# 7. Ground Conditions

Environmental Appraisal
Volume I

# 7. GROUND CONDITIONS

## 7.1 Introduction

This chapter of the Environmental Appraisal (EA) assesses the environmental impact of the Proposed Development with respect to ground conditions. The following is considered:

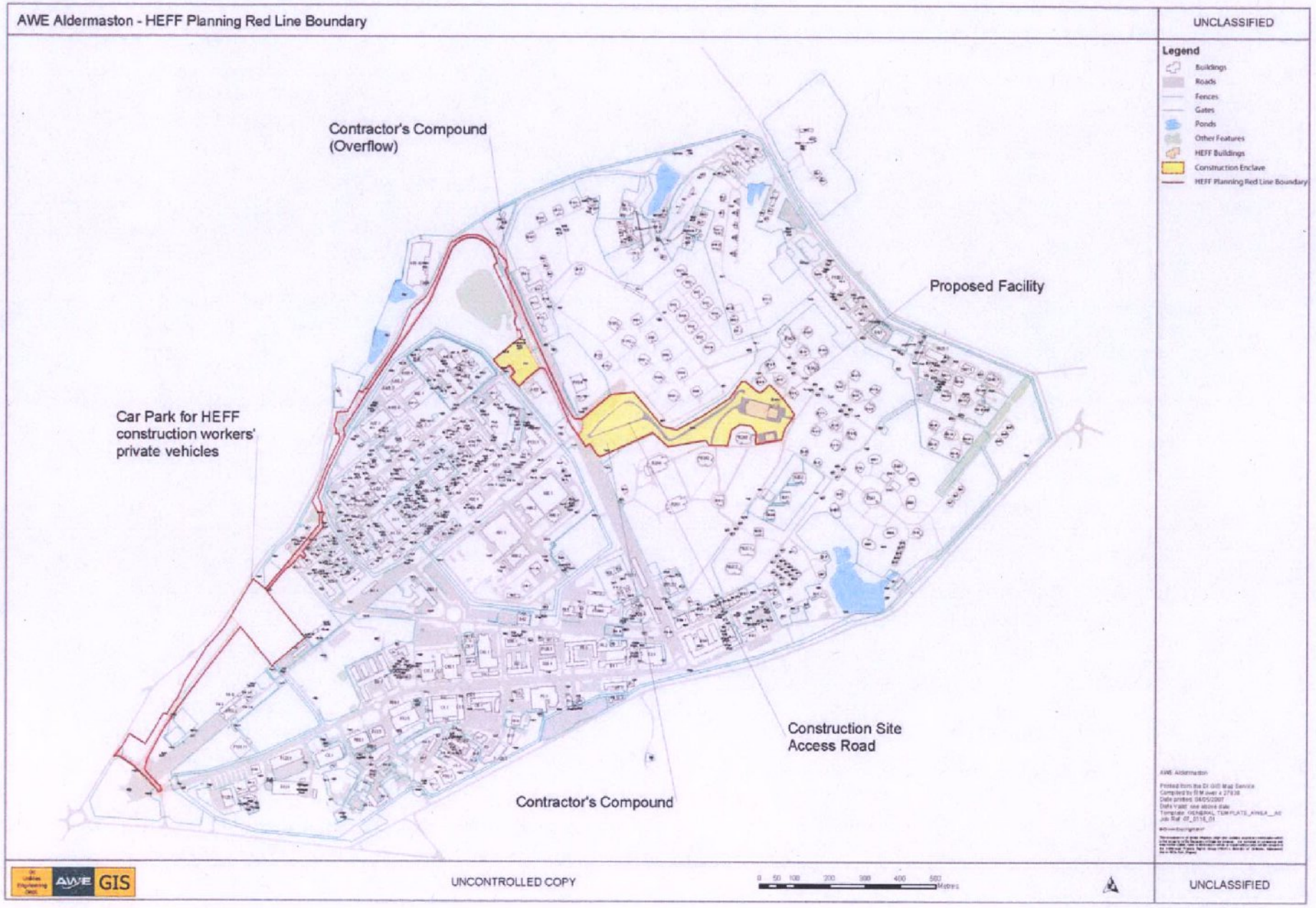
- The key features/characteristics of the ground conditions within the High Explosive Fabrication Facility (HEFF) Construction Enclave and Proposed Facility;
- The sensitivities of identified receptors;
- The direct and indirect environmental impacts arising from the development;
- The mitigation to which AWE is committed in order to reduce the potential scale of any negative impacts and promote positive impacts; and
- The residual environmental impacts that result following implementation of the proposed mitigation.

Environmental impacts predicted during the construction of the facility (short-term impacts) and those predicted to result from the presence of the building (long-term impacts) have been assessed. The potential environmental impacts of the operational phase of the Proposed Development are also assessed.

All areas associated with the proposed development are shown in Figure 7-1. This area, i.e. the 'red line boundary' will be referred to in this chapter as the HEFF Project Area. The areas considered within this chapter comprise the HEFF Construction Enclave (i.e. the temporary contractors' compound and overflow, the construction site, and the construction site access road) and the location of the Proposed Facility (the process building and supporting buildings and associated permanent access routes). The temporary car park already has planning approval and has been considered as part of the New Office Accommodation (NOA) planning application. The use of these facilities has therefore already been addressed as part of that planning application. The area considered within this chapter is highlighted in yellow in Figure 7-1 and will be referred to as the HEFF Construction Enclave (which includes the contractors compound, overflow and construction site) and the Proposed Facility.

Additional supporting information is presented in Appendix A, which is contained within Volume II of this EA. This chapter has been prepared by Golder Associates (UK) Ltd.

*Figure 7-1: The Study Area, HEFF Project Area, HEFF Construction Enclave, and Proposed Facility*



## 7.2 Planning Policy Context

### 7.2.1 National Legislation

The primary legislative driver relating to ground conditions is the Contaminated Land (England) Regulations 2006 (Ref. 7-2). The Regulations came into force on 4 August 2006, and consolidated the provisions of the Contaminated Land (England) Regulations 2000 (Ref. 7-3) and the Contaminated Land (England) (Amendment) Regulations 2001 (Ref. 7-4). They set out provisions relating to the identification and remediation of contaminated land as defined in Part IIA of the Environmental Protection Act 1990 (Ref. 7-5) and include radioactivity. This means the regime for the identification and remediation of contaminated land now covers situations where harm or water pollution attributable to radioactivity or radioactive contamination is occurring.

Figure 7-1 shows the area of the HEFF Construction Enclave and Proposed Facility within the HEFF Project Area considered in this chapter.

Related legislation comprises the following:

- The Radioactive Contaminated Land (Enabling Powers) (England) Regulations 2005 (Ref. 7-6);
- Radioactive Contaminated Land (Modification of Enactments) (England) Regulations 2006 (Ref. 7-7);
- The Water Resources Act 1991 (Ref. 7-8), which imposes liability for clean up where contaminated land is causing polluting material to enter a watercourse; and
- The Environmental Protection Act 1990 (Ref. 7-5), which has provisions for liability consequent upon contaminated land causing pollution to the environment or impact to human health.

Statutory guidance for the Contaminated Land Regulations is contained within DEFRA Circular 01/2006 entitled 'Environmental Protection Act 1990 Part IIA contaminated land' (Ref. 7-9), which describes the statutory regime for contaminated land and provides an outline of statutory guidance. It covers the 2006 regulations and other supporting legislation.

### 7.2.2 National Planning Policy

Planning Policy Statement (PPS) 23 Planning and Pollution Control (Ref. 7-10) sets out the UK Government's policies relating to land use planning and, in particular, development on land affected by contamination. Annex 2 of PPS 23 entitled 'Development on Land Affected by Contamination' advises that a developer must carry out an adequate investigation to inform a risk assessment to determine the following:

- Whether the land in question is already affected by contamination through source-pathway-receptor linkages and how those linkages are represented in a conceptual model;
- Whether the development proposed will create new linkages, e.g. new pathways, by which existing contaminants might reach existing or proposed receptors and whether it will introduce new vulnerable receptors; and
- What action is needed to break those linkages and avoid new ones, deal with any unacceptable risks and enable safe development and future occupancy of the site and neighbouring land. This may include remediation to secure a safe development, and may be a condition of any planning permission granted for a development affecting land that is contaminated.

### 7.2.3 Regional Planning Policy

Policy Q6 of the Regional Planning Guidance for the South East (RPG9) (Ref. 7-11) dated March 2001 provides general guidance for development planning throughout the Region. It states that local authorities and key agencies can play a role in improving the local environment, and public health and safety, including restoring derelict and contaminated land. RPG9 will be replaced by the South East Plan, which will become the adopted Regional Spatial Strategy for the South East in due course.

### 7.2.4 Local Planning Policy

The following local planning documents do not contain any specific policies relating to land contamination:

- The Berkshire Structure Plan 2001-2016 (Ref. 7-12), which contains policies of relevance to Local Authorities including West Berkshire Council in preparing their own development plans;
- The adopted West Berkshire District Local Plan 1991-2006 (Ref. 7-13); and
- The newly evolving local development framework, including documents that will inform the West Berkshire Planning Strategy.

It is therefore considered that the overriding policy document that sets the context for this chapter is PPS 23.

### 7.2.5 Pollution Control Guidelines

The Environment Agency has produced a series of documents providing non-statutory guidance on the prevention and control of pollution from certain activities (Pollution Prevention Guidelines). Relevant documents are listed below:

- PPG1: General guide to the prevention of pollution of controlled waters;
- PPG2: Above ground oil storage tanks;
- PPG3: Use and design of oil separators in surface water drainage systems;
- PPG5: Works in, near or liable to affect watercourses;
- PPG6: Working at demolition and construction sites;
- PPG8: Safe storage and disposal of used oils;
- PPG11: Preventing pollution at industrial sites;
- PPG18: Spillage and fire fighting run-off;
- PPG20: Dewatering underground ducts and chambers;
- PPG21: Site-specific pollution incident plans; and
- PPG26: Storage and handling of drums and intermediate bulk containers.

## 7.3 Assessment Methodology and Significance Criteria

### 7.3.1 Methodology

It is necessary to establish a transparent methodology and to set out clearly the relevant criteria against which the potentially significant effects of a development will be judged. The methodology is summarised here, and is presented in further detail in Section 2.0 of Appendix A.

The AWE Aldermaston site and, specifically, the HEFF Construction Enclave and Proposed Facility have been subject to extensive characterisation in terms of land quality using a variety of desk based, site investigation, and risk assessment techniques over the period 1994 to 2007. Relevant reports associated with these activities, i.e. those that wholly or partly investigated the HEFF Construction Enclave and Proposed Facility or immediately surrounding areas, are summarised in Table 7-1, and relevant exploratory locations are shown in Figure 7-2.

The existing data sources have been reviewed in order to inform the description of baseline conditions, and this has included the identification of potential sources of contamination in soils and groundwater, existing exposure pathways, and sensitive receptors. All available data have been assessed in relation to a series of 'Tier 1 Screening Values'. Appendix A explains how the Tier 1 Screening Values have been derived and how they are applicable to the AWE Aldermaston site. Appendix A also contains the full tabular baseline conditions data summary and Tier 1 Screening Values in Table A and Table B. The term 'determinand' is used generically to describe any single chemical species or compound whose concentration in soil and groundwater has been determined through chemical analysis. The existing information has been used to identify any potential impacts that may occur within the HEFF Construction Enclave and Proposed Facility.

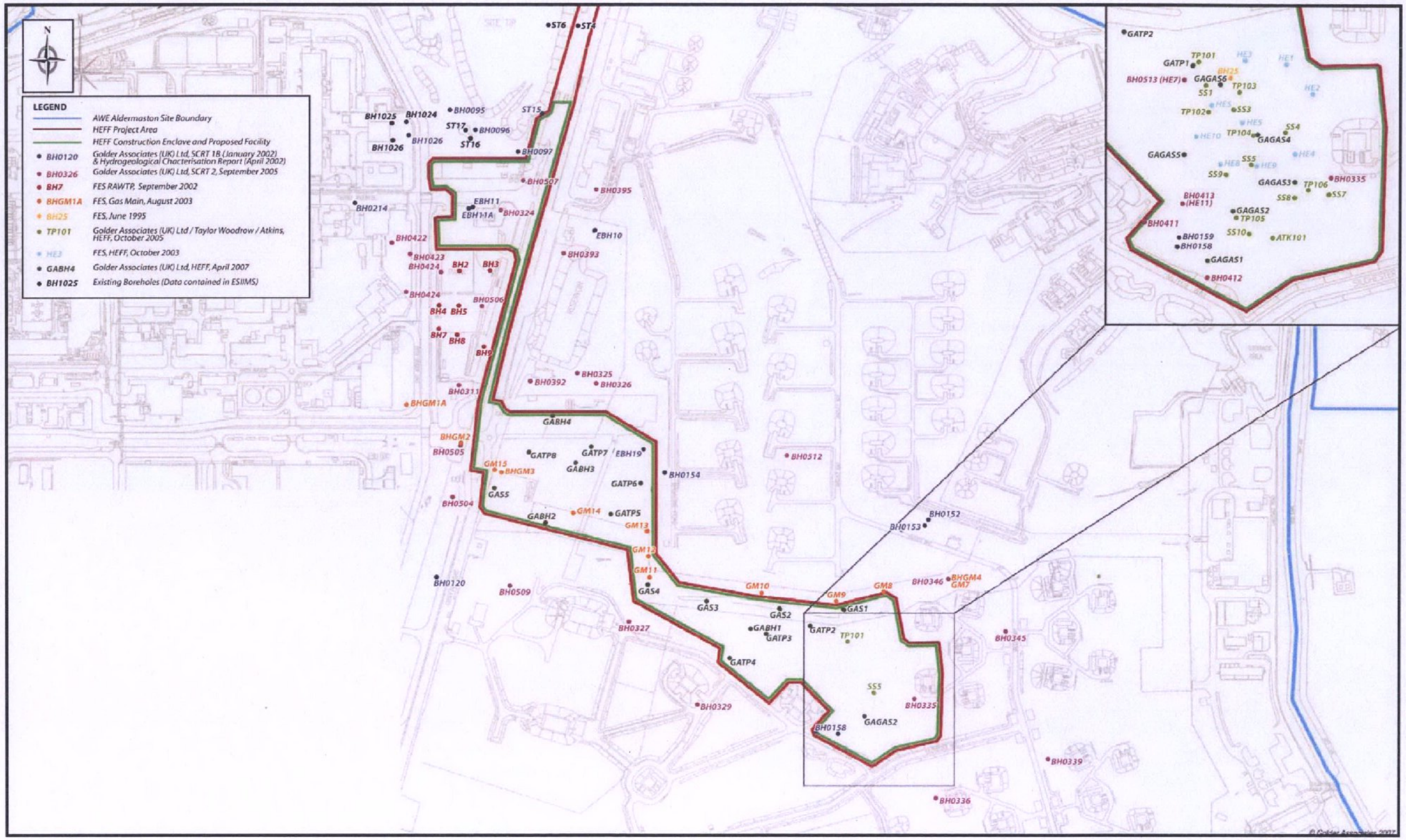
Where determinands have been identified during screening as exceeding criteria, these have been highlighted as initial areas of potential concern (APC). Subsequently, where detailed quantitative (Tier 2) risk assessment was not available within the reports being reviewed, further initial qualitative Tier 2 Screening has been undertaken as part of this EIA in order to identify whether any of the determinands detected in soils and groundwater are likely to present risks to either human health or controlled waters in the HEFF Construction Enclave and Proposed Facility.

Following the Tier 1 Screening, available exposure pathways by which the determinands might reach various receptor groups (human beings, property, controlled waters, ecological receptors) have been assessed. Where determinands have not exceeded criteria, no further consideration has been given. Consequently, only where potential pollutant linkages (sources exceeding criteria, pathways and receptor groups considered at risk) have been identified has the assessment of receptor sensitivity, potential impacts associated with the pollutant linkage, and mitigation been undertaken in this chapter.

*Table 7-1 Summary of Previous Investigation Reports and Relevant Exploratory Locations*

| Report Title, Author, and Issue Date | Report Type | Study Area | Relevant Exploratory Location(s) | |
|---|---|---|---|---|
| | | | Within HEFF Boundary | Outside HEFF Boundary |
| Hydrogeological Survey, Factual Report on-Site Investigation, Fugro Engineering Services (FES) Ltd, June 1995 (Ref. 7-14) | Factual | Unknown | Boreholes: BH25 | N/A |
| SCRT1B: Area 11 Investigation Report, AWE Aldermaston, Golder Associates (UK) Ltd, January 2002 (Ref. 7-15) | Interpretative | Area 11 | N/A. | Boreholes: BH0120 |
| SCRT1B: Area 2 Investigation Report, AWE Aldermaston, Golder Associates (UK) Ltd, January 2002 (Ref. 7-16) | Interpretative | Area 2 | N/A | Boreholes: BH0095-97, BH0181, BH0214 |
| Hydrogeological Characterisation of AWE Aldermaston, Golder Associates (UK) Ltd, April 2002 (Ref. 7-17) | Interpretative | Entire AWE Site | Boreholes: BH0158, BH0159, EBH11, EBH11A, EBH19, ST15 | Boreholes: BH0152-154, EBH10 |
| SCRT2 Exploratory Investigation Design Report, AWE Aldermaston, Golder Associates (UK) Ltd, May 2002 (Ref. 7-18) | Desk Study | B Area | N/A | N/A |
| Desk Study for Proposed New HE Laboratory, EDGE Consultants UK Ltd, December 2002 (Ref. 7-19) | Desk Study | AWE(A) and AWE(B) | N/A | N/A |
| RAWTP Site 2 Aldermaston, Foundation and Exploration Services, September 2002 (Ref. 7-20) | Factual | RAWTP Site | N/A | Boreholes: BH1-BH9 |
| AWE Aldermaston New Gas Main Pipeline, Foundation and Exploration Services, August 2003 (Ref. 7-21) | Factual | Route of new gas main through HEFF Construction Enclave and Proposed Facility | Boreholes: BHGM3, Trial Pits: GM11-15 | Boreholes: BHGM1A, BHGM2, BHGM4, Trial Pits: GM7-10 |
| AWE Aldermaston Proposed New HE Laboratory, Factual Report on Ground Investigation for AWE Aldermaston Plc, Fugro Engineering Services (FES) Ltd, October 2003 (Ref. 7-22) | Factual | HEFF Construction Enclave and Proposed Facility | Boreholes: HE1-11 (HE7 and HE11 correspond to Golder SCRT2 boreholes BH0513 and BH0413, respectively) | N/A |
| SCRT2: Citadel South Exploratory Investigation Report AWE Aldermaston, Golder Associates (UK) Ltd, August 2005 (Ref. 7-23) | Interpretative | Citadel South | N/A | Boreholes: BH0504-0505 |
| SCRT2: Citadel East Exploratory Investigation Report AWE Aldermaston, Golder Associates (UK) Ltd, September 2005 (Ref. 7-24) | Interpretative | Citadel East | Boreholes: BH0324, BH0507 | Boreholes: BH0311, BH0421-424, BH0506 |
| SCRT2: B Area North Exploratory Investigation Report AWE Aldermaston, Golder Associates (UK) Ltd, September 2005 (Ref. 7-25) | Interpretative | B Area | Boreholes: BH0508 | Boreholes: BH0325-0326, BH0392-393, BH0395, BH0512 |
| SCRT2: B Area South Exploratory Investigation Report AWE Aldermaston, Golder Associates (UK) Ltd, August 2005 (Ref. 7-26) | Interpretative | B Area | Boreholes: BH0335, BH0411-413, BH0513 | Boreholes: BH0327, BH0329, BH0336, BH0339, BH0345-346, BH0509 |
| HEFF Additional Ground Investigation at AWE Aldermaston, Golder Associates (UK) Ltd, October 2005 (Ref. 7-27) | Factual | HEFF Construction Enclave and Proposed Facility | Boreholes: ATK101, Surface Scrapes: SS1, SS3-5, SS7, SS8-10, Trial Pits: TP101- TP106 | N/A |
| HEFF Geophysical Survey at AWE Aldermaston, Golder Associates (UK) Ltd, October 2005 (Ref. 7-28) | Archaeological | HEFF Construction Enclave and Proposed Facility | N/A | N/A |
| AWE High Explosives Fabrication Facility Geo-Environmental Interpretative Report, Taylor Woodrow and Atkins, October 2005 (Ref. 7-29) | Factual | HEFF Construction Enclave and Proposed Facility | Boreholes: ATK101, Surface Scrapes: SS1, SS3-5, SS7, SS8-10, Trial Pits: TP101- TP106 | N/A |
| Engineering Project HE Fabrication Facility Archaeological Desk-Based Assessment, AWE, October 2005 (Ref. 7-30) | Desk Study | HEFF Construction Enclave and Proposed Facility | N/A | N/A |
| Archaeology Evaluation Report, Taylor Woodrow and Atkins Heritage, October 2005 (Ref. 7-31) | Archaeological | HEFF Construction Enclave and Proposed Facility | Archaeological Trenches: TR1, TR2, TR3, TR4, TR5, TR6, TR7 and TR8 | N/A |
| Groundwater Sampling of Existing Boreholes, AWE Environmental Materials Analysis Group, August 2006 (Ref. 7-32) | Factual | HEFF Construction Enclave and Proposed Facility | Boreholes: R474W (BH0158), R475W (BH0159), R053W (EBH11A), R054W (EBH11) | Boreholes: R473W (BH0154) |
| SCRT3 Monitoring Data, ESIIMS, Golder Associates (UK) Ltd, March 2003 to December 2006 (Ref. 7-33) | Monitoring Results | Area 2 | Boreholes: ST15 | Boreholes: ST6, ST14, ST16-17, BH1024, BH0126-1027 |
| Clearance Survey Report, AWE Environmental Materials Analysis Group, January 2007 (Ref. 7-34) | Interpretative | HEFF Construction Enclave and Proposed Facility | Surface Scrapes: 56 locations | N/A |
| HEFF Additional Site Investigation Results, Golder Associates (UK) Ltd, April 2007 (Ref. 7-35) | Investigation Results | HEFF Construction Enclave and Proposed Facility | Boreholes: GABH1-4, GAGAS1-6, Trial Pits: GATP1-8, Surface Scrapes: GAS1-5 | N/A |

*Figure7-2: HEFF Construction Enclave and Proposed Facility area Relevant Exploratory Locations*



### 7.3.2 Significance Criteria

Where potential contaminant sources, pathways, and receptors are present, a potential pollutant linkage is considered present and the scale of potential impacts at 'current baseline', 'during construction' and 'with development' conditions are assessed using the qualitative scale of impact assessment criteria summarised in Table 7-2 (further details on the scale of impact can be found in Appendix A of this EA).

*Table 7-2 Methodology for Assessing Impact Scale*

| Scale of Impact | Assessment Criteria |
|---|---|
| High | Impact predicted to extend over a large or very large area, affect considerable numbers of people or other receptors (ecological, businesses, facilities), have transboundary effects, significantly change environmental conditions, entail unusual/complex effects for receptors, affect particularly scarce features/resources, entail a high probability that breaches of legislation or statutory Environmental Quality Standard or Objectives will occur, result in total loss of attribute, continue for a long time, be permanent rather than temporary, be continuous rather than intermittent, or where intermittent, frequent rather than rare, be irreversible, and be very difficult to avoid, reduce, repair, or compensate for.<br>or<br>Significant positive change in environmental conditions resulting in major improvements in quality or value of a receptor. |
| Medium | Impact predicted to extend over a moderate area, affect moderate numbers of people, affect some other receptors (ecological, businesses, facilities), be unlikely to have transboundary effects but possibility remains, moderately change environmental conditions, be unlikely to entail unusual/complex effects for receptors but possibility remains, be unlikely to affect particularly scarce features/resources but possibility remains, entail a low probability that breaches of legislation or statutory Environmental Quality Standard or Objectives will occur, be unlikely to result in loss of attribute but possibility remains, continue for a moderate period of time, be semi-permanent, be intermittent, be reversible, be possible to avoid, reduce, repair, or compensate for.<br>or<br>Notable positive change in environmental conditions resulting in measurable improvements in quality or value of a receptor. |
| Low | Impact predicted to extend over a small area, affect small numbers of people, affect a small number of other receptors (ecological, businesses, facilities), not have transboundary effects, but possibility remains, slightly but discernibly change environmental conditions, not entail unusual/complex effects for receptors, not to affect particularly scarce features/resources, not to result in breaches of legislation or statutory Environmental Quality Standard or Objectives, not to result in loss of attribute, continue for a short period of time only, be temporary, be intermittent and/or rare, be reversible, and be possible to avoid, reduce, repair, or compensate for.<br>or<br>Slight positive change in environmental conditions resulting in minor improvements in quality or value of a receptor. |
| Negligible | Results in effects on attribute but of insufficient magnitude to affect the use/integrity. |

The significance of the identified impacts combines the predicted scale of the impacts with the value or sensitivity of the receptor and the proposed mitigation measures in order to reduce the potential scale of environmental impacts. Residual impact significance is assessed in accordance with Table 7-3 (further details on impact significance can be found in Appendix A of this EA).

*Table 7-3 Methodology for Assessing Residual Impact Significance*

| Significance | Description |
|---|---|
| Major beneficial (positive) effect | Major reduction in risk |
| Moderate beneficial (positive) effect | Moderate reduction in risk |
| Minor beneficial (positive) effect | Minor reduction in risk |
| Negligible effect | No appreciable impact on the attribute, or the attribute is of negligible importance |
| Minor adverse (negative) effect | Minor and/or temporary detrimental effect |
| Moderate adverse (negative) effect | Moderate detrimental effect |
| Major adverse (negative) effect | Severe detrimental effect |

## 7.4 Baseline Conditions

Baseline conditions have been described within this chapter for the area of the HEFF Construction Enclave and Proposed Facility. The overall geographical area including surrounding areas for which impacts have been assessed is referred to as the 'Study Area' for the purposes of this EA. Reference to the 'site boundary' refers to the AWE Aldermaston site boundary.

Additional information relating to the current baseline conditions is contained within Appendix A of this EA.

### 7.4.1 Site Environmental Setting

The near surface geology and hydrogeology of the HEFF Construction Enclave, Proposed Facility and within the Study Area can bear a significant influence on the impact that any identified ground contamination can have on surface and groundwater receptors. This is because permeable strata such as sands and gravels can provide pathways whereby contamination can migrate below ground level. Conversely, impermeable strata, such as clays, can inhibit the migration of contamination.

A description of the geologic, hydrogeologic and hydrologic environments at the HEFF Construction Enclave, Proposed Facility and within the Study Area is presented below. In addition, the baseline conditions with respect to sources of potential contamination are summarised.

### 7.4.2 Geology

The published geological map (Ref. 7-36) shows that the general geological succession comprises Silchester Gravels (River Terrace Deposits) overlying the Bagshot Formation, which in turn overlies the London Clay Formation. The interface between the base of the Bagshot Formation and the top of the London Clay is a gradational boundary known as the Bagshot Beds/Transitional Zone. The base of the London Clay formation has not been proven in the HEFF Construction Enclave and Proposed Facility, but is estimated as being typically 55 m to 100 m thick. (Ref. 7-19). The London Clay overlies the Upper Chalk, which does not outcrop in the local area. The natural geological deposits are overlain by a thin layer of gravelly Made Ground. Occasionally, a number of man-made materials were detected in the subsoil, such as fragments of concrete, bonded asbestos, tarmac, cable and ceramic. Investigations suggest that the Made Ground is typically reworked Silchester Gravel.

Results of previous investigations in the HEFF Construction Enclave and Proposed Facility have been reviewed and a generalised stratigraphic sequence for the materials encountered in the HEFF Project Area is presented in Table 7-4. Further details can be found in Appendix A of this EA.

*Table 7-4 Generalised Geological Sequence Beneath HEFF Construction Enclave and Proposed Facility area.*

| Name | Description | Mean thickness (m) |
|---|---|---|
| Sub Soil and Made Ground | Medium dense, light brown/grey, silty, gravely, sandy Sub-Soil. | 0.50 |
| Silchester Gravels | Dense to very dense orange-brown, sandy, clayey, fine to medium, angular to sub-rounded Gravel. | 3.90 |
| Bagshot Beds | Firm, orange-brown mottled, sandy Clay/Silt. | 8.44 |
| Transitional Zone | Firm to Stiff, grey, laminated, sandy Clay with layers of Sand and Silt. | |
| London Clay Formation | Stiff, grey brown Clay and very dense, slightly clayey Sand. The mean depth to the top of the London Clay Formation was found to be 12.85 m bGL in previous investigations (typically 55 to 100m thick). | N/A |

### 7.4.3 Hydrology and Hydrogeology

*7.4.3.1 Private and Licensed Abstractions*

Two private and six licensed abstractions have been identified within a 2 km radius of the HEFF Construction Enclave and Proposed Facility. Only one of the identified abstractions lies down gradient of the HEFF Construction Enclave and Proposed Facility. The abstraction abstracts water from the Chalk at a depth of 175 m. Due to the depths of the abstraction and presence of a considerable thickness of London Clay non-aquifer, this abstraction is not considered to be at risk from potential impacts related to the Proposed Development.

Further details relating to private and licensed abstractions can be found in *Chapter 8: Water Resources* of this EA.

*7.4.3.2 Site Hydrogeology*

Groundwater in the HEFF Construction Enclave and Proposed Facility area typically lies at approximately 2 m below ground level (bGL) (approximately 100.7 m above Ordnance Datum (AOD)). Groundwater was recorded between 0.8 and 3.8 m bGL in groundwater monitoring boreholes during monitoring conducted in February 2007 (Ref. 7-35).

A summary of aquifer classification for geology underlying the HEFF Construction Enclave and Proposed Facility is provided in Table 7-5.

*Table 7-5 Environment Agency Aquifer Classifications*

| Geological Formation | Aquifer Classification | Classification Description |
|---|---|---|
| Silchester Gravels | Minor Aquifer (Variably Permeable) | Permeable drift deposits, fractured or potentially fractured rocks, which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. Seldom produce large quantities of water for abstraction, they are important for both local supplies and in supplying base flow to rivers. |
| Bagshot Beds/ Transitional Zone | | |
| London Clay | Non-Aquifer (Negligibly Permeable) | Generally regarded as containing insignificant quantities of water, flow although imperceptible does take place, can yield sufficient water for domestic use. |
| Upper Chalk | Major Aquifer (Highly Permeable) | Highly permeable formation with known or probable significant fracturing. May be highly productive and able to support large abstractions for public supply and other purposes. |

*7.4.3.3 Site Hydrology*

No surface watercourses are currently present within or in the immediate vicinity of the proposed HEFF Construction Enclave and Proposed Facility. The nearest surface water bodies are North Ponds (approximately 280 m to the west of contractors compound), Decoy Pond (approximately 270 m to the southeast of the HEFF Proposed Facility), Stock Pond (approximately 450 m to the north of the HEFF Proposed Facility) and Ladies Lake (approximately 480 m to the north of the contractors compound). Each of these water bodies are within the AWE Aldermaston site boundary.

### 7.4.4 Sources of Potential Contamination

*7.4.4.1 Soil Gas*

Gas monitoring has been undertaken in boreholes installed in the area of the HEFF Construction Enclave and Proposed Facility during April 2007. Monitoring was conducted on four occasions for methane, carbon dioxide, oxygen, hydrogen sulphide, and volatile organic compounds, and full monitoring results are discussed in further detail in Appendix A of this EA.

Methane, carbon dioxide, and volatile organic compounds have been identified at concentrations exceeding the equipment detection limit in boreholes located within the HEFF Construction Enclave and Proposed Facility area. In addition, depleted concentrations of oxygen have been identified. To determine whether the identified gas concentrations represent potential sources of contamination under baseline conditions, the gas concentrations have been compared with Tier 1 Screening Values. A summary of the results for those species that exceeded the chosen Tier 1 Screening Values is presented in Table 7-6.

*Table 7-6 Summary of Tier 1 Screening – Soil Gas*

| Determinand (Units) | Concentration Range | Screening Value | Value Source | Number of Exceedences |
|---|---|---|---|---|
| Carbon Dioxide (% v/v) | <0.1-5.1 | >5% | CIRIA Publication C659 | 1 |
| Oxygen (% v/v) | 13.3-21.1 | <18% | CIRIA Publication C659 | 10 |

The presence of carbon dioxide and the absence of oxygen at certain locations within the HEFF Construction Enclave and Proposed Facility area represent sources of potential contamination.

*7.4.4.2 Radiological Contamination in Soil*

The 'AWE High Explosives Fabrication Facility, Geo-environmental Interpretative Report' dated October 2006 (Ref. 7.29) states that 'three soil samples were deemed to require additional detailed radiological screening by AWE. In response, the Environmental Materials and Analysis Group (EMAG) conducted a comprehensive sampling and analysis programme within parts of the HEFF Construction Enclave and Proposed Facility area during December 2006 (Ref. 7-34). The areas covered by the programme included all those areas containing ground that will be disturbed during construction. Fifty-six samples of near-surface soil were collected, and these were analysed for gross alpha and gross beta activity. Tritium activity was determined on 20% of the samples. The results of the work (Ref. 7-34) did not identify any sample containing alpha, beta, or tritium activity above the Tier 1 Screening Value.

Based upon the results contained within the EMAG report, radiological contamination in soil is not considered to represent a potential source of contamination.

*7.4.4.3 Explosive Residues and Buried Unexploded Ordnance*

Given the history of the AWE Aldermaston site and the location of the HEFF Construction Enclave and Proposed Facility within the 'explosives area' of the site, the potential for buried ordnance is noted. Ref. 7-29 states that 'Explosive residual analysis was scheduled on nine soil samples from the Made Ground. No explosive residuals were identified to exceed the detection levels for public open space'. In addition, analysis of samples collected by Golder during their April 2007 investigation did not identify any explosive residuals at concentrations exceeding the laboratory method detection limit.

No testing for buried unexploded ordnance is documented in any of the reports reviewed. It is understood that ordnance has not been manufactured at AWE Aldermaston, and AWE has not considered the presence of unexploded ordnance a potential hazard during previous investigations at the Site. As such, explosive residues and buried unexploded ordnance are not considered to represent potential sources of contamination.

*7.4.4.4 Asbestos*

Asbestos (chrysotile) has been identified during previous investigations in two locations within the HEFF Construction Enclave and Proposed Facility. The asbestos was bonded. Asbestos is therefore considered to represent a potential source of contamination.

*7.4.4.5 Soil Contamination*

Soils testing data has been extracted from the available reference sources for the exploratory locations within the HEFF Construction Enclave and Proposed Facility area.

A number of determinands have been identified at concentrations exceeding the method detection limit (i.e. levels are lower than the minimum detection limit), and full details are contained in Appendix A. To determine whether the identified determinand concentrations represent potential sources of contamination under baseline conditions, the data have been assessed in relation to Tier 1 Screening Values applicable to either human health or water resources.

None of the determinand concentrations encountered in soil exceeded the Tier 1 Screening Values relevant to human health and, therefore, it is considered that soil determinands do not represent a potential source of contamination with respect to impacts to human health.

A summary of the results showing those determinands that exceeded the Tier 1 Screening Values relevant to groundwater is given in Table 7-7.

*Table 7-7 Summary of Soil Tier 1 Screening – Risk to Groundwater*

| Determinand | Units | Range | Screening Value | Source | Locations Exceeding Value |
|---|---|---|---|---|---|
| Acenaphthene | ug/kg | <14-1615 | 14 | LOD | 13 |
| Acenaphthylene | ug/kg | <5-261 | 5 | LOD | 14 |
| Anthracene | ug/kg | <9-1600 | 9 | LOD | 15 |
| Antimony | mg/kg | <1-1 | 1 | LOD | 3 |
| Arsenic | mg/kg | <1-17 | 12 | Background | 2 |
| Barium | mg/kg | 18-53 | 1 | LOD | 17 |
| Benzo(a)anthracene | ug/kg | <12-7400 | 12 | LOD | 15 |
| Benzo(a)pyrene | ug/kg | <12-5700 | 12 | LOD | 14 |
| Benzo(b)fluoranthene | ug/kg | <16-5300 | 16 | LOD | 13 |
| Benzo(ghi)perylene | ug/kg | <10-9500 | 10 | LOD | 14 |
| Benzo(k)fluoranthene | ug/kg | <25-5300 | 25 | LOD | 13 |
| Beryllium | mg/kg | <0.4-1 | 0.4 | LOD | 10 |
| Boron | mg/kg | <1-3 | 1 | LOD | 31 |
| Chrysene | ug/kg | <10-6700 | 10 | LOD | 15 |
| Copper | mg/kg | 5-540 | 9 | Background | 25 |
| Copper (leachate) | ug/l | <1-76 | 1 | FW EQS | 1 |
| Cyanide | mg/kg | <1-3.7 | 1 | LOD | 1 |
| Dibenz(ah)anthracene | ug/kg | <8-1200 | 8 | LOD | 14 |
| Diesel Range Organics | mg/kg | 2-35 | 1 | LOD | 9 |
| Di-sec-octyl phthalate | ug/kg | <100-393 | 100 | LOD | 2 |
| Fluoranthene | ug/kg | <25-8900 | 25 | LOD | 15 |
| Fluorene | ug/kg | <12-1151 | 12 | LOD | 15 |
| Indeno(1,2,3,cd)pyrene | ug/kg | <11-5600 | 11 | LOD | 14 |
| Lead | mg/kg | 3-107 | 23 | Background | 16 |
| Mercury | mg/kg | <0.3-2 | 0.3 | LOD | 4 |
| Mineral Oil / Paraffin | mg/kg | <10-232 | 10 | LOD | 39 |
| Naphthalene | ug/kg | <10-3742 | 10 | LOD | 16 |
| Nickel | mg/kg | 6-27 | 10 | Background | 14 |
| NSO / Resins | mg/kg | 27-2972 | 10 | LOD | 37 |
| pH | pH | 4.26-9.24 | <6, >8.5 | Normal Range | 43 |
| Phenanthrene | ug/kg | <21-5000 | 21 | LOD | 16 |
| Phenol | ug/kg | <10-220 | 10 | LOD | 9 |
| Pyrene | ug/kg | <22-8300 | 22 | LOD | 16 |
| Selenium | mg/kg | <1-3 | 2 | Background | 1 |
| Solvent Extractable Matter | mg/kg | 52-3510 | 10 | LOD | 1 |
| Sulphide | mg/kg | 5-16 | 1 | LOD | 4 |
| Sulphur | % | <0.01-0.51 | 0.01 | LOD | 27 |
| Thiocyanate | mg/kg | <1-3 | 1 | LOD | 4 |
| Total Non-volatile Aromatics | mg/kg | <10-125 | 10 | LOD | 9 |
| Total PAH (leachate) | ug/l | <0.027-0.3 | 0.027 | LOD | 1 |
| Total PAH | mg/kg | <0.025-306 | 0.025 | LOD | 26 |
| Total Sulphate | mg/kg | 83-1885 | 10 | LOD | 28 |
| TPH (C12-C16) | mg/kg | <0.01-23 | 0.01 | LOD | 5 |
| TPH (C16-C21) | mg/kg | <0.01-130 | 0.01 | LOD | 5 |
| TPH (C21-C35) | mg/kg | <0.01-580 | 0.01 | LOD | 8 |
| TPH (C10-C12) | mg/kg | <0.01-3 | 0.01 | LOD | 4 |
| Vanadium | mg/kg | 15-53 | 1 | LOD | 17 |
| Zinc | mg/kg | 7-237 | 52 | Background | 7 |

The determinands presented in Table 7-7 represent initial areas of potential concern (APC) with respect to potential impacts to groundwater resulting from soil contamination. In accordance with the methodology presented in Section 7.3.1, previous reports containing quantitative Tier 2 risk assessments have been consulted to determine whether the concentrations of the determinands presented in Table 7-7 are likely to cause a potentially significant risk to groundwater. Where quantitative Tier 2 risk assessment has not been undertaken for a particular determinand, qualitative Tier 2 risk screening has been undertaken.

The results of this assessment indicate that one of the following applies to all the determinands of concern:

- Quantitative Tier 2 risk assessment has demonstrated that some determinands present no significant risk to water resources (e.g. arsenic, di-sec-octylphthalate, nickel, phenol, zinc);
- Quantitative Tier 2 risk assessment suggests that some impacts could occur, and these potential impacts will be managed accordingly (e.g. copper, all polycyclic aromatic hydrocarbon species); or
- Qualitative Tier 2 risk screening suggests that the determinands are unlikely to pose a significant risk to groundwater at the concentrations encountered (e.g. barium, beryllium, vanadium). This conclusion has been made where similar or higher determinand concentrations have been assessed in previous reports and have not resulted in an impact, or the concentrations encountered are considered to be indicative of natural concentrations of a particular determinand.

Further details relating to the Tier 2 quantitative and qualitative screening exercise are presented in Appendix A.

*7.4.4.6 Groundwater Contamination*

Groundwater laboratory data has been extracted from the available reference sources for the exploratory locations within the HEFF Construction Enclave and Proposed Facility, and immediately up gradient and down gradient of the HEFF Construction Enclave and Proposed Facility.

A number of determinands have been identified at concentrations exceeding the method detection limit, and full details are contained in Appendix A. To determine whether the identified determinand concentrations represent potential sources of contamination under baseline conditions, the data have been assessed in relation to Tier 1 Screening Values applicable to either human health or water resources.

A summary of the laboratory analysis results showing those determinands that exceeded the Tier 1 Screening Values relevant to groundwater is given in Table 7-8.

*Table 7-8 Summary of Groundwater Tier 1 Screening – Risk to Groundwater*

| Determinand | Units | Range | Screening Value | Source | Locations Exceeding Value |
|---|---|---|---|---|---|
| Alkalinity Total | µg/l | <2000-174000 | 2000 | LOD | 5 |
| Ammoniacal Nitrogen as NH4-N | ug/l | <200-1800 | 390 | UK DWS | 7 |
| Benzo(a)pyrene | ug/l | <0.01-0.052 | 0.01 | EU DWS | 3 |
| Benzo(ghi)perylene | ug/l | <0.01-0.109 | 0.01 | LOD | 2 |
| Biological | µg/l | <1000-97000 | 2000 | Water quality | 6 |

| Determinand | Units | Range | Screening Value | Source | Locations Exceeding Value |
|---|---|---|---|---|---|
| Oxygen Demand (BOD) | | | | assessment document | |
| C4-C40 Carbon Banding | ug/l | 15-260 | 10 | DEFRA | 6 |
| Chemical Oxygen Demand (COD) | mg/l | <10-3860 | 20 | Ground-water literature in unpolluted surface water | 8 |
| Copper | µg/l | <1-32 | 28 | FW EQS | 1 |
| Cyanide | ug/l | <50-930 | 50 | EU DWS | 1 |
| Dibenzo(ah)anthracene | µg/l | <0.01-0.01 | 0.0092 | US EPA PRG | 1 |
| Diesel Range Organics | ug/l | <10-520 | 10 | DEFRA | 4 |
| Dissolved Oxygen | ug/l | 5-18900 | 1 | LOD | 4 |
| Gross Alpha | Bq/m$^3$ | <8-56 | 40 (Bq/m$^3$) | AWE 'trigger levels' | 1 |
| Hydrocarbon oil | ug/l | <50-100 | 10 | UK DWS | 2 |
| Manganese | ug/l | 10-1377 | 50 | EU DWS | 4 |
| Mercury | µg/l | <0.05-2.1 | 1 | FW EQS | 1 |
| Nitrite | ug/l | <50-739 | 500 | EU DWS | 2 |
| pH | pH Units | 4.7-8.49 | <6,>9 | FW EQS | 4 |
| Selenium | ug/l | <1-12 | 10 | EU DWS | 1 |
| Solvent Extractable Matter | µg/l | <1000-2000 | 1000 | LOD | 6 |
| Sulphide | ug/l | 50-90 | 0.25 | FW EQS | 4 |
| Total Dissolved Solids | µg/l | 47000-270000 | 1000 | LOD | 4 |
| Total Organic Carbon | µg/l | <1000-10000 | 1000 | LOD | 8 |
| Total Oxidised Nitrogen | µg/l | 300-1300 | 100 | LOD | 3 |
| Total PAH (sum of 4*) | µg/l | 0.18-0.251 | 0.1 | EU DWS | 2 |
| Total Phenol | µg/l | <10-3470 | 30 | FW EQS | 1 |

| Determinand | Units | Range | Screening Value | Source | Locations Exceeding Value |
|---|---|---|---|---|---|
| Total Suspended Solids | µg/l | <10000-800000 | 10000 | LOD | 4 |
| Trichloroethene | ug/l | <1-408 | 10 | FW EQS | 4 |
| Zinc | ug/l | <3-1369 | 500 | FW EQS | 1 |

A summary of the laboratory analysis results showing those determinands that exceeded the Tier 1 Screening Values relevant to human health is given in Table 7-9. Only those detected determinands with a Henry's Law constant greater than $10^{-5}$ atm-m$^3$/mol are shown in this table since these are the determinands that have the potential to represent a risk to human health through generation of organic vapours.

*Table 7-9 Summary of Groundwater Tier 1 Screening – Risk to Human Health*

| Determinand | Units | Range | Screening Value | Source of Henry's Law Constant | Locations Exceeding Value |
|---|---|---|---|---|---|
| 1,1-Dichloroethane | ug/l | <1-8 | LOD and >10-5 atm-m3/mol | Mackey *et al* | 1 |
| 1,1-Dichloroethene | ug/l | <1-3 | LOD and >10-5 atm-m3/mol | Mackey *et al* | 1 |
| 1,2-Dichloroethane | ug/l | <0.5-0.82 | LOD and >10-5 atm-m3/mol | Mackey *et al* | 1 |
| Acenaphthene | ug/l | <0.01-0.265 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 13 |
| Acenaphthylene | ug/l | <0.01-0.078 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 8 |
| Anthracene | ug/l | <0.01-0.162 | LOD and >10-5 atm-m3/mol | SRC 2005 PHYSPROP database | 12 |
| Benzo(b)fluoranthene | ug/l | <0.01-0.06 | LOD and >10-5 atm-m3/mol | US EPA OSWER | 3 |
| C10-20 Carbon Banding | ug/l | 70-100 | Refer to specific fractions | - | 4 |
| C21-30 Carbon Banding | ug/l | 170-260 | Refer to specific fractions | - | 4 |
| C31-40 Carbon Banding | ug/l | 100-160 | Refer to specific fractions | - | 4 |

| Determinand | Units | Range | Screening Value | Source of Henry's Law Constant | Locations Exceeding Value |
|---|---|---|---|---|---|
| Carbon Tetrachloride | ug/l | <0.1-1.6 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 2 |
| Chloroform | ug/l | <1-1 | LOD and >10-5 atm-m3/mol | WHO & ATSDR | 1 |
| Chrysene | ug/l | <0.01-0.04 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 5 |
| Diesel Range Organics | ug/l | <10-520 | Refer to specific fractions | - | 4 |
| Ethyl Benzene | ug/l | <0.1-0.34 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 2 |
| Fluoranthene | ug/l | <1-0.078 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 10 |
| Fluorene | ug/l | <0.01-0.193 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 13 |
| Methyl chloroform | ug/l | <1-98 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 1 |
| Naphthalene | ug/l | <1-8.174 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 13 |
| o-Xylene | ug/l | <10 | LOD and >10-5 atm-m3/mol | R&D Publication SGV18 | 1 |
| PRO C4-C10 | ug/l | <10-192 | Refer to specific fractions | - | 2 |
| Pyrene | ug/l | <0.01-0.794 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 10 |
| Solvent Extractable Matter | µg/l | <1000-2000 | | - | 6 |
| Tetrachloroethene | µg/l | <0.1-2.92 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 3 |
| Toluene | µg/l | <1-2.2 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 1 |
| Total 19 SSPH PAHs | µg/l | 0.143 | Refer to individual PAH's | - | 1 |
| Total GRO (C4-C10) | ug/l | <10-61 | Refer to specific fractions | - | 1 |
| Total PAH | µg/l | <0.01-1000 | Refer to individual PAH's | - | 10 |

| Determinand | Units | Range | Screening Value | Source of Henry's Law Constant | Locations Exceeding Value |
|---|---|---|---|---|---|
| trans-1,2-Dichloroethene | ug/l | <1-3 | LOD and >10-5 atm-m3/mol | Mackey et al | 1 |
| Tricholoroethane | µg/l | <0.1-5.74 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 2 |
| Trichloroethene | ug/l | <1-408 | LOD and >10-5 atm-m3/mol | EA Draft Tech Report P5-079/TR1 | 5 |

The determinands presented in Table 7-8 and Table 7-9 represent initial areas of potential concern (APC) with respect to potential impacts to human health and water resources resulting from groundwater contamination.

In accordance with the methodology presented in Section 7.3.1, previous reports containing quantitative Tier 2 risk assessments have been consulted to determine whether the concentrations of the determinands presented in Tables 7-8 and 7-9 are likely to cause a potentially significant risk. Where quantitative Tier 2 risk assessment has not been undertaken for a particular determinand, qualitative Tier 2 risk screening has been undertaken. The results of this assessment indicate that one of the following applies to all the determinands of concern:

- Quantitative Tier 2 risk assessment has demonstrated that some determinands present no significant risk to water resources or human health (e.g. chloroform, phenol);
- Quantitative Tier 2 risk assessment suggests that some impacts could occur, and these potential impacts will be managed (e.g. copper, polycyclic aromatic hydrocarbon species, trichloroethene); or
- Qualitative Tier 2 risk screening suggests that the determinands are unlikely to pose a significant risk to groundwater or human health at the concentrations encountered, or only one exceedence has occurred and subsequent monitoring identified concentrations below the detection limit (e.g. mercury, nitrite).

Further details relating to the Tier 2 quantitative and qualitative screening exercise are presented in Appendix A.

#### *7.4.4.7 Summary of Existing Potential Sources of Contamination*

Based upon the information presented in Sections 7.4.4.1 to 7.4.4.6, the following potential sources of contamination have been identified:

- Soil gas comprising elevated carbon dioxide and depleted oxygen;
- Asbestos in soil;
- Soil contaminants; and
- Groundwater contaminants.

### 7.4.5 Potential Receptors

Identified potential receptor groups comprise the following:

- 'Site Users': Permanent AWE Aldermaston site employees, contractors, and visitors using or visiting the HEFF Project Area or its immediate surrounds;
- 'Built Environment': Structures and associated services and infrastructure already existing within the HEFF Project Area and its immediate surrounds; and
- 'Water Resources': Groundwater and surface water within the HEFF Project Area and Study Area.

The report entitled 'Environmental Site Setting Exercise: Aldermaston, Volume 1' dated September 2005 (Ref. 7-37) refers to the AWE Aldermaston site as a sheltered site with west and southwest prevailing winds. To the east and northeast of the AWE Aldermaston site lies forested land and mixed agricultural/farmsteads, respectively. Local receptors lying outside the AWE Aldermaston site boundary, including site neighbours, those using footpaths or local roads, occupiers of agricultural property and the ecological receptors within Decoy Pit, Pools and Woods SSSI, are not considered to be potential receptors principally due to the distance of these receptors from the HEFF Project Area. For this reason, other receptors within the AWE Aldermaston site boundary, including Site users and sensitive receptors such as the Grim's Bank Scheduled Monument (SM), are also not considered to be potential receptors for the purposes of this chapter.

Receptor importance/sensitivity has been evaluated in accordance with Table 7-10 (further details on receptor sensitivity can be found in Appendix A of this EA).

*Table 7-10 Methodology for Determining Importance or Sensitivity of Receptors*

| Importance/Significance | Area |
|---|---|
| International | European Community or wider area |
| National | Different parts of England or UK as a whole |
| Regional | West Berkshire |
| District | Reading |
| Local | Aldermaston receptors |

In order to execute a transparent assessment of potentially significant environmental impacts, it is necessary to provide a classification of the overall sensitivity or importance of each of the receptor groups where potential pollutant linkages exist. The overall sensitivity or importance of the receptor groups Built Environment and Water Resources where a linkage exists is considered Local (Aldermaston).

The receptor group Site Users is not assigned an importance in the terms outlined in Table 7-10 since all human receptors are considered to be high sensitivity.

### 7.4.6 Potential Pathways

The identified sources of potential contamination have the potential to impact upon the identified receptors provided that there are pathways connecting the two. A summary of identified pathways and exposure routes, and an assessment of the frequency of exposure via each pathway, is summarised in Table 7-11.

*Table 7-11 Potential Pathways and Exposure Routes, and Frequency of Exposure*

| Potential Pathways and Exposure Route | Frequency |
|---|---|
| Ingestion and uptake of soil or dust by humans | Intermittent and rare (for soil), occasional (for dust) |
| Dermal contact with soil or dust by humans | Intermittent and rare (for soil), occasional (for dust) |
| Inhalation of fugitive soil dust by humans | Intermittent and rare |
| Inhalation of soil gases by humans | Intermittent and occasional |
| Inhalation of soil and groundwater vapours by humans | Intermittent and occasional |
| Direct contact of soil and groundwater contaminants with the built environment | Continuous |
| Vertical and lateral migration of soil gases | Continuous |
| Vertical migration of soil contaminants to groundwater | Continuous |
| Lateral migration of groundwater contaminants to groundwater and surface water | Continuous |

### 7.4.7 Preliminary Conceptual Model

Utilising the information presented in Sections 7.4.1 to 7.4.6, a preliminary conceptual model for the HEFF Project Area, which identifies potential source-pathway-receptor pollutant linkages for the baseline scenario, can be established. Where pollutant linkages exist, there is a risk that there will be an impact on one or more of the identified receptors.

Potential pollutant linkages that exist at the HEFF Construction Enclave and Proposed Facility, taking into account the geological, hydrogeologic and hydrologic setting summarised above and described in additional detail in Appendix A, are given in Table 7-12.

*Table 7-12 Potential Pollutant Linkages*

| Source | Pathway and Exposure Route | Receptor |
|---|---|---|
| Groundwater contamination | Inhalation of organic vapours from contaminated groundwater | Site Users, Visitors, Contractors |
| | Lateral migration of contaminants in groundwater | Groundwater |
| | Lateral migration of contaminants in groundwater | Surface Water |
| | Direct contact with building materials including underground structures | Built environment |
| Soil gas | Migration through the ground or existing drains and subsequent inhalation | Site Users, Visitors, Contractors |
| Asbestos | Inhalation of soil dust containing asbestos fibres | |
| Soil contamination | Dermal contact with contaminated soil or dust | |
| | Ingestion and uptake of contaminated soil or dust | |
| | Inhalation of fugitive soil dust | |
| | Inhalation of organic vapours from contaminated soil | |
| | Vertical migration of soil contaminants to groundwater | Groundwater |
| | Direct contact with building materials including underground structures such as drains | Built environment |

## 7.5 Potential Impacts and Mitigation Measures

### 7.5.1 Potential Impacts

#### *7.5.1.1 Baseline Impacts*

*Existing Ground Gases*

The presence of carbon dioxide in soil at concentrations greater than 5% v/v and oxygen in soil at concentrations less than 18% v/v has the potential to impact upon human health in the event that human receptors were exposed to these conditions within confined spaces, for example excavations and building basements. The HEFF Construction Enclave and Proposed Facility area is currently undeveloped with the exception of building B3A20. The HEFF Utilities Layout Drawing (Ref. 7-38) shows that within the HEFF Construction Enclave and Proposed Facility area existing utilities running adjacent to the eastern red line boundary include High voltage (HV) cables, Freshwater (FW) mains, Potable Water Drainage (PWD) mains, Uninterruptible Power Supply (UPS) Duct Section, and steam and condensate pipework. A sluice valve (SV3962) is also shown on the drawing associated with B3A20. Below ground services can act as pathways for migration of any potential ground gases. Buildings (and their users) can be susceptible to the effects of ground gases (e.g. explosion, asphyxiation) depending upon concentrations and prevailing atmospheric conditions. However, given that the concentration of carbon dioxide encountered only marginally exceeds the Tier 1 Screening Criteria, the scale of impact to humans resulting from soil gas is considered to be *negligible*.

*Existing Soil Quality*

The presence of asbestos in soil has the potential to impact upon human health in the event that human receptors were exposed to asbestos fibres. The asbestos encountered in the soil appeared to be bonded and was not considered friable. The asbestos was encountered at depth within trial pits that have since been backfilled, and was identified in only two locations. Under current conditions, Site Users will generally be making visual observations of the HEFF Project Area or will be undertaking activities within building B3A20. The scale of impact to humans resulting from asbestos in soil is therefore considered to be *negligible* due to the absence of plausible pathways.

Soil determinand concentrations have been screened against Tier 1 Screening Values that have been generated specifically for the AWE Aldermaston site. All of the determinand concentrations in soil were significantly lower than the Tier 1 Screening Values. The scale of impact to human health from soil determinands has therefore been demonstrated to be *negligible*.

Determinands within soil have the potential to impact groundwater quality where vertical migration occurs. Of the soil determinands identified as exceeding the relevant Tier 1 Screening Values, previous reports have identified through quantitative risk assessment that many of these would pose no significant risk to groundwater at the concentrations encountered. For these determinands, the scale of impact has been demonstrated to be *negligible*. As a result, the scale of the impact is considered to be *low* and *negative*. For determinands where the concentrations exceeded the Tier 1 Screening Values, but the potential risks have not been previously assessed through quantitative risk assessment, the concentrations encountered only marginally exceeded the Tier 1 Screening Values or are considered to represent background concentrations. The scale of the impact is therefore considered to be *low* and *negative*.

*Existing Groundwater Quality*

Volatile organic compounds within groundwater have the potential to impact upon human health if migration through soil and collection within buildings occurs. Volatile organics have been identified within groundwater, although the concentrations encountered generally only marginally exceed the laboratory method detection limit. In addition no organic contamination in the form of free product has been observed during previous investigations reviewed. Groundwater is located generally at a depth of 2 m below ground level with a range in the HEFF Construction Enclave and Proposed Facility of 0.8 to 3.2 m below ground level. The shallow geology (the Silchester Gravels and Bagshot Beds) generally comprises clayey gravel and silt/clay. Considering the low determinand concentrations, the absence of free product, and the thickness and lithology of the unsaturated zone, the scale of impact to humans resulting from volatile organic compounds in groundwater is considered to be *negligible*.

Determinands within groundwater have the potential to impact off site groundwater quality and/or off site surface water quality. Of the groundwater determinands identified as exceeding the relevant Tier 1 Screening Values, previous reports have identified through quantitative risk assessment that many of these would pose no significant risk to off site groundwater or surface water at the concentrations encountered. The scale of impact has been demonstrated to be *negligible*. As a result, the scale of the impact is considered to be *low* and *negative*. For determinands where the concentrations exceeded the Tier 1 Screening Values, but the potential risks have not been previously assessed through quantitative risk assessment, the concentrations encountered only marginally exceeded the Tier 1 Screening Values. The scale of the impact is therefore considered to be *low* and *negative*.

The appropriate design specification for concrete has been assessed as part of the Proposed Development and has identified the requirement for a concrete class that takes into account the brownfield location, mobile groundwater, and low recorded pH values in groundwater and soil (<4.5). The concentrations of organic determinands in groundwater and soil are generally low or below detection limits.

Routine maintenance and services checks on buildings and services will ensure that any degradation of materials is identified. It is therefore considered likely, in view of the baseline soil, leachate and groundwater conditions detected, that any impact that may be occurring would be *low* and *negative*.

#### *7.5.1.2 Potential Construction Phase Impacts*

The HEFF Project Construction Management Plan (Ref. 7-39) summarises the planning, design, pre-construction activities, and construction of the Proposed Facility. During construction of the Proposed Development, various ground engineering works will occur that could involve the disturbance and/or removal of soils affected by potential contamination. The scale of potential impacts resulting from these activities during the construction phase is considered in the following sections.

*Excavation and Construction*

The excavation of soil from the HEFF Construction Enclave and Proposed Facility area during construction, and subsequent transportation, storage, and disposal, has the potential to result in the following:

- Exposure of humans to soil contaminants (dermal contact, ingestion and uptake), organic vapours and dusts from contaminated soil (inhalation), and asbestos (inhalation) that is currently at depth;
- Exposure of humans to soil gases in excavations (inhalation); and
- Mobilisation of existing contamination and migration into groundwater.

The concentrations of soil determinands identified in the HEFF Construction Enclave and Proposed Facility area have been compared with Tier 1 Screening Values that are applicable to the current baseline conditions. They are not considered applicable to the conditions that will be encountered during the construction phase of the Proposed Development, as they do not take into account the increased exposure rate that would result from excavation and construction activities. However, it is noted that the concentrations of

determinands in soil are significantly below the Tier 1 Screening Values for human health for most determinands. For exposure to soil determinands, it is predicted that the scale of the potential impact to Site Users and Visitors to the HEFF Development would be *low* and *negative*. For Construction Workers within the HEFF Construction Enclave and Proposed Facility, it is predicted that the scale of the potential impact would be *medium* and *negative*. Mitigation measures will therefore be implemented for this activity.

Exposure to organic vapours may occur where high concentrations of volatile organic compounds are present in soil. However, the concentrations of the volatile organic compounds in soil are considered to be low and have been demonstrated as not producing significant quantities of vapour through monitoring within boreholes. The predicted scale of the potential impact to Site Users, Visitors, and Construction Workers is therefore *negligible*.

Asbestos has been encountered at two locations in the HEFF Construction Enclave and Proposed Facility in areas that may be disturbed during excavation and construction. The asbestos encountered was bonded and therefore would pose little impact unless broken or crushed. The source of this asbestos has been identified and removed resulting in a *negligible* impact to Site Users, Visitors and Construction Workers.

Gas concentrations encountered during previous investigations identified areas of the HEFF Construction Enclave and Proposed Facility area where carbon dioxide concentrations were greater than 5% v/v and oxygen concentrations were below 18% v/v. Excavations below ground surface may allow soil gases to build up, which could affect Construction Workers entering the excavations. The predicted scale of the potential impact is considered to be *low* and *negative* for Construction Workers, and *negligible* for Site Users and Visitors. It is considered that mitigation is merited for this activity.

Determinands have the potential to be leached from soil where previously unexposed soils are exposed. Since the construction of the Proposed Facility will be undertaken over a relatively short period of time, it is considered that the scale of the impact would be *negligible*.

*Accidental Spillages*

A number of potentially contaminating materials are stored and used during construction activities. These include oils and hydrocarbons comprising diesel, fuel oil, lubricating oil, petrol and hydraulic fluids. The use of concrete and cement products can also present a contamination risk through uncontrolled release of washdown water or run-off. During construction there is therefore potential for contamination of groundwater and the site surface water drainage system from accidental spillages of oils, fuels and construction materials, and subsequent migration to surface water. This could lead to short-term impacts on sensitive receptors during the construction phase and longer-term impacts during the operational phase of the development. The potential scale of impact to water resources from fuel, oil and construction material handling, storage and disposal in the absence of mitigation is considered to be *low* (minor spills) to *medium* and *negative* (in the event of more major spills). Mitigation measures will therefore be implemented for this activity.

Spilled materials could also cause harm to human health (Construction Workers) through dermal contact with materials or inhalation of vapours. The predicted scale of the impact to Construction Workers is considered to be *low* and *negative*, and to Site Users and Visitors is considered to be *negligible*. Mitigation measures will therefore be implemented for this activity.

*Disturbance of Sediment*

Construction activities that could result in the disturbance of sediment and therefore a potential source of suspended sediment pollution entering groundwater and the site surface water drainage system include soil stripping, excavation and stockpiling, build up of mud and dust on site access roads, plant and wheel washing, dewatering and discharge of accumulated surface water and groundwater. Sediments can enter groundwater or the site surface water drainage system via rainfall run-off or through washing down during construction. Sediment disturbance could also potentially result in increased determinand mobility through leaching of soil determinands. The potential scale of impacts to groundwater from sediment disturbance during normal construction activities in the absence of mitigation is considered to be *low* and *negative*. This is based on the relatively low concentrations of soil determinands and limited number of mobile determinands identified from soils leachability testing.

French drains are present within the HEFF Construction Enclave and Proposed Facility area and there is potential for direct discharge of sediment into the site drainage system and subsequently surface waters. In the absence of mitigation, the potential scale of impact on the AWE Aldermaston Site surface water drainage system is considered *medium* and *negative*. Mitigation measures will therefore be implemented for this activity.

*Generation of Wastes*

All construction phase activities have the potential to generate waste materials, including potentially contaminated soils from excavations, empty storage containers, etc. These waste materials have the potential to affect human health or the environment through the inhalation of fugitive dust by humans generated as a result of 'windblown' arisings from material storage areas.

The scale of the predicted impact is considered *low* and *negative* for Site Users and Visitors, and *medium* and *negative* for Construction Workers. Mitigation measures will therefore be implemented for this activity.

*7.5.1.3 Operational Phase Impacts*

*Proposed Facility*

The main HEFF building will be constructed of reinforced concrete with external lightweight cladding. The Proposed Facility also includes lightning protection towers, standing at approximately 28 m, an external mechanical and electrical services building of single-storey and associated services/infrastructure (as shown on the Utilities Layout Plan, Ref. 7-38). It is understood that the Proposed Facility will comprise permeable hardstanding, with limited exceptions where soft landscaping is present.

The Construction Management Plan (Ref. 7-39) states that following the completion of construction and fit out, there will be a year of inert testing before handing over the facility, following which, 6 months of live testing will be carried out before the new facility is fully operational.

The nature of the operational processes are unlikely to lead to any impact to soil and/or groundwater. Therefore, the potential scale of impacts from the operation of the Proposed Facility on soil and groundwater is considered *negligible*.

*Existing Ground Gases*

The concentration of carbon dioxide encountered during previous investigations only marginally exceeded the Tier 1 Screening Criteria. The scale of impact to Site Users and Visitors during operation of the Proposed Facility resulting from soil gas is considered to be *negligible*.

*Existing Soil Quality*

The existing soil quality, including the presence of soil determinands have the potential to impact upon Site Users and Visitors during operation of the Proposed Facility. It is understood that the HEFF Project Area will be surfaced with hardstanding, with limited exceptions where soft landscaping is present. The scale of impact to humans resulting from asbestos and determinands in soil is therefore considered to be *negligible* due to the absence/limited presence of plausible pathways.

Determinands within soil have the potential to impact groundwater quality where vertical migration occurs. Under baseline conditions, the scale of the potential impacts was considered to vary from *negligible* to *low* and *negative*. However, where impacts to groundwater from soil determinands were predicted through quantitative risk assessment, it should be noted that this risk assessment assumed the area was not surfaced with hardstanding. As much of the HEFF Project Area is to be surfaced with hardstanding, it is considered that the rate of leaching of soil determinands and migration into groundwater would be reduced from the rate at which these activities are occurring under baseline conditions. As such, it is considered that the Proposed Facility will have a *negligible* to *low* and *positive* impact.

Where excavated soils are to be used for landscaping purposes, the soils will be visually inspected to ensure that unsuitable materials are removed (e.g. potentially asbestos-containing materials). Only suitable soils will be used for landscaping purposes. Excavation and construction phase mitigation will apply (see Section 7.5.2.1).

*Existing Groundwater Quality*

Considering the low volatile organic compound concentrations, the absence of free product, and the thickness and lithology of the unsaturated zone, the scale of impact to Site Users and Visitors resulting from volatile organic compounds in groundwater is considered to be *negligible*.

Determinands within groundwater have the potential to impact off site groundwater quality and/or off site surface water quality. Of the groundwater determinands identified as exceeding the relevant

Tier 1 Screening Values, previous reports have identified through quantitative risk assessment that many of these would pose no significant risk to off site groundwater or surface water at the concentrations encountered. For these determinands, the scale of impact has been demonstrated to be negligible. For determinands where the concentrations exceeded the Tier 1 Screening Values, but the potential risks have not been previously assessed through quantitative risk assessment, the concentrations encountered only marginally exceeded the Tier 1 Screening Values. The scale of the impact is therefore considered to be negligible to low and negative, and mitigation measures will be implemented if required.

The appropriate design specification for concrete has been assessed as part of the Proposed evelopment and has identified the requirement for a concrete class that takes into account the brownfield location, mobile groundwater, and low recorded pH values in groundwater and soil (<4.5). As appropriate building materials are being used, it is considered that the scale of impact will be *negligible*.

### 7.5.2 Mitigation

The qualitative risk assessment has identified that construction of the Proposed Facility has the potential to impact in a negative manner on a range of key receptors under baseline conditions, under construction conditions, and under operational conditions. However, a series of mitigation measures will be implemented in order to ensure that any potential negative impacts that may result from the Proposed Development are reduced to an acceptable and manageable level. The proposed mitigation is outlined below for each activity occurring during the operational and construction phases.

#### *7.5.2.1 Construction Phase Mitigation*

*Excavation and Construction*

The potential impacts of existing soil contamination exposure to Construction Workers will be mitigated by the development and implementation of an Environmental Management Plan (EMP), specific to the HEFF project, which will be produced in accordance with AWE's Code of Construction Practice (CoCP). Suitable method statements, Health and Safety plans and Safe Systems of Work will be available within the EMP to mitigate against the potential impact of exposure of construction workers to soil contamination, asbestos, and ground gases. Mitigating procedures will include the identification of areas of concern with respect to soil contamination, asbestos and ground gases, implementation of appropriate excavation methods, provision of personnel able to identify asbestos containing materials, and safe systems of work for access to excavations. This will include monitoring for unsuitable conditions prior to entering excavations.

The EMP will allow for the provision and use of appropriate personal protective equipment (PPE). This will include protective clothing, gloves and respiratory protection (if necessary). Other Site Users/Visitors who may be at risk of exposure to potential sources of contamination on the HEFF Construction Enclave and Proposed Facility area will be issued with appropriate PPE as necessary before entering active construction or excavation areas. Exposure to wind-blown dusts and general soil dust will be mitigated by employing protective measures during construction (see 'Disturbance of sediment section'). It is considered that the implementation of these measures would reduce the scale of the impact to *negligible*.

*Accidental Spillage*

The use of procedures developed in the EMP during construction of the Proposed Facility will help to prevent construction work from giving rise to contamination, and to prevent the migration of any contamination to areas outside of the HEFF Project Area. All construction works will be conducted in accordance with the appropriate AWE Construction Site Rules (Ref. 7-40).

Adequate risk assessments and method statements will be included within the EMP and followed such that work is carried out in a safe and environmentally acceptable manner. Operational safeguards to prevent accidental spills during construction will be employed. This will include all materials that represent a risk to the environment being labelled, stored, handled and used in an appropriate manner, including the use of sheeting, bunds, and drip trays. In addition, procedures will be put into place to ensure that any spills of materials that do occur are dealt with appropriately and expediently. With the implementation of the proposed mitigation measures, the scale of impact is predicted to be reduced to *negligible*.

*Disturbance of Sediment*

Protective measures will be employed during construction, to include effective dust suppression techniques (e.g. damping down) where prevailing meteorological conditions require, minimisation of the amount of exposed ground and soil stockpiles by appropriate phasing of construction works. The covering of stockpiles will be considered where these are deemed to represent significant sources of windblown dust.

Site access points and roadways will be regularly brushed or scraped and kept clean from dust and mud deposits. The amounts of exposed ground surface at any one time and soil stockpiles will be seeded or covered with use of silt fences or cut-off ditches to prevent or manage the release of sediments. Discharge from wheel washes and plant-washing facilities will be contained and disposed of according to AWE wastewater risk assessment requirements. With the implementation of the proposed mitigation measures, the scale of impact is predicted to be reduced to *negligible*.

*Generation of Waste*

Waste materials could comprise contaminated soils or soils containing asbestos. Appropriate storage, in line with the EMP, will be provided for all wastes generated during construction of the Proposed Facility to ensure exposure to potentially contaminative materials is minimised. This storage will include covering of waste stockpiles and skips, and the separation and segregation of different waste types (e.g. non-contaminated and potentially contaminated). With the implementation of the appropriate mitigation measures, the scale of impact is predicted to be reduced to *negligible*.

#### *7.5.2.2 Operational Phase Mitigation*

A programme of long-term groundwater monitoring to identify any potential impacts from soil determinands to groundwater, and to identify the migration of determinands in groundwater to surface watercourses is in place at the AWE Aldermaston Site. In the event that a potential impact to groundwater and/or surface water is identified through the monitoring, AWE is committed to conducting additional works to reduce, repair, or compensate for the impact. With the implementation of the proposed mitigation measures, the scale of impact is predicted to be reduced to *negligible*.

## 7.6 Monitoring and Refinement

During construction, the Environmental Management Plan will incorporate monitoring requirements for all construction phase activities including waste storage and handling, spillage of materials, dust disturbance, etc. The results of monitoring will be used to refine the mitigation measures in place as required.

## 7.7 Residual Impact Assessment and Conclusions

A detailed assessment of the environmental baseline for Ground Conditions has been undertaken for the Proposed Facility and HEFF Construction Enclave. The assessment has involved an in-depth review of the sites' history, geology, hydrology and hydrogeology, and a review and assessment of a series of intrusive ground investigations that have been conducted within the boundary and immediately surrounding the HEFF Project Area.

The general ground conditions in the HEFF Project Area comprise a thin layer of Made Ground over the clayey gravels of the Silchester Gravels and the sands/silts/clays of the Bagshot Formation. The London Clay Formation underlies the entire site, which in turn is underlain by the Chalk. The Silchester Gravels and Bagshot Formation are classified as a Minor Aquifer. Shallow groundwater is typically present at between 0.8 and 3.2 m below ground level and is either discharged to proximal watercourses as either springs or base flow or can be abstracted for private water supply.

Based on a review of available data, it appears that soil and groundwater quality in parts of the HEFF Construction Enclave and Proposed Facility area have been impacted by historical operations. The Tier 1 Screening Assessment and impact assessments completed within this EA, and the qualitative and quantitative risk assessments completed historically, indicate that the significance of the identified impacts following implementation of the proposed mitigation (i.e. residual impacts) will be negligible under both the construction and operational phases of the Proposed Development..

A summary of the proposed mitigation measures and residual significance assessment is presented in Table 7-13.

## 7.8 Cumulative Impact Assessment

In judging whether the effects of the HEFF development are likely to be significant, it is also relevant to have regard to the possible cumulative effects of this development with any existing, proposed or approved development. AWE has produced a Site Development Context Plan (SDCP) (Ref. 7-41), which outlines the future vision of AWE with respect to the Aldermaston site. This includes a number of proposals to tackle historical groundwater contamination issues on-site. The plan forms part of AWE's programme for responsible site management, summarised in its 'Environmental Stewardship' publication. The latter document sets out the results of the AWE Land Quality Survey and the proposed strategy for site restoration over the current 10 year plan period.

It is clear from the documents that AWE intends to execute a programme of significant investment in new buildings, infrastructure and facilities at the AWE Aldermaston site over the plan period, including the New Office Accommodation development, for which planning permission has recently been consented. This will necessarily entail the identification and assessment of risks associated with land contamination in other areas of the site and demonstration of areas being 'fit for use' for new industrial facilities, which, in some cases, may involve remediation of historical contamination. Overall, the cumulative effect of this programme of work, taken together with the HEFF development, is likely to generate positive impacts for ground conditions across the AWE Aldermaston site in terms of breaking potentially significant pollutant linkages and in bringing under-utilised areas of the site back into use. No significant cumulative impacts are envisaged in relation to the external schemes highlighted in Table 17-2.

*Table 7-13: Summary of Mitigation and Residual Impacts*

| Description of Impact | +ve/ -ve | Time Span | Overall Impact Scale | Mitigation | Residual Impact Description | Residual Impact Significance | Monitoring Measures and Management Techniques Committed to Verify Success |
|---|---|---|---|---|---|---|---|
| ***Potential Construction Phase Impacts*** | | | | | | | |
| Exposure of Site Users and Visitors to soil contaminants exposed during excavation and construction | -ve | Short-term | Low | Provision and use of PPE<br>Employment of protective measures during construction<br>Dust suppression<br>Phasing of construction works to minimise exposed ground and soil stockpiles<br>Covering of stockpiles | No significant exposure to soil | Negligible | Specified in the Construction and Environmental Management Plans |
| Exposure of Construction Workers to soil contaminants exposed during excavation and construction | -ve | Short-term | Medium | | No significant exposure to soil | Negligible | Specified in the Construction and Environmental Management Plans |
| Exposure of Construction Workers to asbestos exposed during construction and excavation | -ve | Short-term | Medium | Production of Environmental Management Plan, method statements, and Health and Safety plans<br>Identification of areas of concern<br>Implementation of appropriate excavation methods<br>Safe systems of work for access to excavations<br>Monitoring prior to entry of excavations | No significant exposure to asbestos | Negligible | Specified in the Construction and Environmental Management Plans |
| Exposure of Construction Workers to ground gases during excavation | -ve | Short-term | Low | | No significant exposure to ground gases | Negligible | Specified in the Construction and Environmental Management Plans |
| Accidental spillage of material and impact to soil, groundwater, or surface water | -ve | Short-term to long-term | Low to medium | Construction work completed in accordance with relevant Construction Site Rules<br>Production of Environmental Management Plan, method statements, and Health and Safety plans<br>Employment of operational safeguards such as adequate labelling, storage, handling and use of materials<br>Use of sheeting, drip trays, bunds<br>Provision of PPE for Construction Workers | Reduction in likelihood of accidental spillage, and removal of likelihood of on-going soil/water/ human health impacts through implementation of immediate clean-up procedures | Negligible | Specified in the Construction and Environmental Management Plans |
| Accidental spillage of material and impact to Construction Workers | -ve | Short-term | Low | | No significant exposure to spilled materials | Negligible | Specified in the Construction and Environmental Management Plans |
| Disturbance of sediment and pollution of groundwater | -ve | Short-term | Low | Protective measures including dust suppression<br>Phasing of construction works to minimise exposed ground and soil stockpiles<br>Covering of stockpiles<br>Site access points and roads to be regularly cleaned and scraped<br>Use of silt fences and cut-off drains<br>Containment of discharges from wheel washing or plant<br>All drainage to be filtered via a silt trap prior to discharge to the site drainage system | No significant release of silt to groundwater | Negligible | Specified in the Construction and Environmental Management Plans |
| Disturbance of sediment and pollution of site surface water drainage system | -ve | Short-term | Medium | | No significant release of silt to site surface water drainage system | Negligible | Specified in the Construction and Environmental Management Plans |
| Generation and storage of wastes and impact to Site Users and Visitors | -ve | Short-term | Low | Production of Environmental Management Plan, method statements, and Health and Safety plans<br>Appropriate storage<br>Covering of any open waste stores (e.g. skips) | No significant releases/exposure to contaminated waste materials | Negligible | Specified in the Construction and Environmental Management Plans |
| Generation and storage of wastes and impact to Construction Workers | -ve | Short-term | Medium | | No significant releases/exposure to contaminated waste materials | Negligible | Specified in the Construction and Environmental Management Plans |
| Migration of existing soil contaminants to groundwater | -ve | Long-term | Low | On-going and long-term monitoring of groundwater quality<br>Implementation of measures, as appropriate, to reduce, repair, or compensate for any impact | Early identification of adverse changes in the condition of groundwater/surface water, implementation of immediate appropriate measures to reduce the scale of any impact identified | Negligible | Specified in the Construction and Environmental Management Plans |
| ***Potential Operational Phase Impacts*** | | | | | | | |
| Migration of existing groundwater contaminants to groundwater | -ve | Long-term | Low | On-going and long-term monitoring of groundwater quality<br>Implementation of measures, as appropriate, to reduce, repair, or compensate for any impact | Early identification of adverse changes in the condition of groundwater/surface water. implementation of appropriate measures to reduce the scale of any impact identified | Negligible | Specified in the Construction and Environmental Management Plans |

## 7.9 References

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