as on the salt marshes and estuary) is also likely to require treatment prior to disposal. Treatment may comprise settlement lagoons, but additional treatment may also be required (depending on contaminant concentrations) before disposal. The disposal of treated water from the Project will also need to consider the following:

a. Discharge to ground which could potentially mobilise shallow contaminants and increase risk of contaminant migration beneath the site. Discharge consents would need to be obtained from the Environment Agency. Furthermore, the treated groundwater is likely to have to comply with the UK DWS and/or EQS values for coastal and estuarine waters;
b. Discharge to land drains which would ultimately discharge to the River Mersey, and so is likely to have to comply with the EQS values for coastal and estuarine waters; and
c. Discharge to sewer which would require detailed consultation with the local water authority to determine if their existing sewer system and treatment systems are capable of accepting the proposed discharge rate and quality. The requirements of any discharge consent agreed with the local water authority would need to be considered in the design of the water treatment system.

LNAPL

14.8.40 There are several remediation options available to deal with free product including pump & treat, dual phase vacuum extraction, skimmer pumps, solvent extraction and flow path management techniques for LNAPL that can then be coupled with gravity separation and air stripping techniques to separate product from groundwater.

14.8.41 It will be necessary to combine the treatment of free phase contamination with any other remediation measures that are proposed for groundwater.

14.8.42 Environmental impacts associated with the above techniques for mitigation of LNAPLs would arise from emissions and energy use in the manufacture, installation and operation of the facilities and potential emissions associated with the destruction of contaminants, especially if incineration is required.

14.8.43 The use of any of the techniques listed above will not guarantee that all of the free product will be recovered. It is generally accepted that complete LNAPL removal is not possible, and that product recovery operations must be combined with extensive monitoring to look for any potential rebound of product beneath the site.

DNAPL

14.8.44 Options for the remediation of DNAPL are considered to comprise:

a. Source removal or recovery as far as is reasonably or practically possible, to include:
    i. Removal / remediation of DNAPL tanks and/or shallow made ground soils saturated with DNAPL; and
    ii. Removal/recovery of DNAPL from beneath the site (made ground, granular alluvium and glacial sand) using techniques such as flow path management, low flow pneumatic pumps, solvent extraction, hot water injection or pump and treat.

For low permeability soils, techniques such as hydraulic fracturing can be coupled with any of the above techniques to mobilise product.

b. Groundwater remediation to reduce concentrations of dissolved phase chlorinated solvents (discussed in paragraphs 14.8.34 to 14.8.39).

14.8.45 The use of any of the techniques listed above will not guarantee that all of the product within the soil will be recovered. Using currently available techniques, it is generally accepted that complete DNAPL removal is not possible, and that product recovery operations must be combined with extensive monitoring to look for any potential rebound of product beneath the site.

14.8.46 Dissolved phase chlorinated solvents are treatable using a range of techniques that are based upon reduction of the chlorinated compounds into lower weight chlorinated compounds and, eventually, to water and carbon dioxide. Techniques that can be utilised to stimulate this active dechlorination process include enhanced bioremediation using oxygen and/or hydrogen releasing compounds or other forms of nutrient, through chemical oxidation methods or, as used in the waste water treatment industry, ultraviolet oxidation. However, groundwater remediation works alone may have a limited impact if a source of the product remains.

14.8.47 An alternative would be to utilise monitored natural attenuation which is where contaminants change in nature and/or reduce in concentration naturally over time and a record of progress is maintained in case intervention is needed. An extensive period of monitoring is likely to be required to demonstrate that attenuation is occurring, although this may prove to be an effective solution in the long term. Consideration would need to be given to residual risks to human health and to groundwater/surface water during attenuation. Monitored Natural Attenuation would need to be coupled with an Emergency Action Plan detailing specific remediation works that could be undertaken in the event that monitoring suggests that natural attenuation is not effective, or that potential receptors are at risk. This Emergency Action Plan would need to detail how the measures would be implemented if the area of concern extended beneath the area of the Works. This might require that measures are built into the scheme to allow for emergency actions to be implemented should the need arise. An extended period of monitoring would have to be included in the overall project programme. If this approach is adopted then the form of works would require approval in this specific respect to ensure that emergency measures were possible.

14.8.48 It will be necessary to combine the treatment of free phase contamination with any other remediation measures that are proposed for groundwater. Given that complete remediation of DNAPL product is unlikely to be possible consideration would need to be given to any residual effect arising from dissolved phase contamination of groundwater following remediation. This could be achieved through a programme of monitored natural attenuation of the residual effect or through containment combined with treatment such as PRBs.

14.8.49 Environmental impacts associated with the above techniques for mitigation of DNAPLs would arise from emissions and energy use in the manufacture, installation and operation of the facilities and potential emissions associated with the destruction of contaminants, especially if incineration is required. Environmental impacts associated with monitored natural attenuation would generally be less than more intensive techniques, assuming there are no adverse impacts from allowing the contaminants to remain in place whilst attenuation occurs.

Detailed Design Stage

14.8.50 So as to accommodate appropriate design responses to contamination the final design of the Project must accommodate mitigation. Also mitigation measures themselves will require detailed design prior to implementation of relevant parts of the Project. There are also issues

that need to be considered in the detailed design which would have implications for contamination, such as drainage issues. These are discussed below.

Construction Environmental Management Plan

14.8.51 A Construction Environmental Management Plan (CEMP) provides the management framework needed for the planning and implementation of construction activities in accordance with environmental commitments identified within the Environmental Statement and any requirements of planning conditions. The purpose of the CEMP is to reduce the risk of adverse impact of construction on sensitive environmental resources and to minimise disturbance to local residents. The CEMP is discussed in greater detail in Chapter 23 of the ES.

14.8.52 The CEMP describes the checking, monitoring and audit processes that would be implemented to ensure works are being undertaken in accordance with these requirements, together with measures to ensure that appropriate corrective actions or mitigation measures are taken. A CEMP will need to be prepared once a Concessionaire has been appointed and the detailed design has been completed.

14.8.53 The CEMP forms part of the overall Project Management and as such, activities described would be integrated with other Quality, Sustainability and Health and Safety management processes.

Minimisation of Intrusive Works

14.8.54 Where possible, design of structures in areas known to contain contamination should minimise the amount of material that has to be excavated and minimise the volume of waste that is produced. Examples include:

a. Consideration of piling techniques (following Environment Agency guidance (Ref. 40)) and balancing the need to minimise the potential to create pathways with reducing the volume of arisings;
b. Avoiding the use of deep trench footings; and
c. The use of supported excavations rather than battered excavations.

14.8.55 This will have benefits in that it will minimise:

a. The risk of personal injuries to site workers and trespassers at the site;
b. The risk of exposure of site workers and trespassers to contaminated soil and groundwater at the site;
c. The potential for ground gas or volatile vapours to:
    i. Accumulate (in the case of CO_2) at the base of excavations;
    ii. Increase potential for a fire or explosion (in the case of CH_4 and volatile vapours); and
    iii. Escape to atmosphere.
d. The risk of introducing new pathways for vertical contaminant migration;
e. The risk of migration of contaminants to surface watercourses via surface run-off;
f. The volume of potential waste being produced at the site; and
g. The volume of contaminated soils requiring treatment.

14.8.56 Limiting the extent of excavations is likely to reduce environmental impacts through reducing the need for disposal and/or treatment of contaminated soils and liquids, assuming that the impacts arising from leaving contaminants in place are mitigated. It is unlikely that the environmental impacts from mitigating these risks will outweigh those from wholesale excavation and removal of contaminated soils from beneath the Project area.

Design of Measures to Incorporate and Protect Surface Water Features from Contamination

14.8.57 The design of the New Bridge and associated embankments and structures will need to consider the presence of surface water features such as Stewards Brook, Bowers Brook, St. Helens Canal and the Mersey Estuary. Measures will need to be incorporated to protect these features from contamination during construction works and during the operational stage.

Design of Measures to Prevent Vertical Migration of Contaminants

14.8.58 Where contamination coincides with poor ground conditions in geotechnical terms it may be necessary to carry structural loads carried to more competent strata at depth. This may involve piling or other forms of ground improvement that could form pathways for vertical and (to a lesser degree) lateral migration. Where piling or other forms of ground improvement is required, consideration must be given to Environment Agency guidance (Ref. 40) on pollution prevention on land affected by contamination.

14.8.59 The most likely foundation solution is based on auger or bored piles with vibro-concrete columns for ground improvement and has considered the requirement to reduce the potential for introducing preferential pathways. If alternative foundation solutions are proposed it will be necessary to design mitigation measures to prevent such migration occurring. A wide range of potential solutions to this issue are available, and the exact technique to be used will be dependent on the type of pile to be used and the techniques available at the time of construction. Techniques include:

a. The use of temporary or permanent sleeving of the piles through contaminated ground; and
b. Avoidance of ground improvement techniques such as stone columns which introduce high permeability pathways.

14.8.60 It will also be necessary to seal existing monitoring wells that are not required for long term monitoring to prevent the risk of vertical migration of contaminants. The exact number and location of the wells to be sealed would depend on the remediation measures that are adopted.

14.8.61 Measures will be required to deal with potential contaminant migration along piles and leachate generation potential for the approach viaduct pier at the Wigg Island Landfill.

14.8.62 Specific mitigation measures at the Wigg Island Landfill (Area D) would include the use of specialist piles (the form and technique for which would require approval) to minimise the potential for contaminant migration along the piles to occur. Alternatively, it would be possible to excavate the landfill beneath the footprint of the pier, and have the piles/pile caps founded within natural soils only. This would remove any risk of vertical migration of landfill leachate along the piles. The waste material from the landfill could either be sent off-site for disposal or re-interred as part of the subsequent landfill re-instatement works. This would be subject to Environment Agency approval, and an authorisation from the Waste Management Licensing Regulations may also be required.

14.8.63 At Wigg Island, the need to remove material around the pier will have a greater environmental impact than installing piles through the landfill assuming that the risk of contaminant migration is mitigated.

Design Measures for Contaminants Remaining Beneath Sections of the Route to be Covered

14.8.64 Where the proposals involve covering contaminated ground, for instance with an embankment, this would be a suitable means of remediation in its own right for certain pathways and it would also reduce infiltration of water into the ground.

14.8.65 The design would need to consider the nature of the contaminants in the ground beneath the embankment given that the structure will be present for the long term. In these areas it may be necessary to consider removing or containing contaminants that may represent a long term risk. This is particularly the case where significant depths of embankment materials are present.

14.8.66 Depending on the mitigation options eventually adopted, it is possible that remedial measures would need to be incorporated within the works to allow long term remediation to be undertaken in some areas. These works would likely relate to the remediation of LNAPL or DNAPL, as discussed in paragraphs 14.8.40 to 14.8.49.

14.8.67 Where existing embankments are to be removed (such as in Area I2 as part of the de-linking works), there is a risk of exposure of soils (original made ground and natural soils) that could contain contaminants from previous historic site uses. In these areas, measures should be considered to prevent exposure of these soils to site workers, visitors or local residents / trespassers until development of these sites takes place. Specific measures could include the retention of some embankment material to form a cap and prevent exposure of the original made ground, or the import / construction of a new capping layer. The overall risks associated with these areas would need to be considered as part of any future development works and are therefore outside the scope of this ES.

Design of Specific Remediation Measures

14.8.68 Remediation measures for specific contamination issues, as detailed in paragraphs 14.8.28 to 14.8.49, would need to be designed in detail to suit the specific conditions at the site. Remediation techniques are available and are discussed in more detail within the Preliminary Remediation Options Appraisal (paragraphs 14.8.6 to 14.8.26). The specific contamination issues are as follows:

a. Soil remediation;
b. Groundwater remediation;
c. LNAPL remediation; and
d. DNAPL remediation.

Recontamination of Treated Areas

14.8.69 Detailed design measures for remediation may need to take into account contamination outside the Project area, which could potentially re-contaminate treated areas. A means to prevent recontamination, such as a containment system with or without treatment sections, could be required in such circumstances. These measures are also discussed in the Preliminary Remediation Options Appraisal in paragraphs 14.8.6 to 14.8.26.

Migration of Contaminants Outside of the Project Area

14.8.70 A further factor that will need to be taken into account in the detailed design stage is the possibility that residual contaminants remaining within/beneath land occupied by the works could migrate outside the Project area. This might also drive the need for remediation and/or containment works.

Design of Protection Measures for Buried Services

14.8.71 Where buried drinking water supply pipes are to be incorporated in the design, consideration of the location of contamination should be made. Contaminated areas should be avoided where possible, but if necessary, buried plastic drinking water supply pipes in such areas will require some form of mitigation from aggressive contaminants.

14.8.72 There may also be risks to construction and maintenance workers where buried services are located in contaminated soils. Buried services include (but should not be limited to) electrical services, gas pipes, drains and sewers, and covers both existing and proposed services. It may be necessary to divert buried services to avoid contaminated soils, or to mitigate any potential risks by installing services above ground or within protected service ducts.

Drainage Design

14.8.73 It will be necessary to avoid infiltration drains as these could mobilise contaminants. Further detail on the proposed drainage strategy is included in Appendix 8.2 of Chapter 8 Surface Water Quality.

Construction Stage

14.8.74 Measures to be taken during construction will be threefold. First, there will be a need to control risks arising from the site operations. Secondly, there will be the need to implement the design measures set out above. These include.

a. Measures to manage the mitigation of contaminants and/or recontamination of treated areas;
b. Measures to prevent vertical migration of contaminants;
c. Measures for contaminants remaining beneath sections of the route to be covered; and
d. Measures to prevent migration of contaminants from embankment or structural loading

14.8.75 Thirdly, it will also be necessary to implement specific remediation measures as discussed in paragraphs 14.8.28 to 14.8.49. These include specific consideration of the following contamination issues at the site:

a. Soil contamination;
b. Groundwater contamination;
c. LNAPL; and
d. DNAPL.

14.8.76 There will be a requirement to undertake monitoring and validation works for specific remediation works that are required at the site. The remediation works, with monitoring, validation and action plans would all need to be agreed with the regulators prior to undertaking the works. Specific remediation techniques are discussed in the Preliminary Remediation Options Appraisal in paragraphs 14.8.6 to 14.8.26, and further discussions on the use of these techniques within the Project area is included in paragraphs 14.8.28 to 14.8.49.

14.8.77 Mitigation measures to be incorporated into the construction stage are discussed below. Each mitigation measure has been assigned a suffix letter for reference in the summary table included at the end of this section in Table 14.30.

Soil Remediation Works (A)

14.8.78 In overall terms the construction of the bridge and associated access roads will break the pathway between site users and soil contamination.

14.8.79 Soil remediation works may be required to mitigate the risks to groundwater from contaminants within the soil. They may also be required to treat waste soils prior to removal from the site.

Groundwater Remediation Works (B)

14.8.80 Groundwater remediation works may be required to mitigate the risks to controlled waters (groundwater beneath the project area, off-site groundwater, or surface water) from contaminated soils (including chemical wastes), LNAPL and DNAPL.

LNAPL Remediation Works (C)

14.8.81 Specific remediation works would be required to remove LNAPL from beneath Areas B2 and I1 to mitigate the risks to groundwater and site (and adjacent site) users.

DNAPL Remediation Works (D)

14.8.82 Specific remediation works would be required to remove DNAPL from beneath Area C to mitigate the risks to groundwater, surface water and site (and adjacent site) users.

Minimisation of Intrusive Works (E)

14.8.83 The detailed design mitigation measures to minimise the extent of excavations at the site, discussed in paragraphs 14.8.54 to 14.8.56, should be implemented to minimise the risks to construction workers/visitors/trespassers, local residents, groundwater and surface water from contaminated soil, groundwater and/or ground gas.

Measures to Mitigate Exposure to Contaminated Soils (F)

14.8.84 Where exposure of receptors such as workers and trespassers or local residents and workers to contaminated soils could arise, it would be possible to break this pathway by introduction of barrier layers. As noted above, the placement of a road would act as a barrier layer. Capping layers may be required in areas of landscaping.

14.8.85 There will be environmental impacts associated with the extraction, transport and placement of fill materials for barrier layers.

Measures to Prevent Vertical Migration of Contaminants (G)

14.8.86 It will be necessary to consider the use of mitigation measures to prevent the vertical migration of contaminants. These are summarised as follows:

a. Vertical migration along foundations:
    i. Selection of appropriate foundation solutions;
    ii. Consideration of pile types;
    iii. The use of temporary or permanent sleeving of the piles through contaminated ground; and
    iv. Avoidance of ground improvement techniques such as stone columns which introduce high permeability pathways.

b. Vertical migration during removal of buried foundations in Areas B2 and C:
   i. Backfill the resulting excavations using appropriate methods to ensure that pathways to deeper layers are not created.
c. Vertical migration at Wigg Island (Area D):
   i. Use of specialist and approved piles for pier; and
   ii. Removal of landfill material prior to construction of pier.
d. Vertical migration along historic abstraction wells in Areas B2 and C.
   i. These wells should be located and grouted before construction works commence.
e. Vertical migration along existing monitoring wells in all areas.
   i. It will be necessary to remove and grout these wells during the construction phase where they are not required for long term monitoring.

Dust Suppression (H)

14.8.87 Dust generated from areas of contaminated soils during dry weather is a potential means for migration of contaminants to both site workers, residents and workers in the locality. Dust suppression measures would be necessary during the works such as the damping down or sheeting of exposed of soils. Monitoring of dust will be required during the works. In some cases it is possible that work would need to be carried out in temporary structures/tents.

Control of Odours & Vapours (I)

14.8.88 Odours are primarily unpleasant; however, there is also the possibility at this site that volatile organic compounds could give rise to vapours with the potential to cause harm. This could affect both site workers and, potentially, local residents or workers.

14.8.89 In addition to minimising excavations, odour controls may still be needed in some areas. Such measures can include covering sources or use of sprays to act as barriers, odour counteractants or modifiers. In terms of vapours with the potential to cause harm, dilution should usually be sufficient to mitigate this impact. However, specific measures may be required in some areas. Monitoring of vapours and odours during the works will be required. In some cases it is possible that work will need to be carried out in temporary structures/tents.

Buried Plastic Pipes (J)

14.8.90 Protection measures for buried plastic water supply pipes at the site would comprise the use of upgraded pipe material, such as to steel, specialist plastic pipes, use of clay backfill to trenches, and/or the installation of service ducts or tunnels to minimise any contact with contaminated soils. The latter would also prevent maintenance workers from coming into contact with contaminated soils.

Gas/Vapour Protection (K)

14.8.91 Gas protection measures would comprise the use of properly installed gas resistant membranes and the incorporation of passive or active ventilation measures in new buildings. For protection against the ingress of volatile vapours, organic vapour resistant membranes installed within foundations would be required.

14.8.92 The need for mitigation measures could be offset if remediation works were able to reduce the concentrations of, or remove, contaminants from the site that produce ground gas, and in particular, volatile vapours. Given the small extent of protection measures that are likely to be required this benefit may not be substantial enough to outweigh the additional remediation work needed.

14.8.93 In order to comply with health and safety requirements during construction it will be necessary to ensure that monitoring is undertaken prior to entering confined spaces, this may include some excavations.

Aggressive Ground Conditions (L)

14.8.94 Due to the potential for encountering aggressive ground conditions, it will be necessary to ensure that where buried concrete foundations are introduced these take into account the appropriate design sulphate class.

Landscaping (M)

14.8.95 Due to the potential for encountering phytotoxic contaminants within the existing soil or embankment fill, it may be necessary to introduce additional sub-soil and topsoil into landscaping areas particularly where trees are proposed. This would also help to ensure the potential for accidental contact by residents, trespassers or workers undertaking maintenance works, such as grass cutting, is minimised.

14.8.96 At St. Michaels Golf Course in Area A, where landscaping is required outside of the footprint of the road and embankment, the existing clay cap, which separates site users from the underlying chemical waste, will require improvement/re-instatement due to its limited thickness in some areas. Such measures would need to be designed appropriately.

Site Hygiene and Personal Protective Equipment (N)

14.8.97 Due to potentially high risks to construction workers from contamination in some parts of the Project, where risks to site workers cannot be fully controlled through changes in design, physical or management mitigation measures, personal protective equipment will be required on site. Good site hygiene, together with the provision of washing facilities, is also an important part of controlling the risks to site workers in terms of preventing ingestion of contaminated materials.

Site Health & Safety File (O)

14.8.98 The site Health and Safety File would be the means to ensure that all site users are aware of the risks present at the site, and the safety management procedures that are in place. The file should also contain all of the relevant risk assessments and method statements for all forms of work required at the site. Following completion, this file would then be made available for maintenance workers to minimise their risk of exposure.

Protocols to Deal with Unexpected Contamination (P)

14.8.99 It will be necessary to have in place protocols to deal with unexpected areas of contamination.

Site Security (Q)

14.8.100 Due to the potential for exposing soil and water contaminants during construction works, or the accumulation of ground gas in excavations and confined spaces during construction works, working areas will need to be secured against potential trespassers.

Accidental Spillages / Releases (R)

14.8.101 In the event of an accidental chemical or fuel spill / release within the saltmarsh and estuary during construction works, response measures will be required to recover spilt products and

remove contaminated sediments as quickly and efficiently as possible, whilst taking due care and consideration of the sensitive ecology of the salt marshes and estuary.

Protection or Removal of Drains (S)

14.8.102 During construction works it may be necessary to undertake the following works to surface water drains due to the potential for discharge into surface water courses.

a. Protect drains from site run-off water, which may be contaminated from contaminated soils at the site;
b. Remove or divert drains to enable the construction works to take place;
c. Grout drains to prevent current or future migration of contaminated silts, sludges, groundwater or site surface water run-off;
d. Remove potentially contaminated silts and sludges from the base of drains to prevent their migration (these silts and sludges would be regarded as waste); and
e. Replace drains to provide greater protection from shallow contaminated soils.

Protection of Surface Water Features (T)

14.8.103 Measures will need to be undertaken to prevent surface water run-off from excavations and other working areas from entering surface water courses such as the River Mersey or Stewards Brook. This requirement is discussed in Chapter 8 Surface Water Quality. Measures may include:

a. Surface drain protection;
b. Bunds where construction works are required immediately adjacent to water features;
c. Wheel washing facilities;
d. Siting of stockpiles away from water courses;
e. Sheeting of soil stockpiles;
f. Control of water levels in excavations; and
g. Secure storage of contaminated water removed from excavations prior to its treatment, discharge or off-site removal.

Radioactive Contaminated Land (U)

14.8.104 The concrete encapsulated radioactive contamination beneath the A557 in Widnes would be removed where necessary. However, wherever possible it is proposed that this remains in place. If the intention was to remove radioactive contamination from the site, further investigation would be required to delineate the area of concern. No additional investigation is proposed if there is no intent to disturb material. However, it may be prudent to undertake monitoring works to protect site workers when undertaking excavations in the vicinity of the A557 embankment if any radioactive contamination is present.

14.8.105 Radioactive contamination has also been identified from investigations in shallow soils and drains at the Catalyst Trade Park. Mitigation measures would primarily consist of on-site monitoring during any required excavation works at Catalyst Trade Park, and for local drains beneath the site to be removed, grouted or sealed to prevent radioactive contamination from migrating from the site. If significant volumes of radioactive contaminated soil are identified during shallow excavations at the site, such as for pile caps or contamination source removal works, these soils would need to be disposed of a suitably licensed facility.

Unexploded Ordnance (V)

14.8.106 The assessment reported in this chapter has identified a risk that unexploded ordnance may be encountered within shallow sediments at bridge pier and tower locations, particularly in the estuary and on the saltmarshes. Monitoring will be required during excavations for these piers and towers. If UXO is encountered then work will need to be stopped until the object has been removed and made safe by suitably qualified specialist personnel.

Operation Stage

Site Users

14.8.107 Given that users will be separated from any areas of contamination by the road construction and through either being on an embankment or the bridge it is considered that no pathway would be present to this receptor during the operation stage. Accordingly, the Project itself will provide mitigation for this potential receptor.

Site Staff

14.8.108 Ground gas and/or vapour protection measures would be necessary to mitigate possible risks to site staff in toll booths or offices from contaminants in fill material or existing underlying ground. These measures are described in paragraphs 14.8.88 to 14.8.89 above.

Maintenance Workers

14.8.109 Maintenance workers who need to excavate ground during the operation phase in areas of contamination may be exposed to risk. Mitigation for such workers would comprise protocols to ensure the use of gas monitors, personal protective equipment and escape equipment common to all maintenance work to specific requirements that may be covered in the design.

14.8.110 Information on ground conditions and construction methods should be retained within the site health and safety file.

Local Residents and Workers

14.8.111 Risks to residents and workers are assessed to be low during the operation phase and there may even be a net benefit due to remedial works undertaken as part of the bridge construction works and because the physical works will form a barrier to contamination in many areas.

Monitoring

14.8.112 Monitoring during the operation phase will be required to ensure the effectiveness of any mitigation measures. Monitoring of the effectiveness of mitigation measures to prevent migration of contamination within groundwater may also be needed.

14.8.113 Long term monitoring may be required to demonstrate that the bridge, embankments and associated structures have not had an adverse effect on groundwater migration and contamination beneath the site. This could require regular monitoring of contaminant concentrations in shallow and deeper groundwater bodies over a prolonged period of time.

14.8.114 In particular, there may also be a requirement to undertake long term monitoring wherever long term remediation systems or certain types of remediation (such as soil stabilisation) are implemented.

Maintenance

14.8.115 Any maintenance works will need to consider the above factors. Specifically, any long term soil and / or groundwater remediation systems installed at the site will require well defined, regular maintenance visits to ensure that the efficiency of the system is maximised at all times and to ensure that licences or consents (such as sewer discharge consents) are being complied with. Furthermore, any filtration media will require replacement at appropriate intervals.

Action Plans

14.8.116 Action plans will be required should monitoring indicate that post-construction remediation or mitigation measures are not performing as anticipated.

Validation

14.8.117 Validation will be required during any long term monitoring and to conclude the remedial works. Such validation monitoring may extend beyond the construction works into the operational stage. Any Validation Report should be updated and submitted to the Regulators for approval as appropriate. Once agreed, the report should be kept with the site Health & Safety file.

Summary of Mitigation Measures by Area

14.8.118 The mitigation measures identified above are shown in Table 14.30 along with the relevant effects identified in Tables 14.21 to 14.29. This enables the residual significance of the effects to be identified in Section 14.9 of this Chapter.

Table 14.30 – Summary of Specific Contaminants of Concern, Effects and Viable Remediation Measures (continued overleaf)

Area	Effect/SPR No. *[1]	Nature of Contaminants	Potential Mitigation Measures
Area A - St. Michaels Golf Course	W36, W45, W48, W56, W58, W82, W91, W94, W102, W104, [W4, W10, W16]	Contaminated Groundwater	A, B, E, G, J, P, Q, R, S
Area B1 - Ditton Junction	As above, plus W32, W33, W34, W78, W81, [W2, W3]	Contaminated Soils*[2]	A, E, F, H, I, J, L, M, N, O, P, Q
	W70, W112, W116, [W28]	Ground Gas	E, I, K, N, Q
	W62	Surface Water	B, E, H, R, S, T

**[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual impact, as shown in Tables 14.11 to 14.20, and in Figures 14.41 to 14.44 (Appendix 14.1).*
**[2] - Contaminated soils, including Galligu and other chemical wastes.*
Effect / SPR numbers in square brackets ([ ]) relate to risks / effects from the Do Nothing scenario.

Table 14.30 (continued) – Summary of Specific Contaminants of Concern, Effects and Viable Remediation Measures (continued overleaf)

Area	Effect/SPR No. *[1]	Nature of Contaminants	Potential Mitigation Measures
Area B2 & I1 - Gussion / Anglo Blackwells	W36, W39, W41, W45, W48, W50, W52, W56, W82, W85, W87, W91, W94, W96, W98, W102, [W4, W7, W9, W10, W12, W14, W16]	Contaminated Groundwater	A, B, C, E, G, J, P, Q, R, S
	As above plus W32, W33, W34, W78, W81, [W2, W3]	Contaminated Soils*[2]	A, E, C, F, H, I, K, L, N, O, Q
	W70, W71, W74, W112, W113, W116, W117, [W26, W28, W29]	Ground Gas	E, I, K, N, Q
	W41, W50, W52, W87, W96, W98, [W12, W14]	LNAPL	C
Area C – Widnes Loops	W36, W45, W48, W51, W53, W56, W59, W82, W91, W94, W97, W99, W102, W105, [W4, W10, W13, W15, W16, W19]	Contaminated Groundwater	A, B, D, E, G, Q, T
	As above, plus W32, W33, W34. W78, W81, [W2, W3]	Contaminated Soils*[2]	A, D, E, F, H, I, K, L, N, O, Q, U
	W70, W71, W112, W113, W116, W117, [W26, W28, W29]	Ground Gas	E, I, K, N, Q
	W51, W53, W97, W99, [W13, W15]	DNAPL	D
	W61, W63, W64	Surface Water	B, D, E, H, R, S, T
Area I2 – De-Linking Works	W32, W33, W34, [W2]	Contaminated Soils*[2]	F, N, O, P, Q
	W61	Surface Water	S, T
Area D – Widnes Salt Marsh	W36, W48, W82, W94, [W4, W10]	Contaminated Groundwater	A, B, E, G, Q, S,
	As above, plus W32, W33, W34, W78, W81	Contaminated Soil/Sediment	A, E, F, G, N, O, Q, V
	W61, W64	Surface Water	E, R, S, T
	W70, W116	Ground Gas	B, E, I, K, N, O, Q

**[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual impact, as shown in Tables 14.11 to 14.20, and in Figures 14.41 to 14.44 (Appendix 14.1).*

**[2] - Contaminated soils, including Galligu and other chemical wastes.*

Effect / SPR numbers in square brackets ([ ]) relate to risks / effects from the Do Nothing scenario.

Table 14.30 (continued) – Summary of Specific Contaminants of Concern, Effects and Viable Remediation Measures

Area	Effect/SPR No. *[1]	Nature of Contaminants	Potential Mitigation Measures
Area D – Runcorn Salt Marsh / Wigg Island / Kemet Works	R41, R43, R47, R48, R50, R78, R83, R84, R86, [R6, R9, R11]	Contaminated Groundwater	A, B, E, G, R
	As above, plus R35, R37, R72, [R3]	Contaminated sediment/soils	A, E, G, K, N, O, Q, V
	R35, R37, R41, R43, R47, R48, R50, R56, R65, R66, [R3, R6, R9, R11, R26, R27]	Landfill*[2]	A, B, E, G, I, K, N, O, Q, T
	R65, R66, R99, R100, [R26, R27]	Ground Gas	E, I, K, N, O, Q
	R55, R56	Surface Water	O, N, T
Area E – Astmoor Industrial Estate Area F – Bridgewater Junction Area G1 – Lodge Lane Junction Area G2 – Lodge Lane Junction Area H – M56 Junction 12	R56	Surface Water	O, N, T

**[1] –SPR (Source / Pathway / Receptor) linkage numbers that have a residual impact, as shown in Tables 14.11 to 14.20, and in Figures 14.41 to 14.44 (Appendix 14.1).*
**[2] - Contaminated soils, including Galligu and other chemical wastes.*
Effect / SPR numbers in square brackets ([ ]) relate to risks / effects from the Do Nothing scenario.

Effects arising from the Project

14.8.119 The majority of significant effects associated with the Project arise during the construction stage and mitigation measures have been proposed for these effects. Many of these mitigation measures will continue or continue to have an effect into the operation phase. Further significant effects have been noted during the operation phase and mitigation measures have been outlined to address these effects.

14.8.120 The overall approach to mitigation for site users is based on the premise that wherever possible contaminated soils will remain in place beneath the road and that the road construction and landscaping will act as a barrier between human receptors and contaminants. The proposed end use is not a sensitive one in terms of human health and on this basis it is considered that widespread removal and/or remediation of contaminated soils would not be an appropriate means of managing this risk. In some cases, the construction of the road will provide benefits as areas of contamination will be covered and risks to some receptors will be reduced when compared to the current situation. The fact that substantial parts of the development in Widnes would be elevated on embankment will further assist in reducing these risks.

14.8.121 With the exception of Wigg Island the pile types already identified for the scheme are not considered to be likely to result in new pathways or cause contaminants to move. On this basis, there are no effects that require mitigation relating to the installation of piles within the Project area. Specific mitigation measures have been identified for Wigg Island.

Existing effects associated with the Project

14.8.122 There are existing effects that have been identified in the do nothing scenario and these will continue regardless of whether the Project is constructed or not. These principally relate to contamination of the groundwater due to past industrial activities in Areas A, B, C and part of Area D (Wigg Island landfill) together with sources of LNAPL (in Area B) and DNAPL (in Area C).

14.8.123 The development should not create new pathways for the migration of contaminants or introduce any new vulnerable receptors. The proposed replacement piling and displacement ground improvement techniques are techniques which are acknowledged in Environment Agency guidance as presenting a low risk of introducing pathways. On this basis it is considered that the Project would not represent a significant additional effect on the existing issue of groundwater contamination.

14.8.124 In areas where there are specific contaminants of concern such as DNAPLs, the proposed ground improvement methods will lie within the alluvial soils that have already been heavily impacted and are likely only to extend for a minimal distance (200mm to 300mm) into the underlying glacial clay. No piles penetrating a greater distance into the glacial clay are proposed in any identified areas of DNAPL contamination. In addition to this, alternative construction proposals have been assessed that could remove the need for ground improvement altogether if necessary.

14.8.125 However, presence of groundwater contamination has to be considered as part of the planning process especially as the Project will cover areas of the site and might affect the ability to remediate such areas in the future.

14.8.126 The Project is a long linear feature that cuts across site boundaries and any remediation proposed for groundwater would need to be considered in the context of the wider contaminated land and groundwater issues in Widnes and on Wigg Island. Potential remedial measures for groundwater beneath the footprint of the scheme have been outlined in the preliminary remedial options appraisal and this includes various groundwater remediation techniques together with options for cut off walls (with and without reactive barriers) and the option of allowing natural attenuation to continue. Any proposals will need to be practical, effective, durable, provide a benefit and not result in adverse environmental impacts. A key issue in this respect is that it will be important to ensure that any remediated areas are not re-contaminated by neighbouring areas of contamination.

14.8.127 Consultation with the Environment Agency indicates they would prefer not to have extensive cut off structures across the Project area as they could interfere with overall groundwater flows and the implementation of more widespread groundwater remediation in the future. It is questionable whether remediation beneath the footprint of the Project in isolation offers any substantial benefit without measures to prevent recontamination in the future.

14.8.128 The final approach that is adopted will need to be part of an overall remediation strategy that takes account of, although does not necessarily deliver in full, the wider contaminated land and groundwater issues in Widnes and at Wigg Island. This would be developed in agreement with the Regulators from the preliminary options appraisal conducted for this ES.

14.8.129 Consideration of the individual issues in each of the Areas A, B, C and D is given below:

Area A

14.8.130 In Area A the route crosses part of a wider area of former landfilling. It is underlain predominantly by made ground though alluvium is also present and this forms a minor aquifer and is therefore a sensitive receptor. The groundwater in the made ground and alluvium has been impacted by a wide range of contaminants; there is evidence of further contamination beyond the boundaries of the Project area across the St Michaels Golf Course.

14.8.131 Potential mitigation measures to address the effects on groundwater directly beneath the Project have been outlined and could be implemented. However, it is unlikely that remediation of groundwater beneath the footprint of the development alone would contribute significantly to the wider issues associated with this Area. These wider issues, if they require further remediation, are more likely to be addressed as part of an overall strategy for the remediation of St Michaels Golf Course rather than at the location of the Project itself.

Areas B and I1

14.8.132 Areas B and I1 is underlain by relatively limited depths of made ground that rest directly upon glacial clay. Alluvium has been identified in the south of Areas B and I1 underlying the made ground, this forms a minor aquifer. The groundwater in the made ground and alluvium has been impacted by a wide range of contaminants; there is evidence of further contaminated made ground beyond the boundaries of the Project area.

14.8.133 There is evidence of LNAPL in this area and this contamination appears to be located within the Project boundaries. It is considered that it would be prudent to remediate the LNAPL as far as is practicable and mitigation measures have been proposed for this.

14.8.134 Consideration would need to be given to the benefits of wider groundwater remediation in this area as part of any remediation strategy. If such remediation is undertaken then it may be necessary to take steps to prevent recontamination of the Project area.

Area C

14.8.135 This area includes Catalyst Trade Park where possible DNAPLs and associated dissolved phase contaminants have been identified made ground, alluvium and upper glacial sands. There is evidence in this area that natural attenuation of these products is taking place; however, the available information also shows that these contaminants are migrating outside the Project area and any remediation scheme would have to acknowledge this. There is evidence to suggest that the Project area may represent the source area for these contaminants.

14.8.136 Options to treat DNAPL have been identified. However, remediation of DNAPLs is complex and Environment Agency guidance acknowledges that it is rarely completely successful. Consultation with the Environment Agency has acknowledged this by noting that they would only expect improvement over the Do-Nothing scenario in this regard.

14.8.137 In addition to the DNAPL consideration would need to be given to the benefits of wider groundwater remediation as part of any remediation strategy and within the context of the fact that at least some natural attenuation does appear to be taking place at present. It is possible that following source removal monitored natural attenuation could be adopted for future remediation. If remediation is undertaken then it may be necessary to take steps to prevent recontamination of the Project area.

Area D Wigg Island Landfill & Former Kemet Works

14.8.138 Current proposals involve the need to construct piers through the existing Wigg Island Landfill and at the former Kemet Works. Measures have been defined to mitigate potential impacts arising from the Project on groundwater at this location. Once again there are wider issues of groundwater contamination in this area; however, it is considered that the construction proposals would not interfere with the ability to remediate these in the future if necessary.

Remediation Strategy

14.8.139 The mitigation measures will need to be implemented as part of an overall Remediation Strategy which will depend on the method/s adopted for the construction of the scheme and the overall programme. Viable mitigation measures have been outlined. However, there will be a need for a detailed evaluation of the remedial options to develop the detailed Remediation Strategy. Mitigation measures should be the Best Practicable Techniques taking account of the following factors:

a. Practicability including constraints arising from practicability, the site itself, the time available and regulatory factors;
b. Effectiveness;
c. Durability;
d. Benefit;
e. Adverse environmental impacts; and
f. Overall sustainability.

14.8.140 The interactions between remedial techniques will also need to be considered to ensure that the overall objectives are achieved without one method compromising any others.

14.8.141 The Remediation Strategy should be incorporated into the Construction Environmental Management Plan (CEMP) for the site, as discussed in paragraphs 14.8.51 to 14.8.53 and in Chapter 23 of the ES.

14.8.142 Additional site investigation and detailed quantitative risk assessment together with laboratory and/or site trials of mitigation measures will be required to define the final remediation strategy. The Remediation Strategy will require regulatory approval before it is implemented on site and sufficient time will need to be allowed in the programme for this to be achieved.

14.8.143 The Remediation Strategy will need to include an Implementation Plan defining in detail how the mitigation measures will be implemented on site. This will include details of the methods to be adopted and any measures to be implemented in parallel with the remedial works to ensure that possible impacts are managed adequelty.

14.8.144 A Verification Plan will be required describing how the effectiveness of the mitigation measures will be verified on site during the Works and any longer term verification measures that may be necessary.

14.8.145 A Monitoring Plan will be required. This will need to include monitoring during the implementation of the mitigation measures, to confirm that there are no adverse impacts from the remedial works themselves, and longer monitoring to measure the efficacy of the remedial works.

14.8.146 An Action Plan will need to be associated with the Monitoring Plan defining actions that will be taken if the monitoring indicates that any parameters are diverging from those anticipated in the Remediation Strategy.

14.8.147 On completion of the remedial works a Verification Report will have to be prepared demonstrating that the mitigation measures have been implemented and that the goals of the strategy have been achieved. If long term monitoring is required as part of the process, for example, associated with monitoring natural attenuation, then there may need to be a series of Verification Reports at regular intervals throughout this process.

14.9 Residual Effects

14.9.1 Tables 14.31 to 14.44 below provide a summary of residual effects associated with the Construction and Operation of the Project taking into account the implementation of mitigation and remedial measures outlined above.

Compliance with Legislation, Policies and Plans

14.9.2 In order to comply with wider policies and plans it would be necessary to ensure that the standard of any mitigation for land affected by contamination meets the tests outlined in the relevant legislation and policies.

14.9.3 The principal tests are considered to be those outlined in Planning Policy Statement 23 and Part IIA of the Environmental Protection Act 1990, namely:

a. The land is "suitable for use" and unacceptable risks have been addressed;
b. The land is not capable of being determined as statutory contaminated land; and
c. The effects of any significant harm, harm attributable to radioactivity or pollution of controlled waters has been remedied

14.9.4 The requirements of the Water Framework Directive and the Water Resources Act will need to be taken into account, particularly the fact that in the future the Water Framework Directive will require that water is brought to specific standards. Mitigation measures must take this into account and ensure, as far as practicable, that this objective is not jeopardised. The requirement under the Groundwater Directive to control List 1 and List 2 substances entering controlled waters will also need to be taken into consideration in the design of mitigation measures.

14.9.5 The Local and Regional policies are largely governed by the principles outlined above.

14.9.6 The HBC contaminated land inspection strategy has identified a number of sites along the proposed route, and potentially extending outside the Project area as being potentially statutory "Contaminated Land". The locations of these sites are consistent with the findings of the study and no new sites have been identified.

14.9.7 On the basis of the assessment undertaken it is considered that the Project will be "suitable for use" as risks to site users can be mitigated. The mitigation measures and the residual significance of these effects are identified in Tables 14.31 to 14.39.

14.9.8 Consideration will also need to be given to mitigation of existing effects and in particular groundwater contamination (i.e. effects that pre-exist and are not caused by the project). It is considered that the Project will not significantly effect the existing situation with respect to groundwater contamination but under Part IIA consideration may still need to be given to remediation. This would need to be addressed as part of an overall remediation strategy to provide practical, effective and durable remedial measures within the context of the wider contamination issues in Widnes and at Wigg Island. Depending on the approach that is adopted to mitigation of the existing issues associated with the groundwater residual effects may remain and these could be significant. In this respect, a number of potentially significant residual effects have been identified for the Construction and Operation Stages of the Project and these have been identified separately in Tables 14.40 to 14.44.

Table 14.31 – Summary of Residual Effects Arising from the Project and Common to Areas A to C and I1 in Widnes Following Mitigation (continued overleaf)

WIDNES					
All Areas – Effects Common to Areas A, B, C, I1 in Widnes					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Ingestion, inhalation, and dermal contact with contaminants (W32)	Human health (construction workers)	Temporary, Short Term Direct	Significant	H&S file, PPE, good site management, minimise excavations.	Not Significant
Ingestion, inhalation, and dermal contact with contaminants (W33)	Human health (site visitors & trespassers)	Temporary, Short Term Direct	Significant	H&S File, PPE, Good site management, minimise excavations, Site Security	Not Significant
Ingestion, inhalation, and dermal contact with contaminants (W34)	Human health (local residents)	Temporary, Short Term, Indirect	Significant	Good site management, minimise excavations, Dust Suppression.	Not Significant
Vertical migration of contaminants in areas where existing foundations are removed beneath Area B1 (W45)	Shallow groundwater	Temporary, Long Term, Direct	Significant	Leave existing foundations in-situ, backfill voids with impermeable material.	Not Significant
Migration of contaminants off-site along buried drains or services (W56)	Off-site groundwater or surface water	Temporary, Long Term, Direct and Indirect	Significant	Blocking of drains, good site management, replacement of old services, sealing of disused services / drains.	Not Significant
Migration of ground gas into excavations (W70)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant
Operation Stage					
Ingestion, inhalation, and dermal contact with contaminants (W78)	Human health (service & maintenance workers)	Temporary, Short Term, Direct	Significant	H&S File, PPE, good site management, Minimise Excavations	Not Significant
Contaminated water supplies from new buried services (W81)	Human health	Temporary, Long Term, Direct	Significant	Use of clean fill in excavations for buried water pipes, upgrade pipe material. Removal of contaminated soils from close proximity to buried water pipes.	Not Significant
Migration of contaminants along buried drains or services (W102)	Off-site groundwater or surface water	Temporary, Long Term, Indirect and Direct	Significant	Blocking of drains, good site management, replacement of old services, sealing of disused services / drains.	Not Significant

Table 14.31 (continued) – Summary of Residual Effects Arising from the Project and Common to for Areas A to C and I1 in Widnes Following Mitigation

WIDNES					
All Areas – Effects Common to Areas A, B, C, I1 in Widnes					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Operation Stage					
Migration of ground gas (W112)	Human health (site users within offices or toll booths)	Temporary, Long Term, Direct	Significant	Gas protection measures for offices and toll booths	Not Significant
Migration of ground gas into excavations (W116)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant

Table 14.32 – Summary of Residual Effects Arising from the Project Specific to Areas A and B1 Following Mitigation (continued overleaf)

WIDNES					
Effects Specific to Areas					
Area A – St. Michaels Golf Course **Area B1 –Ditton Junction**					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Migration of contaminants through groundwater to surface watercourses (W58)	Stewards Brook	Temporary, Long Term, Direct	Significant	Replace / re-instate barrier to prevent migration, good site management, minimisation of excavation or other activities that may mobilise contaminants.	Not Significant
Migration of contaminants through surface water run-off to surface watercourses (W62)	Stewards Brook	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off, physical barriers to prevent flow into Stewards Brook.	Not Significant
Operation Stage					
Vertical migration of contaminants in areas where existing foundations are removed beneath Area B1(W91)	Shallow groundwater	Temporary, Long Term, Direct	Significant	Leave existing foundations in-situ, backfill voids with impermeable material.	Not Significant

Table 14.32 (continued) – Summary of Residual Effects Arising from the Project Specific to Areas A and B1 Following Mitigation (continued overleaf)

WIDNES					
Effects Specific to Areas					
Area A – St. Michaels Golf Course **Area B1 –Ditton Junction**					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Operation Stage					
Migration of contaminants through groundwater to surface watercourses (W104)	Stewards Brook	Temporary, Long Term, Direct	Significant	Replace / re-instate barrier to prevent off-site migration, good site management, minimisation of excavation or other activities that may mobilise contaminants.	Not Significant

Table 14.33 – Summary of Residual Effects Arising from the Project Specific to Areas B2 and I1 Following Mitigation (continued overleaf)

WIDNES					
Effects Specific to Areas					
Area B2 - Gussion Transport, Anglo Blackwells and S.Evans & Sons Scrapyard **Area I1 – Gussion Transport**					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Vertical migration of contaminated groundwater along disused water wells (W39)	Groundwater in bedrock beneath Gussion	Temporary, Long Term, Direct	Significant	Search for and decommission disused well.	Not Significant
Vertical migration of free product along disused water wells (W41)	Groundwater in bedrock beneath Gussion	Temporary, Long Term, Direct	Significant	Search for and decommission disused well.	Not Significant
Migration of volatile vapours into excavations (W71)	Human health (people entering excavations)	Temporary, Short Term and Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations, LNAPL/groundwater remediation.	Not Significant
Operation Stage					
Vertical migration of contaminated groundwater along disused water wells (W85)	Groundwater in bedrock beneath Gussion	Temporary, Long Term and Direct	Significant	Search for and decommission disused well.	Not Significant
Vertical migration of free product along disused water wells (W87)	Groundwater in bedrock beneath Gussion	Temporary, Long Term and Direct	Significant	Search for and decommission disused well.	Not Significant

Table 14.33 (continued) – Summary of Residual Effects Arising from the Project Specific to Areas B2 and I1 Following Mitigation

WIDNES					
Effects Specific to Areas					
Area B2 - Gussion Transport, Anglo Blackwells and S.Evans & Sons Scrapyard **Area I1 – Gussion Transport**					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Operation Stage					
Vertical migration of contaminants in areas where existing foundations are removed (W91)	Shallow groundwater	Temporary, Long Term, Direct	Significant	Leave existing foundations in-situ, backfill voids with impermeable material.	Not Significant
Migration of volatile vapours (W113)	Human health (site users within offices or toll booths)	Temporary, Long Term Direct	Significant	Vapour protection measures for offices and toll booths, LNAPL remediation.	Not Significant
Migration of volatile vapours into excavations (W117)	Human health (people entering excavations)	Temporary, Short Term and Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations, LNAPL remediation.	Not Significant

Table 14.34 – Summary of Residual Effects Arising from the Project Specific to Area C Following Mitigation (continued overleaf)

WIDNES					
Effects Specific to Areas					
Area C – Freight Line to Thermphos					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Migration of contaminants through groundwater to surface watercourses (W59)	Bowers Brook	Temporary, Long Term, Direct and Indirect	Significant	Barriers to prevent off-site migration, DNAPL remediation (see above), possible shallow barriers / flow path management, minimisation of excavation or other activities that may mobilise contaminants. See comments in paragraphs 14.8.122 to 14.8.129 regarding cross boundary migration.	Not Significant

Table 14.34 (continued) – Summary of Residual Effects Arising from the Project Specific to Area C Following Mitigation (continued overleaf)

WIDNES					
Effects Specific to Areas					
Area C – Freight Line to Thermphos					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Migration of contaminants through surface water run-off to surface watercourses (W61)	River Mersey	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off, physical barriers to prevent flow into River Mersey.	Not Significant
Migration of contaminants through surface water run-off to surface watercourses (W63)	Bowers Brook	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off, physical barriers to prevent flow into Bowers Brook.	Not Significant
Migration of contaminants through surface water run-off to surface watercourses (W64)	St. Helens Canal	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off, physical barriers to prevent flow into St. Helens Canal.	Not Significant
Migration of volatile vapours into excavations (W71)	Human health (people entering excavations)	Temporary, Short Term and Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations, DNAPL/groundwater remediation.	Not Significant
Operation Stage					
Vertical migration of contaminants in areas where existing foundations are removed (W91)	Shallow groundwater	Temporary, Long Term Direct	Significant	Leave existing foundations in-situ, backfill voids with impermeable material.	Not Significant

Table 14.34 (continued) – Summary of Residual Effects Arising from the Project Specific to Area C Following Mitigation

WIDNES					
Effects Specific to Areas					
Area C – Freight Line to Thermphos					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Operation Stage					
Migration of contaminants through groundwater to surface watercourses (W105)	Bowers Brook	Temporary, Long Term, Direct and Indirect	Significant	DNAPL remediation (see above), possible barriers / flow path management, minimisation of excavation or other activities that may mobilise contaminants. See comments in paragraphs 14.8.122 to 14.8.129 regarding cross boundary migration.	Not Significant
Migration of volatile vapours (W113)	Human health (site users within offices or toll booths)	Temporary, Long Term, Direct	Significant	Vapour protection measures for offices and toll booths.	Not Significant
Migration of volatile vapours into excavations (W117)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant

Table 14.35 – Summary of Residual Effects Arising from the Project Specific to Area I2 Following Mitigation (continued overleaf)

WIDNES					
Effects Specific to Areas					
Area I2 – De-linking Works					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Ingestion, inhalation, and dermal contact with contaminants (W32)	Human health (construction workers)	Temporary, Short Term, Direct	Significant	H&S file, PPE, good site management, minimise excavations.	Not Significant
Ingestion, inhalation, and dermal contact with contaminants (W33)	Human health (site visitors & trespassers)	Temporary, Short Term, Direct	Significant	H&S File, PPE, Good site management, minimise excavations, Site Security	Not Significant
Ingestion, inhalation, and dermal contact with contaminants (W34)	Human health (local residents)	Temporary, Short Term, Direct	Significant	Good Site Management, minimise excavations, Dust Suppression.	Not Significant

Table 14.35 (continued) – Summary of Residual Effects Arising from the Project Specific to Area I2 Following Mitigation

WIDNES					
Effects Specific to Areas					
Area I2 – De-linking Works					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Migration of contaminants through surface water run-off to surface watercourses (W61)	River Mersey	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off.	Not Significant
Operation Stage					
No significant effects have been assessed for the Operation Stage in Area I2 because the embankments would have been removed and any existing underlying contamination would be addressed as part of future development and, therefore, would not be part of the Project.					

Table 14.36 – Summary of Residual Effects Arising from the Project Specific to Area D (Excluding Wigg Island) Following Mitigation (continued overleaf)

MERSEY ESTUARY					
Area D – River Mersey, Widnes Warth Saltmarsh and Astmoor Saltmarsh					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Ingestion, inhalation, and dermal contact with contaminants (W32)	Human health (construction workers)	Temporary, Short Term Direct	Significant	H&S file, PPE, good site management, minimise excavations.	Not Significant
Ingestion, inhalation, and dermal contact with contaminants (W33)	Human health (site visitors & trespassers)	Temporary, Short Term, Direct	Significant	H&S file, PPE, good site management, minimise excavations, site security.	Not Significant
Ingestion, inhalation, and dermal contact with contaminants (W34)	Human health (local residents)	Temporary, Short Term, Direct	Significant	Good Site Management, minimise excavations, Dust Suppression.	Not Significant
Migration of contaminants through surface water run-off to surface watercourses (W61)	River Mersey	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off, physical barriers to prevent flow into River Mersey.	Not Significant

Table 14.36 (continued) – Summary of Residual Effects Arising from the Project Specific to Area D (Excluding Wigg Island) Following Mitigation

MERSEY ESTUARY					
Area D – River Mersey, Widnes Warth Saltmarsh and Astmoor Saltmarsh					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Migration of contaminants through surface water run-off to surface watercourses (W64)	St. Helens Canal	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off, physical barriers to prevent flow into St. Helens Canal.	Not Significant
Migration of ground gas into excavations (W70)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant
Operation Stage					
Ingestion, inhalation, and dermal contact with contaminants (W78)	Human health (service & maintenance workers)	Temporary, Short Term, Direct	Significant	H&S file, PPE, good site management, minimise excavations.	Not Significant
Migration of ground gas into excavations (W116)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant

Table 14.37 – Summary of Residual Effects Arising from the Project Specific to Area D (Wigg Island) Following Mitigation (continued overleaf)

MERSEY ESTUARY					
Area D – Wigg Island					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Ingestion, inhalation, and dermal contact with contaminants (R35)	Human health (site visitors, trespassers at Wigg Island)	Temporary, Short Term, Direct	Significant	H&S file, PPE, good site management, minimise excavations, site security.	Not Significant
Ingestion, inhalation, and dermal contact with contaminants (R37)	Human health (construction workers at Wigg Island)	Temporary, Short Term, Direct	Significant	H&S file, PPE, good site management, minimise excavations.	Not Significant
Vertical migration of contaminants due to installation of piled foundations (R43)	Groundwater beneath Wigg Island	Temporary, Long Term, Indirect	Significant	Use of appropriate pile type, remove landfill material at location of pier prior to installation of piles.	Not Significant

Table 14.37 (continued) – Summary of Residual Effects Arising from the Project Specific to Area D (Wigg Island) Following Mitigation

MERSEY ESTUARY					
Area D – Wigg Island					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Migration of contaminants through surface water run-off to surface watercourses (R55)	River Mersey	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off.	Not Significant
Migration of contaminants through surface water run-off to surface watercourses (R56)	Canals	Temporary, Short Term, Direct	Significant	Good site management, minimisation of excavations, block drains on-site, control of surface water run-off.	Not Significant
Migration of ground gas into excavations at Wigg Island (R65)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant
Migration of volatile vapours into excavations at Wigg Island (R66)	Human health (people entering excavations)	Temporary, Short Term, Direct	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant
Operation Stage					
Ingestion, inhalation, and dermal contact with contaminants (R72)	Human health (service maintenance workers at Wigg Island)	Temporary, Short Term, Direct	Significant	H&S file, PPE, good site management, minimise excavations.	Not Significant
Migration of ground gas into excavations at Wigg Island (R99)	Human health (people entering excavations)	Temporary, Short Term, Indirect	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant
Migration of volatile vapours into excavations at Wigg Island (R100)	Human health (people entering excavations)	Temporary, Short Term, Indirect	Significant	H&S file, good site management, PPE, limit excavations, active ventilation of deeper excavations.	Not Significant

Table 14.38 – Summary of Residual Effects Arising from the Project Specific to Areas E and F Following Mitigation

RUNCORN					
Area E – Astmoor Industrial Estate **Area F – Bridgewater Junction**					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
Migration of contaminants through surface water run-off to surface watercourses (R56)	Canals	Temporary, Short Term, Direct	Significant	Good site management, minimise excavations, block drains on-site, control of surface water run-off.	Not Significant
Operation Stage					
No significant effects have been identified for the Operation Stage in Area E and F.					

Table 14.39 – Summary of Residual Effects Arising from the Project Specific to Areas G and H Following Mitigation

RUNCORN					
Area G - Lodge Lane Junction and Weston Link Junction **Area H – M56 Junction 12**					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Mitigation & Enhancement Measures**	**Residual Significance**
Construction Stage					
No significant effects have been identified for the Construction Stage in Areas G or H.					
Operation Stage					
No significant effects have been identified for the Operation Stage in Areas G or H.					

14.9.9 A series of potentially significant residual effects have been identified relating to contaminated groundwater where it is considered that there is an existing risk or significant effect that would remain in the Do-Nothing scenario. With the mitigation measures that are proposed it is considered that the Project will not increase the significance of these risks or effects. Options for further mitigation measures to address these existing effects have been identified, and these would need to be developed as part of an overall remediation strategy to take account of the wider contamination issues in the area. These effects are summarised in Tables 14.40 to 14.44. Given that there are existing effects these tables include the source-pathway-receptor numbers for the Do Nothing, Construction and Operation stages.

Table 14.40 – Summary of Residual Effects Relating to Existing Contamination and Common to Areas A to C and I1 in Widnes Following Mitigation

WIDNES					
All Areas – Effects Common to Areas A, B, C, I1 in Widnes					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Potential Mitigation & Enhancement Measures**	**Residual Significance**
Contamination of groundwater from continued leaching and vertical migration of contaminants (W4, W36 & W82)	Shallow groundwater	Temporary, Long Term, Indirect	Significant	The development will cap the contaminated soils and reduce infiltration. See comments in paragraphs 14.8.122 to 14.8.129 regarding cross boundary migration	Significant
Continued off-site migration of contaminated groundwater (W10, W48 & W94)	Shallow Groundwater	Temporary, Long Term, Indirect	Significant	Groundwater remediation, use of barrier systems. Avoid activities that could mobilise contaminants or introduce new pathways. See comments in paragraphs 14.8.122 to 14.8.129 regarding cross boundary migration.	Significant

Table 14.41 – Summary of Residual Effects Relating to Existing Contamination Specific to Areas B2 and I1 in Widnes Following Mitigation

Area B2 - Gussion Transport, Anglo Blackwells and S.Evans & Sons Scrapyard **Area I1 – Gussion Transport**					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Potential Mitigation & Enhancement Measures**	**Residual Significance**
Continued off-site migration of LNAPL (W12, W50 & W96)	Shallow groundwater adjacent to Gussion	Temporary, Long Term, Indirect	Significant	LNAPL remediation. See comments in paragraphs 14.8.122 to 14.8.129 regarding cross boundary migration.	Significant
Continued transfer of contaminants from LNAPL to groundwater (W14, W52 & W98)	Shallow groundwater beneath Gussion	Temporary, Long Term Indirect	Significant		Significant

Table 14.42 – Summary of Residual Effects Relating to Existing Contamination Specific to Area C in Widnes Following Mitigation

WIDNES					
Area C – Freight Line to Thermphos					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Potential Mitigation & Enhancement Measures**	**Residual Significance**
Continued off-site migration of DNAPL (W13, W51 & W97)	Shallow groundwater adjacent to CTP	Temporary, Long Term, Indirect	Significant	DNAPL remediation. See comments in paragraphs 14.8.122 to 14.8.129 regarding cross boundary migration	Significant
Continued transfer of contaminants from DNAPL to groundwater (W15, W53 & W99)	Shallow groundwater beneath CTP	Temporary, Long Term, Indirect	Significant		Significant

Table 14.43 – Summary of Residual Effects Relating to Existing Contamination Specific to Area D (Excluding Wigg Island) Following Mitigation

MERSEY ESTUARY					
Area D – River Mersey, Widnes Warth Saltmarsh and Astmoor Saltmarsh					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Potential Mitigation & Enhancement Measures**	**Residual Significance**
Contamination of groundwater from continued leaching and vertical migration of contaminants (W4, W36 & W82)	Shallow groundwater	Temporary, Long Term, Indirect	Significant	The development will not cover the contaminated soils on the saltmarshes. Groundwater remediation options have been identified if considered appropriate. See comments in paragraphs 14.8.129 to 14.8.129 regarding cross boundary migration.	Significant
Continued off-site migration of contaminated groundwater (W10, W48 & W94)	Shallow Groundwater	Temporary, Long Term, Indirect	Significant		Significant

Table 14.44 – Summary of Residual Effects Relating to Existing Contamination Specific to Area D (Wigg Island) Following Mitigation (continued overleaf)

MERSEY ESTUARY					
Area D – Wigg Island					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Potential Mitigation & Enhancement Measures**	**Residual Significance**
Contamination of groundwater from continued leaching and vertical migration of contaminants between made ground and shallow groundwater (R6, R41 & R78)	Groundwater beneath Wigg Island	Temporary, Long Term, Indirect	Significant	Reinstate landfill capping.	Significant

Table 14.44 (continued) – Summary of Residual Effects Relating to Existing Contamination Specific to Area D (Wigg Island) Following Mitigation

MERSEY ESTUARY					
Area D – Wigg Island					
Effect	**Receptor**	**Nature of Effect**	**Significance**	**Potential Mitigation & Enhancement Measures**	**Residual Significance**
Continued vertical migration of contaminated groundwater to bedrock (R9, R47 & R83)	Groundwater in bedrock beneath Wigg Island	Temporary, Long Term, Indirect	Significant	Use of appropriate pile type, remove landfill material at location of pier prior to installation of piles.	Significant
Continued off-site migration of contaminated groundwater (R11, R48 & R84)	Shallow groundwater beneath Wigg Island	Temporary, Long Term, Indirect	Significant	Use of appropriate pile type, remove landfill material at location of pier prior to installation of piles.	Significant
Continued off-site migration of contaminated groundwater (R13, R50 & R86)	Groundwater in bedrock beneath Wigg Island	Temporary, Long Term, Indirect	Significant	Use of appropriate pile type, remove landfill material at location of pier prior to installation of piles.	Significant

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