Environment Agency

A17/2b - Volume 2b: Technical Report: Contaminated Land

Transport and Works Act 1992

Boston Barrier Order

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Acting to reduce the impacts of a changing climate on people and wildlife is at the heart of everything we do.

We reduce the risks to people, properties and businesses from flooding and coastal erosion.

We protect and improve the quality of water, making sure there is enough for people, businesses, agriculture and the environment. Our work helps to ensure people can enjoy the water environment through angling and navigation.

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Quality Assurance

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Approvals

Name	*Title*	*Date*	*Version*
JD	*Contaminated Land Expert*	*12/08/2016*	*1*
EL	*EIA Project Director*	*12/08/2016*	*1*

EIA Quality Mark

This Environmental Statement, and the Environmental Impact Assessment (EIA) carried out to identify the significant environmental effects of the proposed development, was undertaken in line with the EIA Quality Mark Commitments.

The EIA Quality Mark is a voluntary scheme, operated by the Institute of Environmental Management and Assessment (IEMA), through which EIA activity is independently reviewed, on an annual basis, to ensure it delivers excellence in the following areas:

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EIA Content
EIA Presentation
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1 Introduction

1.1 Overview

1.1.1 This Report forms part of the Technical Reports (Volume 2a – 2d) that support the Boston Barrier Project Environmental Statement (ES) (Volume 1). Volume 2 reports the EIA for the Project, identifying all the predicted effects, irrespective of their significance. Whereas Volume 1 discusses only those effects, both temporary and permanent, deemed significant under the EIA regulations.

1.2 The Project

1.2.1 The purpose of the Project is to improve the standard of protection from tidal flooding. The proposals would not affect the existing standards of fluvial flood protection provided upstream within the River Witham and South Forty Foot Drain (SFFD). In January 2015 water level management (WLM) was removed from the scope of this current Project. In making the decision, the Environment Agency, Lincolnshire County Council (LCC) and Boston Borough Council (BBC) confirmed that it remains the vision to provide WLM at a later date through a standalone project and consenting process.

1.2.2 The Project would connect to the existing defences downstream of the town. The Project would consist of water-based works (the barrier structure) and land-based work (along the Haven).

1.2.3 Defences immediately downstream of the barrier structure would be improved to a 1 in 300 standard of protection as a part of the barrier structure works. This level of protection is to ensure protection against a 0.33% (1 in 300) annual probability of flooding over the 100 year project life.

1.2.4 The Project would be constructed south of the town of Boston across the area of the River Witham known as ‘the Haven’ (see ES (Volume 1): Appendix A; Figure 1.1). It would be approximately 100m downstream of Black Sluice, adjacent to the Starch Berth (on the Port of Boston (PoB) estate - left bank) and existing residential properties (along Wyberton Low Road - right bank).

1.2.5 It should be noted that, references to left and right bank of the Haven are described in a downstream facing direction. Therefore, the left bank (north side) is on the left side when facing downstream and the right bank (south side) is on the right side when facing downstream.

1.2.6 A detailed description of the Project is included in the ES (Volume 1): Chapter 2.

1.3 Purpose of assessment

1.3.1 The purpose of this contaminated land assessment is to consider the contaminated land baseline relevant to the Project and assess the potentially significant issues scoped in as part of the Project's Updated Scoping Report (2014) (outlined in Section 2.7). The assessment includes consideration of the risks to human health and environmental receptors associated with the proposed construction and operation of the Project.

1.3.2 The assessment identifies the predicted environmental effects and proposes management and mitigation measures to negate or minimise those effects.

1.3.3 Impacts of the Project on flooding are discussed in the ES (Volume 2c): Flood Risk Assessment and in the ES (Volume 2b): Surface Water and Flood Risk Technical Report.

1.3.4 Groundwater quality issues related to dredging (and to piling) are addressed in the ES (Volume 2b): Estuarine and Geomorphology Processes Technical Report.

1.4 Report structure

1.4.1 This Report comprises the following key sections:

- Methodology: Outlining the methodology used to carry out the study;
- Legislation and planning policy: Outlining the key legislation and polices relevant to the area and to the Project;
- Baseline conditions: Presenting the baseline scenario and current local environmental conditions including data on geology, hydrogeology, site history and soil, sediment and groundwater chemical laboratory data;
- Impact Assessment: Setting out likely effects on human health and environmental receptors present during construction and operation following the implementation of appropriate mitigation measures;
- Summary: Describing the predicted residual significant effects following the implementation of mitigation measures; and
- References: Containing the references and source materials relating to the contaminated land assessment.

2 Assessment methodology

2.1 Study area

2.1.1 The study area relevant to this assessment is the area of the proposed construction works, including both land-based and in-channel elements, and including all areas of proposed dredging (see ES (Volume 1), Appendix A: Figures 1.1 and 1.2). The Envirocheck Report for the area (Landmark, 2014) includes information within a 500m and 1000m buffer zone around the study area.

2.2 Sources of information

Desk study

2.2.1 Desk study information on the site history, geology and hydrogeology including potential contamination sources has been obtained by review of a Landmark Envirocheck Report (2014) for the site which includes historical maps of the area.

2.2.2 Additional baseline data has been obtained from the following sources:

- British Geological Survey (BGS) Boston Sheet 128 Solid and Drift Edition 1:50000 Geological Map, NERC (1995);
- British Geological Survey (BGS) borehole scans (available via www.BGS.co.uk);
- British Geological Survey (BGS), Geology of the country around Kings Lynn and the Wash, NERC (1994);
- The Environment Agency website (accessed March 2015);
- Interactive mapping of geographic information about the natural environment from the Multi Agency Geographic Information for the Countryside (www.magic.gov.uk); and
- Landmark "Envirocheck Report National Grid Reference: 533190, 342920," (December 2014).

2.3 Surveys

2.3.1 The survey documents reviewed comprised:

- White Young Green (WYG) Environment, "Boston Barrier Phase 3 Final Factual Ground Investigation Report," (2015);
- Mott MacDonald, "Ground Investigation Report" (2015);
- Environment Agency "Marine Monitoring Report" (2014b); and
- Jacobs/Halcrow "Boston Barrier and Haven Works, Water Quality and Sediment Chemistry" Technical Note (2011).

2.4 Historical surveys

2.4.1 Two historical phases of ground investigation (GI) have been carried out in the area surrounding the Project:

- First investigation, Soil Engineering (2010) to inform initial geotechnical design considerations at two potential barrier locations and determine the condition of existing flood defences; and
- Second investigation, WYG Environment (2012) to facilitate design and construction of a new tidal barrier.

2.4.2 Contamination testing was carried out on samples taken on land and within the river channel in the vicinity of the proposed barrier structure during these GIs.

2.4.3 The methodology and results for the sediment sampling in the channel undertaken in 2010 are reported in a technical note by Jacobs and Halcrow (2011). A summary of these results was also set out in a Marine Monitoring Report (Environment Agency, 2014b). This information has been incorporated to inform baseline chemical conditions.

2.4.4 A third phase of GI was carried out in 2014 to obtain additional information associated with the land and water based aspects of the Project. This investigation was carried out between September and November 2014 by WYG Environment (2015).

2.5 Recent survey

2.5.1 Site investigations were carried out in 2014. These included a number of boreholes and window sample locations on the land based areas which would be affected by the Project as well as sediment sampling within the Haven in the vicinity of the proposed barrier structure.

2.5.2 Environmental analysis was carried out on soil, groundwater and channel sediment samples. Results provided information on baseline contamination surrounding the site.

2.5.3 A Ground Investigation Report (see the ES (Volume 2c): Ground Investigation Report) has been completed by Mott MacDonald (2015) which includes interpretation of the chemical results, with comparison to the Contaminated Land Exposure Assessment (CLEA) Soil Guidance Values (SGVs) (Environment Agency, 2009b) for soils and Environment Quality Standards (EQS) for groundwater. The Ground Investigation Report also includes a Conceptual Site Model (CSM) and associated risk assessment.

2.6 Consultation

2.6.1 Consultation with the Environment Agency and BBC has been undertaken. Consultation with the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) was undertaken during the ground investigation (2015); they tested the sediment samples for a range of contaminants required to assess disposal off-shore. No further consultation with CEFAS has been carried out.

2.7 Scoping assessment

2.7.1 The scoping process for this Project has been carried out using information from both the Original (2011) and Updated Scoping Reports (2014) and professional judgement, based on our understanding of the baseline conditions and how the Project will be constructed and operated.

2.7.2 An Updated Scoping Opinion was received from the Secretary of State for the Environment, Food and Rural Affairs in December 2014. Where significant effects were identified in the Updated Scoping Report, these have been taken forward for further consideration in this ES. These are:

- The disposal of potentially contaminated dredged material; and
- Remobilisation of potentially contaminated sediments during dredging and operation of the barrier with the potential to affect the Haven water quality and fauna and flora.

2.7.3 Contaminated land and ground conditions were initially scoped out however certain aspects relating to contaminated land were scoped in including use of potentially contaminated dredged material and remobilisation of potentially contaminated sediments during dredging. These aspects have been addressed in this Report and also in ES (Volume 2b): Ecology and Nature Conservation Technical Report; Surface Water and Flood Risk Technical Report; and Estuarine and Geomorphology Processes Technical Report.

2.7.4 Risks to ecology are further considered in the ES (Volume 1): Chapter 10, and within the ES (Volume 2b): Ecology and Nature Conservation Technical Report.

2.8 Impact assessment methodology

2.8.1 The Environment Agency provides guidance on EIA with regard to contamination issues (Scoping Guidelines on EIA; Environment Agency, May 2002). There is also a considerable amount of guidance that has been prepared in order to assist both local authorities and practitioners in assessing the degree to which land is contaminated and deciding whether such land is contaminated within the meaning of the Part IIA of the Environmental Protection Act 1990 (as amended, hereon after, as amended for each piece of legislation where appropriate) and associated guidance.

2.8.2 The Environmental Protection Act 1990 provides a statutory definition of contaminated land: “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
- Significant pollution of controlled waters is being, or is likely to be caused.”

2.8.3 Underpinning the guidance is a source-pathway-receptor methodology, which is used to identify Significant Pollutant Linkages (SPLs). The following definitions apply:

- Source/hazard: contamination identified (exceeding corresponding guideline values);
- Pathway: the means by which the hazardous contamination can come into contact with the receptor; and
- Receptor: the entity which is vulnerable to harm from the source.

2.8.4 Without a significant pollutant linkage, the contamination source may be a hazard but does not constitute a risk to human health or the environment.

2.8.5 When the potential for contamination to cause a significant effect was assessed, the extent and nature of the potential source or sources of contamination were assessed, the pathways identified, and any sensitive receptors or resources identified and appraised. This was completed to determine the receptor value and sensitivity to contamination related impacts.

2.8.6 When a significant hazard was identified and potential sensitive receptors noted as present, then the potential effects were determined by considering the pathways whereby the hazard may affect the receptors. During the assessment it was assumed that there would be (either during or after construction) a pathway present between the source and the receptor, unless there is a clear indication that this would not be the case.

2.8.7 The strength of a pathway between a source and receptor is a function of the distance between the two and the ease or otherwise of transport along the migration pathway. For example, on sites underlain by impermeable clays, the migration pathway via groundwater would be weak, even over short distances. When sites overlie sands, the migration pathway would be stronger for receptors in close proximity to a source and weak for receptors at some distance from the source.

2.8.8 For a Project such as this where much of the ground is covered in hard surfacing, the migration pathway for soil or water contamination is generally moderate or weak. This is because the hard surfacing breaks any direct contact pathways associated with human health and reduces or minimises the extent of infiltration and mobilisation of any contamination bound to soils, which could have an impact on environmental receptors.

2.8.9 The pathway is invariably strong for construction workers on contaminated sites, because they are likely to be in close proximity to the soils, particularly during ground works. However, the effect may be weaker as the effects are acute (short term), as opposed to being chronic (long term).

2.8.10 The combination of the sensitivity of the receptor and the magnitude of the impact was used to provide an indication of the level of contamination risk on the site and the nature and severity of possible effects.

2.8.11 The following sensitivity criteria in Table 2.1 were derived to take into account the nature of the receptor as well as the period of exposure. The sensitivity of the receptor/resource is based on the value of the feature. The categories were derived based on standards and targets set by governmental authorities such as Natural England and the Environment Agency and advisory bodies, such as the Construction Industry Research and Information Association (CIRIA).

Table 2.1: Scale for evaluating the sensitivity of receptors (to land contamination)

Receptor Sensitivity	Low	Moderate	High
Construction Workers	Minimal construction works	Limited construction works	Intensive Construction Works
Future Site Users	Industrial, infrastructure, warehouses, car parks	Commercial, open spaces	Residential land use, allotments
Controlled Waters (ground or surface waters)	Controlled waters with limited potable use, or limited input to sensitive or important ecosystems. Surface water with poor ecological quality.	Used for public water supplies, private water supplies. Surface water with good to moderate ecological quality.	Water resources that perform a major function in relation to nationally protected sites (SSSI). Surface water with high ecological quality.
Built Environment	Infrastructure (e.g. Roads, railways, tramways)	Sites with a local interest for education or cultural appreciation	Sites of international importance, World Heritage Sites, Scheduled monuments

Source: Mott MacDonald, 2016

2.8.12 Impacts of contaminated land on the receptors were assessed taking into account the magnitude. This was expressed in terms of severity (high, moderate and low). The following qualitative descriptions of magnitude of impact shown in Table 2.2, are based on CIRIA C552 (CIRIA, 2001), the General Quality Assessment (GQA) Scheme, Source protection zones and published Contaminated Land Reports (CLRs), Technical Reports (TRs) and Science Reports (SRs).

Table 2.2: Scale for magnitude with respect to impacts from land contamination

Magnitude	Definition
High	Previous or ongoing activities on or near to a site where severe harm to a defined receptor is very likely; Site investigation data indicating contamination on many sites affected by current or former uses. Quantitative or qualitative risk assessment data estimating a significant likelihood of adverse effects from exposure to pollutants in the environment; and Loss of special characteristics of a water resource. Change in GQA grade, pollution of potable source, severe flood risk, loss of fisheries. Any pollution inside Zone 1 or of a groundwater protection zone of special interest.
Moderate	Previous or ongoing activity where harm to a defined receptor is possible but severe harm is unlikely; Site investigation data indicating moderate contamination. Quantitative or qualitative risk assessment data estimating medium risk of adverse effects from exposure to

Magnitude	Definition
	pollutants in the environment; and Impact on water resources. Reduction in the production of fisheries, moderate changes insufficient to reduce water quality.
Low	Greenfield site or previous ongoing activities where harm to a defined receptor is unlikely; Site investigation data indicating significant contamination is unlikely. Quantitative or qualitative risk assessment data estimating low likelihood of adverse effects from exposure to pollutants in the environment; and Minor impact insufficient to affect the use or characteristics of the water resource.

Source: Mott MacDonald, 2016

2.8.13 The likely severity of the effects were assessed using the matrix in Table 2.3, in conjunction with professional judgement to consider any site specific factors that were considered relevant.

Table 2.3: Severity of effects

Magnitude of Impact	Sensitivity of Receptor		
	Low	**Moderate**	**High**
Low	1	2	3
Moderate	2	3	4
High	3	4	5

Source: Mott MacDonald, 2016

2.8.14 A descriptive meaning for each of the five points on the severity of effects scale and the corresponding significance of the effect is detailed in Table 2.4. Indicative examples of potential effects for each scale point are included for illustration (adapted from CIRIA publication C552 (CIRIA, 2001)).

Table 2.4: Significance criteria for land contamination

Scale Point	Description and examples		Significance
1	Negligible	No discernible negative effects	Not significant
2	Slight	Measurable change in attribute, but of limited size/proportion. No permanent health effects on humans Minor low-level and localised contamination of on-site soils	
3	Minor	Easily preventable, non-permanent health effects on humans Minor low-level and localised contamination of on-site soils Easily repairable damage to buildings / infrastructure	

Scale Point	Description and examples		Significance
4	Moderate	Medium / long term (chronic) risk to human health. Moderate damage to buildings /.infrastructure (on or off site) including services infrastructure impairing their function. Contamination of off-site soils.	Significant
5	Major	Short term (acute) risk to human health. Damage (including catastrophic) to buildings / infrastructure including the services infrastructure (e.g. explosion). Generation of significant quantities for excavated soils for disposal to landfill.	

Source: Mott MacDonald, 2016

2.9 Cumulative effects of contaminated land

2.9.1 Cumulative effects result from the additional changes to potential contaminated land caused by the Project, in conjunction with other developments which exist or are likely to take place in the future. These may include:

- Other examples of the same type of development; and
- Different types of development within or proposed for within the study area.

2.9.2 The combined (in-combination) effects that may arise as a result of the individual effects from various elements within the Project do not apply for Contaminated Land as the impacts from land contamination are localised in discrete areas. The effects of contaminated land on water resources may, however, include in-combination effects. These are discussed further in the surface water chapter.

2.9.3 For the purpose of this assessment, cumulative effects would include:

- Schemes with planning consent; and
- Schemes which have been submitted for planning approval but where the application has not been determined.

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3 Legislation and planning policy

3.1 Legislative requirements

3.1.1 The main legislative framework regarding geology and soils (including contaminated land) is set by the following Acts and Regulations:

Land based

3.1.2 The main legislative framework regarding land based resources is set by the following Acts and Regulations;

- Wildlife and Countryside Act 1981 and (Amendment) Act 1985;
- Agriculture Act 1986;
- Environmental Protection Act 1990;
- Town and Country Planning Act 1990;
- Environmental Protection (Duty of Care) Regulations 1991;
- Landfill Directive 1999/31/EC 1999;
- Control of Pollution (Oil Storage) (England) Regulations 2001;
- Control of Substances Hazardous to Human Health 2002 ;
- Landfill (England and Wales) Regulations 2002;
- Hazardous Waste (England and Wales) Regulations 2005;
- Contaminated Land (England) Regulations 2006;
- Construction (Design and Management Regulations) 2015; and
- Environmental Permitting Regulations (England and Wales) 2010.

Part IIA of the Environmental Protection Act 1990 (EPA 1990)

3.1.3 The statutory process for dealing with contaminated land in England and Wales is set out in Part IIA of the Environmental Protection Act 1990 (EPA 1990). Part IIA sets in place a regime whereby contaminated land can be identified, a decision made as to how the land would be remediated and where responsibility for this would fall. The Act sets out categories for potentially contaminated sites from Category 4, describing land that is not contaminated land, in the legal sense to Category 1, describing land where there is a significant possibility of significant harm. The primary legislation is supported by a number of secondary legislative instruments including the Contaminated Land (England) Regulations 2006 and Defra Circular 01/2006 'Contaminated Land'.

Town and Country Planning Act 1990

3.1.4 The Town and Country Planning Act 1990 provides local authorities with the ability to require developers to investigate contamination and, if necessary, remediate the land.

3.1.5 There are also a number of waste related regulations which serve to protect soils from contamination by waste management:

- Hazardous Waste (England and Wales) Regulations 2005;
- Environmental Protection (Duty of care) Regulations 1991;

- Waste Management Licensing Regulations 1994;
- Landfill Directive 1999; and
- Landfill (England and Wales) Regulations 2002.

3.1.6 Under the Control of Substances Hazardous to Health Regulations 2002 and the Construction and Design Management Regulations 1994, where a developer knows or suspects the presence of contaminated soil, provision should be made to ensure that risks to the public and site workers are minimised.

Water based

3.1.7 The main legislative framework regarding water resources is set by the following Acts and Regulations;

- Water Framework Directive (2000/60/EC);
- Water Act 2003;
- Protection of Groundwater against Pollution and Deterioration (2006/118/EC); and
- Water Resources Act 1991 (1991) and Amendment 2009.

Environmental Permitting Regulations 2010

3.1.8 The Environmental Permitting Regulations 2010 regulate pollution control by requiring permits for emissions to, for example, air and water. During construction of the Project, there may be requirements for environmental permits if dewatering of excavations or re-use of soils is required.

3.2 Planning policy

3.2.1 It has been noted that the South East Lincolnshire Local Plan 2011-2036 was submitted as a draft for Public Consultation between January and April 2016. As this Plan is still a draft, it currently carries a limited material weight, but reference the polices relevant to this Report are outlined below:

3.2.2 Planning policies which are of direct relevance to geology, soils and contaminated land are described below.

3.2.3 National Planning Policy Framework

- The National Planning Policy Framework (NPPF) attaches importance to contributing to and enhancing the natural and local environment by:
  - Protecting and enhancing valued landscapes, geological conservation interests and soils;
  - Recognising the wider benefits of ecosystem services;
  - Minimising impacts on biodiversity and providing net gains in biodiversity where possible;

- contributing to the Government's commitment to halt the overall decline in biodiversity, by establishing coherent ecological networks that are more resilient to current and future pressures;
- Preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability; and
- Remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

3.2.4 The main paragraphs noted in the NPPF relating to land contamination are Paragraphs 120, 121 and 122 which provide a framework with which unacceptable risks from pollution to human or environmental health must be accounted for, with remediation as appropriate. Reference should be made to Part 2A of the EPA. The NPPF also states what the focus of the local planning authority should be when considering if land is acceptable for the proposed use.

Boston Borough Local Plan (1999)

3.2.5 The Boston Local Plan (1999) sets out the planning policies and proposals for Boston Borough. The main items related to the Project are:

- Item G4 - planning permission will not be granted for developments which will have an adverse effect on the water environment, or the quality of surface or groundwater. Contamination of the surface and groundwater must be prevented to protect these resources; and
- Item G8 - planning permission will not be granted for developments which will have an adverse effect upon the quality of air or soil.

South East Lincolnshire Local Plan (2011 – 2036)

3.2.6 It has been noted that the South East Lincolnshire Local Plan 2011-2036 was submitted as a draft for Public Consultation between January and April 2016. As this Plan is still a draft, it currently carries a limited material weight, but reference the polices relevant to this Report are outlined below:

- Policy 25: The Natural Environment; and
- Policy 27: Pollution.

3.3 Guidance

Land based

3.3.1 Procedures are set out in the Environment Agency's Contaminated Land Reports (CLR), specifically CLR 11, for completion of preliminary contaminated land risk assessment and the development of a conceptual model. The conceptual model is described in terms of the

contaminant sources, transport pathways and possible receptors that may be present, and the potential pollutant linkages between them, as defined in the relevant legislation and guidance.

3.3.2 Contaminated land risk assessment procedure including the methodology for the classification of risk is set out in CIRIA Report C552 (CIRIA, 2001).

3.4 Soil assessment

3.4.1 For the assessment of existing soil data, current published UK screening criteria have been used to compare the chemical concentrations to. The screening criteria include the Department for Environment, Food and Rural Affairs (Defra), which has published revised Statutory Guidance (SG) for categorising sites on the basis of contaminated land in accordance with Part 2A of the Environmental Protection Act 1990 (Defra, 2012a). A methodology for deriving suitable screening levels was presented by Defra in conjunction with Contaminated Land Applications in Real Environments in 2014 (CL:AIRE, 2014). Category 4 screening levels (C4SLs) have been derived for six contaminants to date. They act as guidance values to determine if sites fall into Category 4 of Part 2A. Category 4 refers to sites that pose no risk of possibility of significant harm.

3.4.2 In addition to the C4SLs, Land Quality Management (LQM) has developed screening criteria for a greater number of determinants, following a similar methodology to that used to derive the Environment Agency's Soil Guidance Values (SGVs). The SGVs were produced using the contaminated land exposure assessment (CLEA) and LQM apply a similar approach to defining the 'Suitable for Use' levels (S4ULs) for residential and commercial land uses. These represent a tolerable risk level and therefore are generally less conservative than the existing Soil Guidance Values (SGVs) but are currently widely used for the assessment of human health risks. The S4ULs were released for use in 2014.

3.5 Controlled waters risk assessment

3.5.1 Risks to the aqueous environment (groundwater and surface water) are generally assessed in the UK by reference to the Environment Agency's Remedial Targets Methodology Hydrogeological Risk Assessment for Land Contamination (Environment Agency, 2006).

3.5.2 This allows remedial target concentrations for leachate extracts and groundwater to be derived for selected contaminants. The methodology is a tiered approach, with a remedial target being derived at the end of each tier, which would provide sufficient protection to controlled water resources.

3.5.3 The Environmental Permitting Regulations (2010) aim to protect groundwater from pollution by controlling the inputs of potentially harmful and polluting substances. The Regulations implement the Water Framework Directive (2000/60/EC) and the Groundwater Directive on

the Protection of Groundwater against Pollution and Deterioration (2006/118/EC). Substances controlled under these Regulations fall into:

- Hazardous substances (H) - the most toxic and must be prevented from entering groundwater; and
- Non-hazardous pollutants (NH) - less toxic but could be harmful to groundwater, and the entry of these substances into groundwater must be limited.

3.6 Sediment assessment

3.6.1 CEFAS has set out Action Levels 1 and 2 which are generally used to assess dredged material and its suitability for disposal to sea.

3.6.2 Canadian sediment guidance values (CCME, 1999) are used to assess the potential impacts of sediment quality on the aquatic environment as there are currently no UK guidance values available. The guidelines have Threshold Effect Levels (TEL) and Probable Effect Levels (PEL).

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4 Baseline Conditions

4.1 Introduction

Geology

4.1.1 Discrepancies exist between the geological sequence published by British Geological Survey (BGS) in the geological maps and memoirs and the geological sequence found in historical boreholes and previous ground investigations.

4.1.2 The 1:50,000 paper geological map of Boston and the online geology viewer show that the bedrock geology has a shallow dip to the north east and is comprised of Oxfordian Age Ampthill Clay Formation (of the Ancholme Clay Group) which is a mudstone.

4.1.3 Kimmeridge Clay (also part of the Ancholme Clay Group) which overlies the Ampthill Clay is shown on the geological map to outcrop 4km north east of the site. The superficial geology specified on the paper geological map comprises Barroway Drove Beds. The online BGS resources confirm the paper geological map with regard to the solid geology, although the superficial deposits are described as 'Tidal Flat' deposits.

4.1.4 Shallow borehole records from the site identify that the superficial geology comprise Alluvial deposits. Underlying the Alluvium is Glacial Till which directly overlies Kimmeridge Clay. There is no mention in the records of Ampthill Clay which may not have been encountered in shallow boreholes (as presented in the ES (Volume 2c): Ground Investigation Report: Drawing 105-Rev 3; Project No. A081319-1). Typical descriptions of all strata encountered during the 2014 ground investigation, as presented in the ES (Volume 2c): Ground Investigation Report at the site are presented in Table 4.1.

Table 4.1: Summary of strata encountered during ground investigation

Strata	North eastern area (Knuckle)	Left Bank (PoB)	River Witham	Right bank	Northern access road
Made ground	Sandy silty GRAVEL overlying very soft to soft sandy gravelly CLAY	Hardstanding overlying sandy GRAVEL which in turn overlies gravelly clayey SAND and then gravelly sandy silty CLAY. The gravel component comprises mixed material of brick, flint, quartzite, sandstone, metal, glass, coal, chalk.	N/A	Topsoil overlying alternating layers of gravelly clayey SILT and soft silty CLAY	Made ground material in PO5 typically comprises gravel overlying clay. The gravel typically comprises mixed material and has been described in the borehole logs as well compacted
Alluvium	Soft silty CLAY and clayey SILT with varying minor	Soft CLAY but there is also loose sand and silt present across the area but	Very soft silty CLAY	Clayey SILT and silty CLAY with organic material and	Silty CLAY becoming gravelly sandy CLAY

Strata	North eastern area (Knuckle)	Left Bank (PoB)	River Witham	Right bank	Northern access road
	constituents and gravel of fine to coarse sub angular to sub rounded mudstone, flint, chalk and wood.	not laterally continuous.		peat	
Glacial Till	Firm to stiff becoming very stiff gravelly CLAY. Gravels comprise chalk and flint.				
Kimmeridge Clay	Extremely weak mudstone				

Source: Mott MacDonald Ground Investigation Report 2015 (ES (Volume 2c): Ground Investigation Report)

4.1.5 Table 4.2 shows the typical thickness of the strata across the site as encountered during the 2014 GI. Cross sections are presented in the ES (Volume 2c): Ground Investigation Report.

Table 4.2: Typical strata thicknesses across the site

Strata	Typical depth to top (m bgl)	Typical thickness (m)
Made ground	Ground level	1.0 - 6.6
Alluvium	1.0 – 6.6	2.8 – 6.7
Glacial Till	7.5 – 9.2	18.5
Kimmeridge Clay	Base not proven	

Source: Mott MacDonald Ground Investigation Report 2015 (ES (Volume 2c): Ground Investigation Report)

Soils

4.1.6 Natural soils in the area of the Project comprise ‘loamy and clayey soils of coastal flats with naturally high groundwater’ (MAGIC, 2015). These soils are considered to be lime rich with moderate fertility.

4.1.7 The agricultural classification of this area is ‘urban’ suggesting low sensitivity of soils. Due to the urban nature of the area, presence of made ground material across the area is likely (Mott MacDonald, 2016).

4.2 Hydrogeology

4.2.1 Hydrogeological mapping (Landmark, 2014) shows that the Alluvium and Glacial Till that underlie the site are classified by the Environment Agency as Unproductive Strata; defined as rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

4.2.2 The Envirocheck Report also indicates that within 1km of the study area there are:

- No groundwater abstractions; and
- No Source Protection Zones.

4.3 Hydrology

4.3.1 The River Witham is a tidal river, which is named 'the Haven' in the area in front of the PoB. The works associated with the Project would be established on either side of the river and within the Channel. The Envirocheck Report (Landmark, 2014) designates the entire area as liable to 'extreme flooding from rivers or sea without defences (Zone 2)'. Existing flood defences run from the tidal limit at Grand Sluice, through the town of Boston and to the mouth of the Haven. Coastal defences continue in The Wash and around the Lincolnshire cost.

4.3.2 The Updated Scoping Report (Environment Agency, 2014a) states that the high water spring tides are higher than the ground level around the site which leads to tidal flooding. The risk of tidal flooding in Boston is far greater than the risk of fluvial flooding.

4.3.3 The SFFD flows into the Haven through the Black Sluice which is upstream of the Project. Downstream of the barrier location, the Maud Foster Drain flows into the Haven through the Maud Foster Sluice.

4.3.4 This area of the Haven is designated as having moderate ecological quality by the Environment Agency based on the River Basin Management Plan and is reported to fail chemical quality analysis (Environment Agency website, 2015).

4.4 Site history

4.4.1 Historical maps show the development of the port area from 1888 (Landmark, 2014). The port was built in 1884, prior to the publication of the first edition of the OS maps of the area.

4.4.2 Detailed information on the site history is included in the ES (Volume 2c): Ground Investigation Report. The locations have been described in relation to Package Orders, as set out in the ES (Volume 2c): Ground Investigation Report. The most pertinent historical developments relating to potential contamination sources are shown in Table 4.3.

Table 4.3: Potential contamination sources based upon historical land use

Package Order	Location	Year	Potentially contaminative land use
P01	Centre of the knuckle	1888	Dock Railway - potential for leaks and spills of oils and hydrocarbons from train use.
P01	Approximately 200m to the north east of the knuckle	1906	Iron Works – potential associated contamination may comprise metals, cyanides, sulphides, solvents and coal tars.
P01	Northern edge of Wet Dock entrance approximately 100m	1938	Railway sidings (potential contaminants as above).

Package Order	Location	Year	Potentially contaminative land use
	north of the knuckle		
P02	Approximately 100m north	1888	Saw Mill located on PoB site, potential contaminants may include creosotes, hydrocarbons and metals.
P02	Within far western area of P02 and adjacent to the west of P02.	1956	Potential infilling of reservoir behind public baths. Unknown materials used for infill therefore potential for contamination.
P04	Adjacent to embankment in western area of the scheme. Area of existing oil depot.	1938	Four circular structures, suspected tanks. This area of the site was not labelled therefore it is not clear what the tanks were used for. Uses may have been oil/ fuel storage.
P05	Southern area of P05 approximately 100m to the west of Boston Dock.	1888	Dock Railway (potential contaminants as above)
P05	Southern area of P05, 100m south west of Boston Dock.	1906	Potential infilled reservoir. Unknown materials used for infill therefore potential for contamination.
P05	To east of P05, approximately 70m to the north east of Boston Dock.	1906	Hydraulic Engine House. Potential for storage, spills and leaks of hydraulic oils.

Source: Landmark (2014)

Boston Borough Council historical maps

4.4.3 BBC has provided historical planning drawings for the PoB area which have been reviewed. The main findings in terms of contamination sources at the site are:

- Aggregate depot located in the south of the PoB (2002);
- Ammonium nitrate storage adjacent in the south of the dock area (2003);
- Timber drying kiln in western area of the site (2006); and
- Hazardous substance storage of ammonium nitrate in south eastern area of the PoB (2009).

4.5 Landfill

4.5.1 A historical landfill site lies approximately 230m to the north west of the left bank, in the area of the proposed northern access road. The landfill site was called Bath Garden Area and the records presented in the Envirocheck Report (Landmark, 2014) and Environment Agency records (the Environment Agency website, 2014) indicate that this received inert waste.

4.6 Trade directory entries

4.6.1 The Envirocheck Report (Landmark, 2014) identifies a number of industrial uses in the surrounding area of the site. A summary of the active entries within 250m of the site have been summarised in Table 4.4.

Table 4.4: Active trade directory entries within 250m of the site

Package Order	Industrial land use	Location and distance from the site (m)
P02	Agricultural merchants	Adjacent to the north west of P02
P04	Distribution services	Approximately 200m south of the centre of P04
P04	Oil fuel distributers	Approximately 100m to the south of the western end of P04
P05	Agricultural merchants	Adjacent to the northern end of PO5

Source: Landmark, 2014

Hazardous substances

4.6.2 The PoB holds a 'hazardous substances consent' for ammonium nitrate and its compounds (Landmark, 2014). There are no other known hazardous substances consents associated with the PoB.

Potential sources of contamination

4.6.3 There is potential for contamination to be present at the site and surrounding area from historical and current industrial uses. The main potentially contaminative uses include;

- Area of the Dock where the dock railway and hydraulic engine house were present;
- Industrial activities in the surrounding area such as a Saw Mill and Iron Works;
- Possible presence of above/ below ground tanks;
- An oil depot;
- Existing electricity substation; and
- Infilled historical channels and construction and demolition activities.

4.6.4 Based upon the Department of the Environment Industry Profile for dockyards/docklands, potential contaminants at a dockyard include heavy metals/metalloids, sulphide, sulphate, cyanide, hydrocarbons, phenols, creosote, asbestos, ammonia and its derivatives and solvents (Department of the Environment, 1995).

4.6.5 The presence of the historical landfill site west of the proposed northern access road suggests potential for contamination. There is the potential for variable waste material to be present at the former landfill site.

4.7 Survey information

Ground investigation summary

4.7.1 Details of the ground investigation completed on the land side area are provided in the ES (Volume 2c): Ground Investigation Report. The Ground Investigation Report included a conceptual site model (CSM) and risk assessment with respect to contaminated land following procedures set out in CLR11.

4.7.2 The ground investigation was completed based upon a scope provided by Halcrow. The Ground Investigation Report identified the risk from unexploded ordnance as moderate to low (Halcrow, 2011). A further memo report assessed the risk at this site as low (Halcrow, 2011). Based upon this, the mitigation measures recommended during ground investigation comprised a tool box talk at the beginning of the works by a specialist. This should also be completed if further ground investigation is undertaken at the site.

4.7.3 The environmental sampling was completed on a non-targeted basis with the aim of obtaining an appropriate sampling density over the land based areas and within the river channel. The location of a number of the exploratory holes was dictated by presence of underground services, obstructions and access limitations during the investigation. The samples were analysed by Jones Environmental Laboratory who are MCERTS accredited. The sediment sampling location plan (see Appendix A: Figure 4.1 of this Report) shows the location of the exploratory holes and sediment samples collected.

4.7.4 Localised areas of contamination were identified in the soils at the site through visual inspection and laboratory analysis. Contaminants included asbestos, metals and PAH within the made ground. The presence of Total Petroleum Hydrocarbons (TPH) is noted to be widespread across the site at low concentrations, generally marginally above detection and restricted to the made ground. The made ground was shown to be variable in depth and is present up to depths of 6.6m.

4.7.5 Presence of TPH and PAH identified along the northern access road may be related to the historical landfill in the area. The following points were noted from the ground investigation works:

- Presence of TPH was identified in the made ground along the route of the flood defence wall on the left bank;
- Presence of asbestos-containing material was noted in the made ground in one location on the left bank to the east of the tidal barrier, laboratory analysis identified chrysotile cement. There is the potential for further asbestos to be present due to the historical use of the site;
- The borehole logs record the presence of blue billy in the made ground across the site, the source of this material is not clear as it is usually found as a by-product of gasworks sites. The historical plans presented in the Envirocheck Report do not identify the

presence of any gasworks in the immediate surrounding area. Blue billy comprises cyanide, although cyanide was not identified in the majority of soil samples in concentrations above the laboratory detection limit, with the exception of three samples (2.1 – 5.7mg/kg); only one of which was in an area recorded as having blue billy present;

- The results of soil analysis were also assessed using the Hazwasteonline tool. This tool uses the soil analysis to identify potentially hazardous waste, if the material was removed for disposal during construction. The tool only distinguishes between hazardous and non-hazardous waste, it does not identify areas of inert waste. The majority of the soil samples tested comprised non-hazardous waste with 13 samples comprising hazardous waste due to elevated concentrations of cyanide, polycyclic aromatic hydrocarbons (PAH) and metals. Asbestos containing material was encountered in one location (as above). Asbestos may be classified as hazardous waste;
- Waste Acceptance Criteria (WAC) testing should be undertaken by waste producers for all waste destined for disposal once it has been classified as hazardous or non-hazardous (Environment Agency, 2013). WAC testing was not completed during the ground investigation as requirements for disposal of material or areas for disposal had not been confirmed. There is a requirement to re-use the majority of excavated material and therefore classifying it as a waste would not have been appropriate at this time. It is recommended that WAC testing is completed during construction if material requires disposal to ensure representative results;
- Whilst there is considered to be no mobile groundwater present, water has been collected from the Alluvium and Glacial Till. This water is considered to be an accumulation of soil leachate or perched water in granular lenses which may represent a potential source of contamination;
- The water in the Alluvium and Glacial Till has been shown to be impacted by low level PAH contaminants and metals in hotspots. The lack of TPH contamination in the water in the Alluvium and Glacial Till suggests that it is largely confined to the made ground soil at the site and does not readily leach into the superficial deposits; and
- Nine ground gas monitoring standpipes were monitored at the site on seven occasions between October 2014 and December 2014. One of these visits was completed in low atmospheric pressure conditions (i.e. below 1000mb). Ground gas monitoring identified elevated concentrations of methane in the north eastern area (knuckle) and elevated concentrations of carbon dioxide along the left bank in the area of the proposed control building. The results have been assessed according to CIRIA C665 guidance where a Characteristic Situation (CS) is identified based upon the maximum gas concentration and the maximum gas flow rate. A CS2 was identified on a number of occasions at the location of the control building due to presence of elevated methane concentrations (1.0% - 52%) within the Alluvium and Glacial Till deposits. It is considered likely that this is due to the presence of peat deposits within the alluvial materials.

4.7.6 During the 2014 ground investigation, sediment sampling was undertaken at eight locations within the Haven. The samples were taken in order to provide a good sampling density in the area of proposed dredging and to supplement data obtained in the previous ground investigations. The samples were tested by CEFAS to assess the potential for disposal of the

sediments to sea. The chemical laboratory results have been compared to CEFAS Action Levels 1 and 2 which are generally used to assess dredged material and its suitability for disposal to sea.

- Action Level 1 – Sediment with contaminant concentrations below AL1 are likely to be allowable for disposal at sea;
- Action Level 1 to 2 – Sediment with contaminant concentrations between AL1 and AL2 require further testing before a decision can be made; and
- Action Level 2 – Sediment with contaminant concentrations above AL2 is unsuitable for disposal at sea and may require disposal via landfill.

4.7.7 The results are summarised below:

- Arsenic was present in concentrations between AL1 and AL2 in three samples;
- Chromium was present in concentrations between AL1 and AL2 in seven samples;
- Nickel was present in concentrations between AL1 and AL2 in twelve samples;
- Lead was present in concentrations between AL1 and AL2 in three samples;
- Zinc was present in concentrations between AL1 and AL2 in two samples; and
- PAHs were present between AL1 and AL2 in the majority of samples tested.

4.7.8 Any reuse or disposal options would require re-assessment of the sediment quality to determine its suitability for use. As an initial assessment, for protection of human health, the available results have been compared to the S4UL guidance values for commercial land use and public open space (park). For the protection of aquatic life the results have been compared to the Canadian Sediment Quality probable effect levels (PEL) – lowest concentration of a substance that is known to have an adverse effect on the aquatic environment (CCME,1999), in the absence of UK values. In summary the results show:

- No exceedances of the S4UL values for commercial or public open space (park) land use; and
- Exceedances of metals including lead, copper, mercury and zinc when compared to Canadian sediment quality values.

4.7.9 It should be noted that the sediment testing was limited in terms of the number of contaminants as the CEFAS analysis included a specific suite for disposal to sea only. This means that there are contaminants that have not been included in the analysis, which would be required in order to conduct a full assessment of the risks to human health, should the material be assessed for reuse. Additional testing is required to inform the re-use options identified above. A risk assessment for the reuse of the sediment would be completed following the additional testing and identification of viable options, which would then be provided to the Environment Agency for review.

Sediment sampling 2010

4.7.10 During 2010 three intertidal and three subtidal sediment sites were sampled within the River Witham (Jacobs/ Halcrow Technical Note (2011)). The Technical Note compares the

sediment laboratory results to the following Environment Canada (CCME, 1999) guideline values to assess potential impacts to the aquatic environment:

- Threshold effect levels (TEL) – concentration below which contaminants are not considered to represent significant hazards to the aquatic environment; and
- Probable effect levels (PEL) – lowest concentration of a substance that is known to have an adverse effect on the aquatic environment (CCME, 1999).

4.7.11 The results are presented in the Jacobs/ Halcrow Technical Note (2011) and are summarised below:

- Arsenic exceeded the TEL at all six sampling locations;
- Sites with fine sediments identified exceedances of the TEL for zinc, copper, lead and nickel;
- No metals exceeded the PEL;
- Polycyclic Aromatic Hydrocarbons (PAH) were present above their TELs; and
- Naphthalene was present above the PEL in one location.

4.7.12 It is considered that the contaminants identified above are consistent with an estuary and a working dock area.

Sediment sampling 2012

4.7.13 The 2012 ground investigation at the site comprised 14 overwater boreholes focused around the area of the tidal barrier. These included sampling of the sediment/ soils at depths between 0m and 5m.

4.7.14 The results of the laboratory analysis are included in the WYG Factual Report (2014). Comparison of the results with the Canadian Sediment quality PEL identified exceedances of metals including copper, lead and mercury. Sediment sampling locations are shown in, Appendix A of this Report: Figure 4.1.

Conceptual site model

4.7.15 A conceptual site model was completed for the land based area in the ES (Volume 2c): Ground Investigation Report. The conceptual site model is summarised and updated below to include the sediments from dredging operations as a source. The potentially active source-pathway-receptor linkages at the site during construction and operation of the scheme are included below.

Construction

4.7.16 The identified potential pollutant linkages during construction are summarised in Table 4.5.

Table 4.5: Conceptual site model during construction

Source	Pathway	Receptor
Existing made ground up to 6.6m thick. Identified presence of widespread hydrocarbons and localised metals, PAH and one positive identification of asbestos containing material. Presence of perched water (leachate) identified in the underlying Glacial Till or Alluvium. Historical landfill adjacent to the northern access road. Identified presence of ground gas. Dredged sediment stored on land during drying. Potential leaks and spills during construction.	Direct contact and inhalation and ingestion of contaminated soil, sediment and water.	Construction workers
Existing made ground up to 6.6m thick. Presence of widespread hydrocarbons and localised metals, PAH and one positive identification of asbestos containing material.	Direct contact inhalation of dust or direct contact with perched water migrating off-site.	Adjacent site users
Existing made ground up to 6.6m thick. Presence of widespread hydrocarbons and localised metals, PAH and one positive identification of asbestos containing material. Potential leaks and spills during construction. Disturbance of sediment and storage of sediment on land during drying.	Surface water run-off or migration of perched water / leachate. Transport through manmade pathways (sheet piled walls).	The Haven

Operation

4.7.17 The identified potential pollutant linkages during operation are summarised in Table 4.6.

Table 4.6: Potentially active pollutant linkages identified

Source	Pathway	Receptor
Presence of ground gas.	Accumulation in proposed control buildings and subsequent inhalation. Explosive risk, potential damage to buildings if accumulation of methane occurs.	Site end users
Potential re-use of dredged sediment (off-site) and made ground.	Surface run-off Leaching Transport through manmade pathways (sheet piled walls)	The Haven
	Direct contact, ingestion, inhalation	Site end users

5 Impact assessment

5.1 Introduction

5.1.1 The impact assessment methodology is set out in Section 2.8 above.

5.2 Construction assessments assumptions and limitations

5.2.1 This contaminated land assessment has been carried out using the Project design and construction methods described in the ES (Volume 1): Chapter 2 and shown in the ES (Volume 1): Appendix A; Figures 2.1 to 2.5. The following assumptions have been made:

- Construction would be carried out in line with best practice and under an Environmental Action Plan (EAP);
- Construction dust would be carefully monitored using best practice techniques to minimise impacts on the surrounding land users;
- Construction workers would wear Personal Protective Equipment (PPE) during intrusive works;
- Barrier control building would be designed to include ground gas protection measures which would be agreed with the BBC and the Environment Agency. Installations would be tested and validated by an appropriately qualified person;
- Surface water run-off would be managed in line with best practice during any dewatering operations;
- Materials re-use would be completed under a materials management plan during the detailed design phase of works, a copy of which would be submitted to the Environment Agency for review upon completion;
- Capital dredging operations during operation of the Project would be completed by the Environment Agency with maintenance dredging would continue as the current situation and be carried out under the existing PoB licence following construction;
- Proposed change of Barrier operation level from 5.6mAOD to 5.3mAOD +/-0.2m is anticipated to have no effect on ground contamination; and
- Projected 24 hours a day, 7 days per week construction activity at the Wet Dock Entrance would not affect local ground contamination.

5.3 Construction impact assessment

Construction workers

5.3.1 During construction, the main impacts to human health would be related to the construction workers as they would be in direct contact with the made ground and any water within the deeper strata. Construction workers are also likely to be in direct contact with dredged sediment and associated leachate, as the sediment is likely to be stored on site during drying. There is the potential for drying sediments to become airborne during this period; this would be managed through monitoring and dust suppression, if required. These impacts are considered to be temporary.

5.3.2 Ground gas may accumulate in any excavations required for foundation construction or for construction of the flood walls and construction workers in these areas may be impacted via inhalation if gas accumulates. These impacts are considered to be temporary.

5.3.3 The ground investigation undertaken in 2014 has identified presence of contaminants within the made ground at the site including TPH, PAH and metals. One location identified asbestos cement. Based upon the assessment criteria above, the construction workers are considered a high sensitivity receptor due to the scale of construction required, the magnitude of impact is considered to be moderate. As the sensitivity of the receptor is considered to be high and the magnitude of the impact is moderate this results in a moderate, significant effect. This effect can however be mitigated as detailed in Section 5.5 of this Report. These impacts are considered to be temporary.

Surrounding site users

5.3.4 The PoB and commercial properties and residential properties (right bank) would be in use during the construction. There are potential impacts on these adjacent site users associated with ingestion of windblown dust created during the works. The windblown dust could contain particulates with TPH, PAH and metals present, although dust particles would be dispersed and diluted through the air. Although, this would be a temporary impact, the sensitivity is assessed as high due to the presence of sensitive residential properties. As the sensitivity of the receptor is considered to be high and the magnitude of the impact is low, with a low likelihood of adverse effects from exposure to the low concentrations of dispersed particulate concentrations, this would result in a minor, non-significant effect. This would be mitigated further during construction by use of standard construction best practice, including dust control methods such as damping the material down and covering stockpiles to minimise the generation of dust. These impacts are considered to be temporary.

The Haven

5.3.5 There is the potential for effects upon the Haven during construction associated with creating a preferential pathway along the piled walls. The piles may connect the made ground and leachate from the made ground with the Alluvium beneath, the Alluvium is considered likely to be in connection with the river. Effects would be from leaching of contaminants through the made ground and lateral migration. The sensitivity of the receptor is assessed as moderate as it is a Haven with moderate ecological quality, based on the river basin management plan as presented in Section 4.3 of this Report. The magnitude of impact is assessed as low due to: the cohesive nature of the alluvial deposits, the low likelihood of there being any groundwater flow through the Alluvium, and the likelihood that the Alluvium would create a good seal against the piles reducing the potential for leaching. As the sensitivity of the receptor is considered to be moderate and the magnitude of the impact is low this would result in a slight, non-significant effect. These impacts are considered to be temporary.

5.3.6 There is the potential for surface runoff effects if spills and leaks occur during the construction works and if the dredged sediment is stored for dewatering. The sediment results have identified the presence of metals above the Canadian sediment guidance values and therefore leachate from this material should be restricted from entering the river. The sensitivity of the receptor is considered to be moderate due to the presence of surface water of moderate to good quality and the magnitude of the impact is moderate, with no reduction in the overall water quality status for the river, resulting in a minor, non-significant impact.

5.3.7 There are potential temporary effects to the Haven associated with disturbance of the river sediments and mobilisation of contaminants during dredging operations and construction of the barrier. Effects may include changes to the water quality, increases in turbidity and impacts on ecology. These impacts are assessed in the ES (Volume 2b): Ecology and Nature Conservation Technical Report and in the ES (Volume 2b): Surface Water and Flood Risk Technical Report.

5.4 Operation impact assessment

The Haven

5.4.1 Potential re-use of dredged sediments behind the flood wall, on top of the flood embankment and on the parcel of land near-by (right bank) has potential to affect the Haven from leaching of contaminants. Impermeable or low permeability hardstanding would be reinstated behind the flood walls during construction, which would minimise any leaching from the dredged material.

5.4.2 Hardstanding would not be present along the flood embankment or on land adjacent to Western Power Distribution (WPD) and therefore leaching from the dredged sediments may occur. The ground conditions beneath the existing made ground comprise of cohesive Alluvium and Glacial Till which are likely to restrict the migration of any leachate generated. The Alluvium may be in connectivity with the river. Surface runoff to the Haven from land adjacent to WPD site is unlikely to occur as it is located behind an existing flood embankment and placement of the sediment would be 100m from the embankment. Runoff from the embankment would be restricted by the presence of the sheet piled flood wall between the embankment and the river. The receptor is of moderate sensitivity and the magnitude of impact is low, with no changes to the characteristics of the water resource arising from run-off from the material dredged from the river, resulting in a slight effect, which is not considered to be significant.

5.4.3 Potential re-use of the sediment off-site may impact upon the water quality of the Haven, depending on the location and re-use option decided upon. Impacts on the Haven are likely to be as a result of leaching from the dredged material following initial dewatering and placement. As it is not yet certain whether the sediment would be used off-site, an

assessment for this potential impact has not yet been carried out in accordance with the methodology in Section 2.8.

Control building

5.4.4 There is potential for effects on site end users during operation of the barrier which are associated with the presence of ground gas and potential accumulation within the proposed new control building. The sensitivity of the receptor is assessed as moderate and the magnitude of impact is considered to be high, due to the presence of elevated methane concentrations measured, therefore the effect is moderate and therefore considered to be significant. This can be mitigated during design as set out in Section 5.2. The local authority (Planning, Environmental Health and Building Control) and the Environment Agency would be provided with the design proposals for appropriate ground gas protection measures for the barrier and Wet Dock control buildings. The control buildings would be constructed on shallow foundations and therefore there would be no preferential pathways into the buildings that may have arisen from use of piles. The installation of the protection measures is the responsibility of the construction contractor and must be selected and installed appropriately. The gas protection measures would need to be closely managed, tested and validated by appropriately qualified persons. The control buildings are the only enclosed structure where site end users would be working.

Public open space

5.4.5 Potential re-use of dredged sediments in areas of public open space including on top of the flood embankment and in a parcel of land directly downstream of the barrier (right bank) has potential to impact site end users should they come into direct contact with this material. Comparison of the sediment quality data to Suitable for Use Levels for commercial and public open space (park) land uses has not identified any exceedances. However, additional testing of the sediments is required prior to completion of a detailed risk assessment to ensure suitable assessment of the re-use options can be completed, particularly as there are currently a number of contaminants that have not been included in the analysis data currently available.

5.4.6 Based on the results obtained to date, the sensitivity is assessed as moderate and the magnitude is assessed as low, which results in a slight effect which is not considered to be significant. This would be revised following additional testing and confirmation of re-use options.

5.5 Mitigation

Incorporated mitigation – construction workers

5.5.1 Potential moderate effects were identified to construction workers from the presence of contaminated made ground and ground gas. These impacts were assessed as significant,

prior to mitigation. Incorporated mitigation during construction would reduce this impact to minor (not significant) effect. These mitigation measures include:

- Toolbox talks would be given to all construction workers at the site by a specialist on potential presence of contamination including hydrocarbons and asbestos cement. Construction workers would be trained to identify these contaminants and any significant contamination would be reported. Where significant hydrocarbon or asbestos contamination is identified, a watching brief during construction by a suitably qualified specialist would also be implemented if required. Appropriate health and safety risk assessments and protection to construction workers during construction would consider risks from contamination and a precautionary approach would be applied;
- A method statement would be put in place for use where contamination is likely to be encountered and for any unexpected contamination encountered during construction and to ensure the safe management and disposal of materials as necessary. This would include methods of excavation, appropriate storage, testing, treatment/ disposal options and monitoring requirements including air quality;
- Personal Protective Equipment (PPE) would be used appropriate to the task. This may include gloves, safety boots, eye protection and masks (if required); and
- If working in excavations at the site, monitoring of ground gas levels would be completed and appropriate protective equipment used based on the monitoring. Working in excavations would only be undertaken by appropriate persons with suitable training for working in confined spaces/excavations. A permit to work scheme would be considered as a requirement for working in excavations.
- An EAP would be used which would include details on dust suppression during the works.

5.5.2 Despite asbestos being identified on site in one location there is the potential for it to be discovered in other locations during the construction phase given the history of the site. Asbestos cement may not be the only form of asbestos present. Therefore suitably trained personnel, capable of spotting and identifying asbestos, in its many forms, should be on hand and providing appropriate training to ground workers prior to earth works exercises.

Incorporated mitigation – surrounding site users

5.5.3 Potential minor, non-significant effects on surrounding site users from production of dust during construction were identified.

Incorporated mitigation – the Haven

5.5.4 Potential minor, non-significant effects were identified on the Haven from leaks and spills and run-off from the sediment drying operations. Although the effects are assessed to be not significant, the risks would be further mitigated by use of an EAP detailing storage of fuels on site including use of bunded tanks and spill kits. Sediment drying may continue for a significant amount of time, the runoff from this would be appropriately managed so as not to allow direct entry to the river, particularly as metals have been measured in the existing sediment. The management measures associated with sediment drying (or dewatering) would

be within a bunded area where leachate and runoff water can be effectively collected and discharged or disposed of appropriately to ensure there are no unacceptable risks to the environment, including the Haven.

5.5.5 Water samples would be collected from the leachate/runoff water to assess the most appropriate method of discharging or disposing of the water. If the water quality is suitable for disposal to the Haven, information would be provided to the Environment Agency to demonstrate that no adverse effects would occur to the quality of the Haven. Should the results indicate that discharge into the Haven is not appropriate; the collected water would be disposed of to an appropriate licensed water treatment facility.

5.5.6 Various options are being considered for the reuse of dredged material as a preferred option based on requirements of the waste hierarchy. Options include re-use off-site in flood embankments, disposal to a suitable off-site facility or as surface material for an existing off-site landfill. Dewatering would be required if the dredged sediment is to be re-used. This process would need a designated area on-site to ensure that the dewatering activity is contained and that any leachate generated from dewatering is contained and managed appropriately so as not to cause an adverse impact to the environment. There are a number of potential options for the dewatering area, including vacant industrial areas on the right and left bank. The Environment Agency is currently in negotiations regarding the use of a near-by parcel of land on the right bank immediately downstream of the barrier structure for dewatering.

5.6 Operation

Incorporated mitigation - the Haven and site users

5.6.1 Potential slight (non-significant) effects on the Haven and site users were identified, from the reuse of made ground and dredged material. Incorporated mitigation would include the preparation of a materials management plan which would include a risk assessment for each proposed reuse location. A verification plan would be required following completion of the works. The verification plan is a requirement of the Environment Agency to ensure that the agreed materials management plan has been followed. Risks to the Haven are likely to be low due to the presence of sheet piled walls creating a barrier between the materials and the river. Risks to site users are likely to be low due to presence of hardstanding at surface. Additional testing of the sediment would be required to inform reuse options and risk assessment for the dredged material.

Incorporated mitigation - Control building and site end users

5.6.2 Potential moderate and significant effects were identified on control building users due to measured concentrations of ground gas. This significant effect can be reduced to non-significant by including ground gas protection measures within the design and construction of

the building based upon best practice as set out in CIRIA C665 (2007), Assessing Risks Posed By Hazardous Ground Gas to Buildings. The gas protection measures would effectively break the pathway and limit the magnitude of impact to low and the effect as not significant.

5.7 Residual impacts

5.7.1 No significant residual effects are anticipated following the mitigation measures set out above.

5.8 Cumulative and in-combination effects

Inter-project cumulative effects

5.8.1 The inter-project cumulative effects have been assessed based on the current information available and a number of assumptions for the Environment Agency schemes. Should the final designs be different from the assumptions made here, the relevant project/scheme would revise the potential cumulative effects, as necessary.

5.8.2 In addition to the Project, other proposed developments in the area include:

- Maintaining Standard of Protection downstream of the Project;
- Downstream Grand Sluice left bank piling, including installing a piled toe revetment to a few hundred metres of the bank toe. There is currently no known date for this to happen;
- Haven Banks / Western Power, which is a separate scheme that would share a common boundary. This work may commence in 2018/2019 with completion by 2020 and is unlikely to occur at the same time as works for the Project;
- Demolition of University Campus buildings (Boston College De Montfort Campus) and erection of 108 dwellings and associated infrastructure approximately 500m to the north east of the wet dock lock at Mill Road, Boston;
- Erection of 32 detached, semi-detached and terraced dwellings & garages with associated parking and landscaping located approximately 700m to the south west of the wet dock lock at Sir Isaac Newton Drive, Boston;
- Construction of 26 dwellings plus roads, open spaces, footpaths and parking areas located approximately 1km south west of the wet dock lock, off St Thomas Drive, Boston;
- Residential development approximately 200m to the south west of the proposed barrier location; and
- Residential development approximately 1km to the north west of the proposed barrier structure.

5.8.3 Construction activities associated with the residential developments may overlap with construction of the barrier. There is the potential for cumulative impacts on off-site users associated with dust creation. However as the barrier operation and the residential developments would undertake dust suppression and the overlapping operations are likely to be of limited duration these impacts are not considered to be significant.

5.8.4 It is considered unlikely that there would be any significant inter-project cumulative effects relating to any of the above proposed developments.

In-combination effects

5.8.5 No in-combination cumulative effects were identified for contaminated land.

Climate change

5.8.6 Climate change may result in both changes to both long term average variables, such as temperature and precipitation, as well as changes to extreme conditions. The principal climate change considerations relate to the potential mobilisation of contaminants as a result of rising surface water levels. However in this location the presence of sheet piled walls along the river would reduce this impact.

6 Summary

6.1 Contaminated land and ground conditions

6.1.1 Without mitigation two significant effects were identified relating to contaminated land. These comprised:

- Impacts on construction workers associated with direct contact with contaminated made ground and presence of ground gas; and
- Impacts on site end users (control building users) associated with accumulation of ground gas in the control building and inhalation.

6.1.2 By implementing the mitigation measures described in Section 5.5 (construction mitigation) and 5.6 (operation mitigation) of this Report, for the protection of construction workers and site end users, these significant effects would be reduced to non-significant. Mitigation to reduce the two significant impacts to non-significant include:

- Toolbox talks, method statements, appropriate PPE and gas monitoring to protect construction workers; and
- Suitable gas protection measures in the control building to protect site end users against potential gas risks.

7 References

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8 List of abbreviations

Abbreviations	Definition
BBC	Boston Borough Council
BGS	British Geological Survey
CCME	Canadian Council of Ministers of the Environment
CIRIA	Construction Industry Research and Information Association
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CLEA	Contaminated Land Exposure Assessment
CLR	Contaminated Land Report
CSM	Conceptual Site Model
DWS	Drinking Water Standard
EIA	Environmental Impact Assessment
EPA	Environmental Protection Act
ES	Environmental Statement
EQS	Environment Quality Standards
GI	Ground Investigation
GIR	Ground Investigation Report
GQA	General Quality Assessment
LQM	Land Quality Management
MCERTS	Monitoring Certification Scheme
MDL	Method Detection Limit
MRV	Minimum Reporting Value
NPPF	National Planning Policy Framework
PAH	Polycyclic Aromatic Hydrocarbons
PEL	Probable Effect Level
PoB	Port of Boston
S4UL	Suitable for Use Levels
SFFD	South Forty Foot Drain
SG	Statutory Guidance
SGV	Soil Guidance Value
SR	Science Report
TEL	Threshold Effect Level
TPH	Total Petroleum Hydrocarbons
TR	Technical Reports
WPD	Western Power Distribution
WYG	White Young Green

9 Glossary

Term	Definition
Baseline	A description of the present state of the environment with the consideration of how the environment would change in the future in the absence of the plan/programme/project as a result of natural events and other human activities.
Baseline studies/ survey	Collection of information about the environment which is likely to be affected by the project
Catchment	A surface water catchment is the total area that drains into a river. A groundwater catchment is the total area that supplies the groundwater part of the river flow.
Conservation Area	An area designated under the Town and Country Planning Act, 1990 to protect its architectural or historic character.
Countryside and Rights of Way (CRoW) Act 2000	This Act applies to England and Wales and has five parts: - Access to the countryside Public rights of way and road traffic Nature conservation and wildlife protection Areas of outstanding natural beauty Miscellaneous and Supplementary This act increases the protection of SSSIs. Environment Agency plans/programmes/projects must gain consent for works in or near SSSIs using a CRoW form.
Cumulative Impacts	The combined impacts of several projects within an area, which individually are not significant, but together amount to a significant impact.
Department for Environment, Food and Rural Affairs (DEFRA)	The government department responsible for flood management policy in England
Environmental Action Plan (EAP)	A standalone report or section within another environmental impact assessment document which ensures that constraints, objectives and targets set in the main Environmental Report/Statement are actually carried out on the ground. Actions are separated into those to be carried out before, during and after construction.
Environmental Impact Assessment (EIA)	"EIA is an assessment process applied to both new development proposals and changes or extensions to existing developments that are likely to have significant effects on the environment. The EIA process ensures that potential effects on the environment are considered, including natural resources such as water, air and soil; conservation of species and habitats; and community issues such as visual effects and impacts on the population. EIA provides a mechanism by which the interaction of environmental effects resulting from development can be predicted, allowing them to be avoided or reduced through the development of mitigation measures. As such, it is a critical part of the decision-making process." www.iema.net/eiareport
Environmentally Sensitive Area (ESA)	An area of particularly high landscape, wildlife or historical importance within which DEFRA offered inducements to encourage farmers to adopt agricultural practices to safeguard or enhance those features. Payments have now been superseded by the ESS
Environmental Statement (ES)	The document produced to describe the environmental impact assessment process where statutory environmental impact assessment is required.
Flood risk mapping	A system of maps created by the Environment Agency to show areas that are at risk of a flood that has a 1 in 100 chance (or higher) of occurring in any given year

Term	Definition
Health impact assessment	"A combination of procedures, methods and tools by which a policy, programme or project may be judged as its potential effects on the health of a population, and the distribution of those effects within a population." World Health Organisation.
Land Drainage Regulations	The Environmental Impact Assessment (Land Drainage Improvement Works) Regulations (SI 1999 No. 1783) apply to improvement works to land drainage infrastructure undertaken by land drainage bodies, including the Environment Agency. Such works are permitted development and therefore not subject to the Town and Country Planning EIA requirements.
Main river	A watercourse designated by DEFRA. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities on main rivers. Responsibility for maintenance rests on the riparian owner.
Marine Management Organisation	An executive non-departmental public body established under the Marine and Coastal Access Act 2009 with responsibilities including marine licensing and working with Natural England and others to manage a network of marine protected areas (marine conservation zones and European marine sites).
Mitigation measures	Actions that are taken to minimise, prevent or compensate for adverse effects of the development.
National Nature Reserve (NNR)	Nature reserves designated under the National Parks and Countryside Act (1949) for nationally important wildlife or geological features (these may be the best examples in the country). They are controlled by English Nature.
National Rivers Authority (NRA)	A predecessor of the Environment Agency.
Natural Areas	Sub-divisions of England, characterised by wildlife and natural features. There are 120 Natural Areas in England. Designations are managed by English Nature.
Natural England	Natural England is an Executive Non-departmental Public Body responsible to the Secretary of State for Environment, Food and Rural Affairs. Their purpose is to protect and improve England's natural environment and encourage people to enjoy and get involved in their surroundings. Their aim is to create a better natural environment that covers all of our urban, country and coastal landscapes, along with all of the animals, plants and other organisms that live with us.
Nitrate vulnerable zone (NVZ)	Area where surface or ground waters are above the standards set by the Nitrates Directive (91/676), as implemented in England and Wales by SI2164/2002
Ordinary water course	A watercourse not designated as main river. The local authority or Internal Drainage Board has permissive powers to maintain them.
Ramsar site	Wetland site of international importance listed under the Convention on Wetlands of International Importance under the Conservation of Waterfowl Habitat (Ramsar) Convention 1973.
Scoping	The process of deciding the scope or level of detail of an EIA/ SEA. During this stage the key environmental issues (likely significant effects) of a project/strategy are identified so that the rest of the process can focus on these issues. Issues may result from the proposal itself or from sensitivities of the site.
Screening	(1) For environmental impact assessment, the process of deciding which developments require an environmental impact assessment to be carried out and whether this will be statutory. (2) For strategic environmental assessment, the decision on which plans,

Term	Definition
	strategies or programmes require strategic environmental assessment to be carried out and whether this will be statutory.
Screening opinion	Statutory opinion from the competent authority as to whether a proposed project requires statutory environmental impact assessment according to the Environmental Impact Assessment Regulations.
Site of Special Scientific Interest (SSSI)	Nationally important sites designated for their flora, fauna, geological or physiographical features under the Wildlife and Countryside Act (1981) (as amended) and the Countryside Rights of Way (CRoW) Act (2000).
Special Area for Conservation (SAC)	Sites of European importance for habitats and non-bird species. Above mean low water mark they are also SSSIs.
Special Protection Area (SPA) and proposed Special Protection Area (pSPA)	An area designated for rare or vulnerable birds, or migratory birds and their habitats, classified under Article 4 of the EC Directive on the Conservation of Wild Birds (79/409/EEC). They are also SSSIs. Proposed sites receive the same protection as fully protected sites
Standard of protection (SoP)	The level of protection from flooding, for example an SoP of 1 in 100 means that the flood defences in an area provide protection from floods up to a size of flood with a probability of occurring of 1 in 100 in any year
Strategic Environmental Assessment	SEA is a process designed to ensure that significant environmental effects arising from proposed plans and programmes are identified, assessed, subjected to public participation, taken into account by decision-makers, and monitored. SEA sets the framework for future assessment of development projects, some of which require Environmental Impact Assessment (EIA). SEA is carried out according to the requirements of the SEA Directive 2001/42/EC

Appendices

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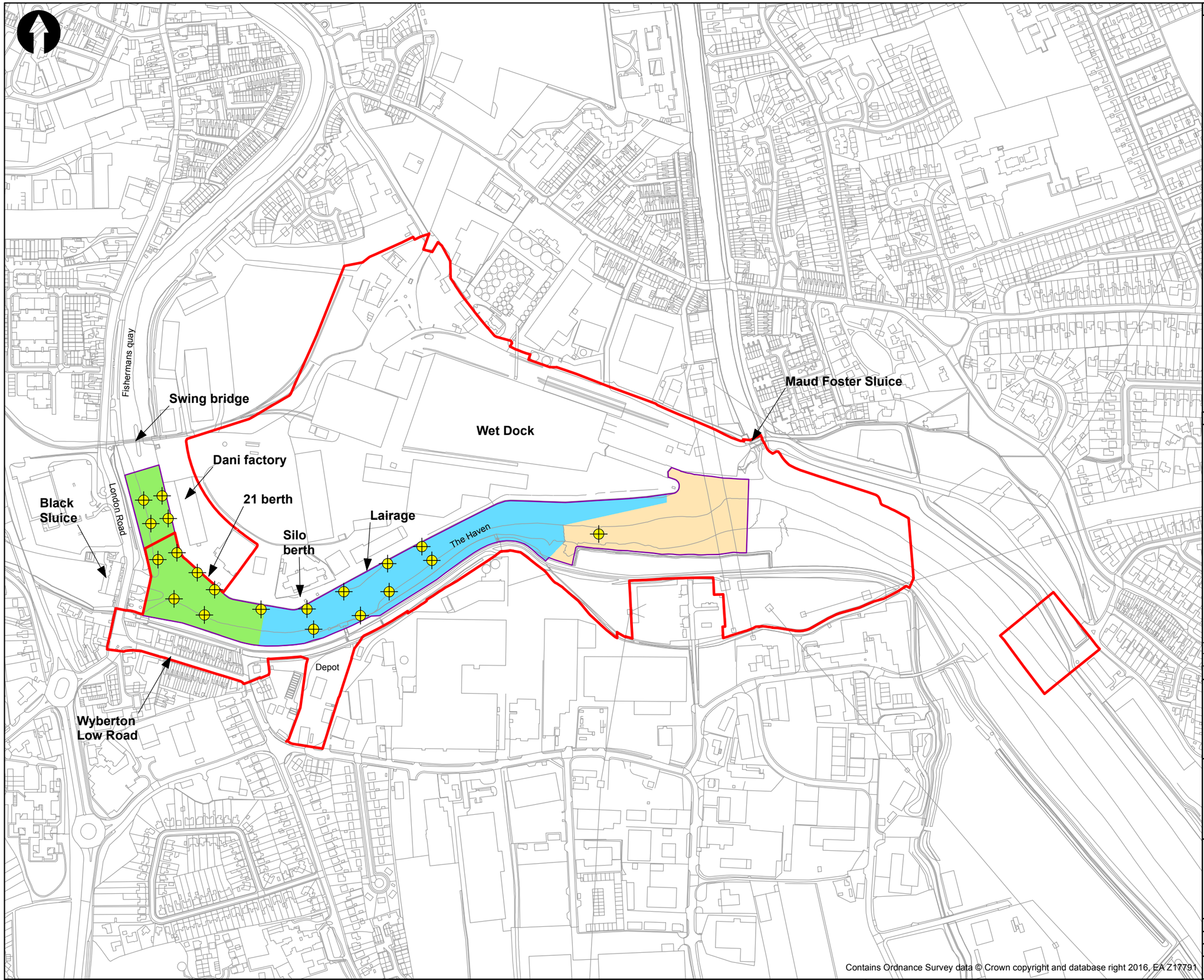
A. Figures



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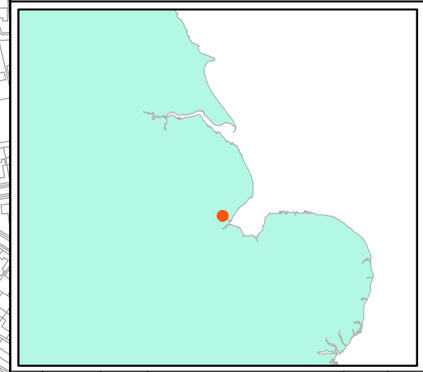
Key to Symbols

- Site boundary
- Sampling locations
- Dredging extent

Sampling Phases

- Phase 1: Not yet completed
- Phase 2: Not yet completed
- Phase 3: Not yet completed

Location Reference



Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	05/08/16	DT	Site boundary update	JL	EL
P0	12/01/16	LC	Draft	JL	EL

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Environment Agency

Title

Boston Barrier Project
Sediment Sampling Locations

Figure 4.1

Designed	J. Ledingham	ENV Check	L. Herbert
Drawn	L. Cutting	Coordination	G. Hughes
GIS Check	J. Ledingham	Approved	E Lunt

Scale at A3	Status	Rev
1:5,000	PRE	P1

Figure Number

IMAN001472-ES-FIG-508

0 50 100 200 Metres

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