13 GROUND CONDITIONS (GEOLOGY, HYDROGEOLOGY AND CONTAMINATION)

Introduction

13.1 This chapter identifies and assesses likely effects relating to ground conditions and land contamination during the construction and operational phases of the proposed development. This has been informed through the collation of baseline data from a range of sources, including published data and a review of the RPS Desk-Top Study and Preliminary Risk Assessment (Appendix 13.1) and RPS Ground Investigation Report (Appendix 13.2).

13.2 Due to the potential link between ground conditions and water quality at the site this chapter also considers hydrological and hydrogeological baseline conditions and potential effects. Specific effects with regard to hydrology and marine ecology are however assessed in the Hydrology and Flood Risk Chapter (Chapter 15) and the Marine Environment Chapter (Chapter 6).

Assessment Methodology

Legislative Context

13.3 The principal legislative drivers for conserving sites of geological importance, protecting groundwater and managing risks to human health and the environment from historic land contamination are:

- European Water Framework Directive 2000;
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017;
- The Groundwater Directive 2006;
- Groundwater (England and Wales) Regulations 2009;
- The Water Resources Act 1991 (as amended);
- The Water Act 2003;
- The Environment Act 1995;
- Environmental Liability Directive 2004;
- Environmental Protection Act (EPA) 1990 (as amended);
- Contaminated Land (England) Regulations 2006 (as amended);
- Environmental Permitting (England and Wales) Regulations 2016 (as amended); and

- Wildlife and Countryside Act 1981 (as amended) (in terms of sites designated for their geological interest).

13.4 The Water Resources Act 1991 principally relates to the protection of controlled waters (i.e. rivers, lakes, canals and groundwater) from pollution. It sets out the responsibilities of Natural Resources Wales (NRW) in relation to water pollution, resource management, flood defence, fisheries and in some areas, navigation. It also regulates discharge to controlled waters, namely rivers, estuaries, coastal waters, lakes and groundwater.

13.5 The Groundwater (England and Wales) Regulations (2009) supplement existing regulations to protect groundwater in England and Wales. These regulations control groundwater pollution from contaminated land. The regulations provide a more flexible, risk-based approach than previous legislation and cover a wider range of substances.

13.6 The Environmental Permitting (England and Wales) Regulations 2016 introduced a new streamlined system of environmental permitting in England and Wales for certain installations, waste operations, mobile plant and discharges to groundwater.

13.7 The Environment Act 1995 (Section 57) amends the Environmental Protection Act (1990) and makes provisions for a risk-based framework for identification, assessment and management of contaminated land within the UK. It includes measures for protection of the environment, including power to prevent water pollution.

13.8 Part 2A of the Environmental Protection Act is implemented by the Contaminated Land (Wales) Regulations 2006 and the Contaminated Land (Wales) (Amendment) Regulations 2012. The Part 2A regime is aimed at ensuring that actions taken with respect to contaminated land are directed by a technically well-founded assessment of risk that considers the 'contaminant-pathway-receptor' scenario (contaminant linkage). A source, pathway and receptor must be present to complete the pollutant linkage and for a potentially significant risk to exist.

Planning Policy Context

Planning Policy Wales

13.9 The Planning Policy Wates (PPW) (Welsh Government, 2018) sets out the land use planning policies of the Welsh Government. It is supplemented by a series of Technical Advice Notes (TANs), Welsh Government Circulars and policy clarification letters, which together with PPW provide the national planning policy framework for Wales.

13.10 Regarding previously developed land, PPW states:

'*Previously developed land should, wherever possible, be used in preference to greenfield sites where it is suitable for development. In settlements, such land should generally be considered suitable for appropriate development where its re-use will promote sustainability principles and any constraints can be overcome. It is recognised, however, that not all previously developed land is suitable for development. This may be, for example, ...because it is highly contaminated. For sites like these it may be appropriate to secure remediation for nature conservation, amenity value or to reduce risks to human health.*'

13.11 Planning authorities should work with landowners to ensure that suitably located previously developed sites are brought forward for development and to secure a coherent approach to their development. To incentivise the appropriate re-use of previously developed land, planning authorities should take a lead by considering and identifying the specific interventions from the public and/or private sector necessary to assist in its delivery. This will normally support regeneration initiatives and land allocations in development plans and will include the need to raise awareness of risks as part of an effective de-risking strategy. This approach will inform the development of appropriate risk assessments and remediation strategies at the application level intended to safeguard new developments from the health and environmental risks arising from past land uses, such as contamination.

13.12 Authorities are encouraged to take a de-risking approach to unlocking the development potential of sites. In some instances, the authority may need to purchase land in order to facilitate redevelopment. Wherever possible this should be with the agreement of the landowner however, in exceptional circumstances planning authorities may use compulsory purchase powers.

13.13 PPW paragraph 6.9.4 states that:

'The benefits of 'cleaning up' land through the planning process stretch beyond the uplift in land value and reduction of liabilities gained by landowners. There are wider societal and natural resource benefits, particularly on sites where past uses have left a legacy of surface and subsurface hazards. High value uses may be necessary to make investment viable and whilst development objectives can align in some places, in others, re-development potential may be limited'.

13.14 PPW requires planning authorities to take into account the nature, scale, and extent of surface and subsurface hazards which may pose a risk to the environment, to ensure that:

- *'New development is not undertaken without an understanding of the risks, including those associated with the previous land use, pollution, groundwater, flood risk, subsidence, landslips, rock falls, mine and landfill gas emissions and rising groundwater from abandoned mines;*
- *Development does not take place without appropriate remediation or precautions;*
- *Consideration is given to the potential impacts which remediation of land, including land contamination, might have upon the natural and historic environment;*
- *Development is not allowed if expensive engineering projects, which have implications for the public purse, will be required to serve it, for example, to prevent erosion, or in the case of receding cliffs, if a site is likely to be affected by loss of land to the sea during its lifetime or if it could contribute to pollution at a later date; and*
- *Unstable land is restored to safeguard investment and, where possible, returned to productive use.'*

Local Planning Policies

13.15 The Pembrokeshire County Council (PCC) Local Development Plan (LDP) was adopted in February 2013.

13.16 Policy GN.1-General Development is relevant to geology, hydrogeology and contamination. This policy states that development will be permitted where the following criteria are met:

- '*Does not adversely affect landscape character, quality or diversity;*
- *It would not result in unacceptable harm to health and safety; and*
- *It would not have a significant adverse impact on water quality.*'

Relevant Guidance

13.17 The following national guidance and accepted industry good practice is relevant to this assessment:

- Contaminated Land Statutory Guidance (Welsh Government, 2012);
- Model Procedures for the Management of Land Contamination (CLR11) (Defra and the Environment Agency, 2004);
- Groundwater Protection Technical Guidance (Environment Agency, 2017a);
- The Environment Agency's Approach to Groundwater Protection, Version 1.2 (Environment Agency, 2018);
- Land Contamination Groundwater Compliance Points: Quantitative Risk Assessments (Environment Agency, 2017b);
- Construction Industry Research and Information Association (CIRIA) 132: A Guide for Safe Working on Contaminated Sites (CIRIA, 1996);
- CIRIA C552: Contaminated Land Risk Assessment - A Guide to Good Practice (C552) (CIRA, 2001);
- CIRIA C665: Assessing Risks Posed by Hazardous Ground Gases to Buildings (CIRIA, 2007);
- CIRIA 73: Role and Responsibility in Site Investigation (CIRIA, 1991);
- British Standard (BS) 6187: Code of Practice for Full and Partial Demolition (BSi, 2011a);
- BS10175: Investigation of Potentially Contaminated Sites: Code of Practice (BSi, 2011b);
- BS5930: Code of Practice for Site Investigations (BSi, 2015); and
- Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination (Environment Agency, 2006).

Study Area

13.18 The study area comprised the proposed development site. Where historical land uses were assessed land immediately adjacent to the site was also considered. All landfills within 250m of the site boundary were also considered within the Desk-Top Study and Preliminary Risk Assessment (Appendix 13.1).

Baseline Methodology

13.19 The assessment of ground conditions has involved the review of available information pertaining to the type of geology, soils and groundwater on the site. This information has been used to develop an understanding of baseline conditions for the site, to inform a Conceptual Site Model (CSM).

13.20 Information has been collated from published environmental and geological data from various sources including Defra, Envirocheck and the British Geological Survey. In addition, a review of previous ground investigation reports has been undertaken.

13.21 RPS has carried out a detailed review of the previous investigations and undertook a supplementary site investigation in November 2018. The findings of the review and the supplementary investigation can be found in the following reports:

- RPS Desk Study and Preliminary Risk Assessment (Appendix 13.1); and
- RPS Ground Investigation Report (Appendix 13.2).

13.22 The baseline information gathered is summarised within the Baseline Environment section of this chapter (with further details provided within Appendix 13.1 and Appendix 13.2). The appendices provide a summary of known ground conditions at the site and describe the CSM used to assess potential risk to human health and controlled waters from the presence of chemical contaminants within the soil and groundwater.

13.23 The conclusions presented within this chapter are drawn from the findings of the desk study and ground investigation reports listed above and the authors experience and professional judgement.

Assessment Criteria and Assignment of Significance

13.24 The significance of effects has been determined taking into account the sensitivity of the receptor affected and the magnitude of the impact. The assessment of significance takes into account the effect of the mitigation measures included as part of the proposed development and described within this chapter.

Receptor Sensitivity/Value

13.25 Two main receptor types are associated with contaminated land. These are humans and controlled waters (i.e. surface water courses including rivers and groundwater/aquifers). The sensitivity of an attribute of controlled water is largely determined by its quality and scale (i.e. local, national and international). The sensitivity for humans is determined by proximity to the source of contamination, age, structure of the people and duration of residence/presence in proximity to contamination. Sensitivity of attributes relevant to this chapter has been informed by professional judgement and published screening criteria. Receptor sensitivity is defined in Table 13.1.

Table 13.1: Example Definitions of Sensitivity or Value

Sensitivity	Typical Descriptors

Very High	Controlled Waters – Attribute with a very high quality and rarity on a regional to international scale with very limited potential for substitution. Examples include: Principal Aquifer providing potable water to a large population. Humans – Residential Areas, construction workers.
High	Controlled Waters - Attribute with a high quality and rarity on a local scale with limited potential for substitution, or attribute with a medium quality or rarity on a regional to national scale with limited potential for substitution. Examples include Aquifer providing potable water to a small population and/or large resource potential or Regionally Important Geological/Geomorphological Sites (RIGS). Humans –recreational areas
Medium	Controlled Waters – Attribute with a medium quality and rarity on a local scale with limited potential for substitution, or attribute with a low quality and rarity on a regional to national scale with limited potential for substitution. Examples include: Secondary aquifer unit supporting abstraction for agricultural or industrial use and/or moderate resource potential or Non-designated geological exposures important at a regional or local scale. Humans - Schools, hospitals and care Institutions
Low	Attribute with a low quality and rarity on a local scale with limited potential for substitution. Examples include: Unproductive strata (Aquifer designation) previously disturbed land or non-designated geological exposures important at a very local scale; abandoned quarries and mining activities. Humans – commercial/retail/industrial employment areas.
Negligible	Attribute with very low importance and rarity at the local scale. Examples include non-aquifer unit that does not afford protection to underlying water bearing units; No designated geological exposures common at a regional or local scale.

Magnitude of Impact

13.26 The magnitude of any predicted impact has been determined by consideration of the following criteria:

- The temporal scale of individual effects, which are described as either short, medium or long term; where short term relates to the initial demolition and construction phase, medium term extends from 1-5 years from the end of construction, and long term extends beyond five years from the end of construction;
- Temporary or permanent: effects may occur over the life time of the project or may occur for a limited period of time e.g. whilst a specific activity is taking place;
- Reversible/irreversible effect: effects can be reversed by mitigation measures or by natural environmental recovery within reasonable timescales (e.g. 5-10 years following cessation of construction); and
- Geographical scale: whether the effect would be experienced at the local, regional or national level.

13.27 The magnitude of the impact has been defined qualitatively and categorised based on the criteria summarised in Table 13.2.

Table 13.2: Example Definitions of Magnitude

Magnitude	Typical Descriptors	
	Adverse	Beneficial

High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.	Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality.
Medium	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements.	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Low	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements.	Very minor benefit to or positive addition of one or more characteristics, features or elements.
No change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.	

Significance of Effects

13.28 The significance of an effect has been determined taking into account the magnitude of the impact and sensitivity of the receptor. The matrix presented in Table 13.3 has been used determine overall significance of the effect, together with professional judgement.

Table 13.3: Assessment Matrix

Sensitivity	Magnitude of Impact				
	No Change	**Negligible**	**Low**	**Medium**	**High**
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
Very high	No change	Minor	Moderate or Major	Major or Substantial	Substantial

13.29 Where the matrix offers more than one significance option, professional judgement has been used to decide which option is most appropriate.

13.30 The broad definitions of the terms used should be in line with the following:

- Substantial: Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.

- Major: These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.

- Moderate: These beneficial or adverse effects may be important but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.

- Minor: These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process but are important in enhancing the subsequent design of the project.

- Negligible: No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Limitations of the Assessment

13.31 The assessment of effects presented in this chapter is based on a review of information available for the site at the time of writing. Several site investigations had been undertaken across the site area, with the majority of the investigations focused on the Gate 1 and Gate 4 areas. RPS carried out a supplementary investigation in November 2018 to provide up to date information and to allow for assessment of the whole site area. The RPS Ground Investigation Report (Appendix 13.2) also included an updated assessment of the data from the previous reports.

13.32 The previous reports were undertaken by third parties between 1996 and 2016. It should be noted that copies of the reports were only available to RPS in various stages of completeness. The findings of the previous third-party reports were incorporated into the RPS Ground Investigation Report (Appendix 13.2).

Baseline Environment

13.33 An overview of the baseline (existing) environmental conditions is given in this section. Further details are provided in Appendix 13.1 and Appendix 13.2.

Geology

Made Ground

13.34 Made Ground was encountered across the site and typically ranged in thickness from 0.2 to 7.9 m bgl (below ground level), where fully penetrated. Made Ground was not fully penetrated in all locations and therefore thicker deposits of Made Ground may be present.

13.35 Surface coverings generally comprised concrete, asphalt underlain by subbase to thicknesses of 0.05 to 0.3 m where encountered across the site.

13.36 Made Ground was variable across the site but generally comprised soft dark brown or greyish brown gravelly clay, or gravelly clayey silty sand. Gravel size constituents include flint, sandstone, mudstone, brick, slag, concrete, coal and limestone.

Weathered Bedrock

13.37 Weathered bedrock was encountered in the majority of the exploratory locations. In previous reports this strata was referenced as Head Deposits.

13.38 The weathered bedrock was encountered to a thickness of between 3.6 and 10.4 m although the weathered strata was not fully penetrated in all locations. The variability of the thicknesses is potentially related to a dissolution feature encountered where the deepest weathered bedrock was encountered.

13.39 The weathered bedrock was variable in nature and generally comprised a firm to very stiff dark reddish brown or light yellow brown gravelly clay or sandy clayey gravel locally with low cobble content. Gravel and cobbles are limestone, mudstone and sandstone.

Pembroke Limestone Group

13.40 Where the weathered bedrock was fully penetrated, strata of the Pembroke Limestone Group was encountered. The generally comprised strong grey fine grained limestone with fractures, occasional occurrence of calcite mineralisation and clay mineralisation along fracture planes. Completely weathered clay bands were encountered. In some locations the limestone was recovered as a limestone gravel.

Metamorphic Rock

13.41 In the Quantum Report from 2015 (included as Appendix 13.3) a very strong yellow brown thin to thickly laminated medium grained metamorphic rock with discolouration weathering and occurrence of quartzite mineralisation nodules was encountered in two boreholes.

Hydrogeology

13.42 The Pembroke Limestone Group is classified as a Principal Aquifer by NRW and is of regional and national importance in terms of water supply.

13.43 The site is not located in a Source Protection Zone.

13.44 It is considered that due to the proximity of the Milford Haven Waterway, the groundwater is likely to be impacted by saline intrusions. Extracted groundwater is unlikely to be suitable for drinking water and subsequently the sensitivity is lower than would otherwise be expected for a Principal Aquifer.

13.45 During the site investigations undertaken, groundwater was generally encountered across the site within the Made Ground and Bedrock Strata. Groundwater within the Made Ground is considered to be perched and discontinuous. Based on the results of the groundwater monitoring across the site, it is considered that groundwater encountered within the weathered bedrock and bedrock are a continuous groundwater body. The cohesive nature of the Made Ground and weathered bedrock will limit vertical and lateral migration of the groundwaters. Whilst the unweathered limestone is likely to have a high permeability and allow for horizontal and vertical migration of groundwater and any associated contaminants, significant dilution is likely to occur within this unit and within the Milford Haven Waterway.

Hydrology

Surface Water Bodies

13.46 There is a Timber Pond on-site, which is proposed to be infilled as part of the development proposals. In addition, the Milford Haven Waterway bounds the site to the north.

13.47 There is the potential for surface water run off to enter the Milford Haven Waterway and the Timber Pond. The existing site drainage discharges to the Milford Haven Waterway.

13.48 Groundwater beneath the site is considered to be in hydraulic connectivity with the Milford Haven Waterway.

Discharge Consents

13.49 There is a single active discharge consent for the site, this relates to trade discharges and site drainage to discharge into the Milford Haven Waterway.

13.50 In addition, there are records of five active discharge consents within 500 m of the site. These consents are for the discharge of storm sewage overflow, sewage - crude and sewage final/treated effluent. These consents all discharge into the Milford Haven Waterway.

Summary of Pollution Incidents

13.51 There are records of two pollution incidents identified within the site, these both related to farm effluent/slurry in February 1995 and are recorded as Category 3 - Minor Incidents.

13.52 There are records of two pollution incidents within 250 m of the site, these relate to the release of heavy fuel oil and diesels into the estuary and are both categorised as Category 3 - Minor Incidents. In addition, whilst not listed in the Envirocheck Report, it should be noted that in February 1996 an oil tanker lost a large amount of crude oil in Milford Haven approximately 15 km to the west of the site.

Landfills

13.53 There are three records of licensed waste management facilities on site. These relate to two sites; a household, commercial and industrial transfer station and a metal recycling site.

13.54 There is a single historic landfill site recorded within 250 m of the site, located 180 m to the east and was authorised to receive stone, brick, hardcore and concrete.

Site History

13.55 A Dockyard has occupied the site since the earliest mapping, with previous land features mapped including: tar tanks, timber sheds, pitch house, sawmills, joiner shops, foundry, smithy, coalyard, building lips, drill battery, oil tanks, lube oil storage, diesel tanks, workshops, hoppers electrical substation and depot.

Site Features

13.56 A site walkover survey was carried out on 24 January 2018 as part of the RPS Desk-Top Study and Preliminary Risk Assessment. This is summarised below. Further details can be found within Appendix 13.1 with the Gate 1, Milforge Site and Gate 4 areas are shown on drawing within the appendix - Site Reconnaissance Plan JER1262-DTS-001.

13.57 The site is currently used for a variety of commercial and light industrial land uses including marine engineering. The site includes an area that is not under the control of MHPA which is currently in use as a garage and scrap yard.

13.58 No visual or olfactory evidence of contamination was observed during the walkover (except for a small area of burnt ground within the Gate 4 area).

13.59 The majority of the site is concrete hardstanding which appears to be in good condition.

13.60 Within the Gate 1 area features include:

- Security gate and administration building;
- Warehouses;
- Area of sand storage;
- Skips and waste bins;
- Double skinned diesel fuel tank;
- Two water tanks;
- Vehicle washdown area;
- Electrical sub-station;
- Empty bund area providing evidence of historical fuel tanks.

13.61 Within the Milforge Site area features include:

- Two disused warehouses; potentially including an inspection pit;
- Electrical sub-station;
- Overgrown area and numerous mature trees;
- Compacted gravel and demolition rubble (it is understood this area had recently been flattened). The demolition rubble included asphalt and concrete.

13.62 Within the Gate 4 area features include:

- The Timber Pond;
- Mobile home storage;
- Fuelling points: two plastic fuel tanks, control board and small hut (no evidence of stains or leaks);
- An electricity substation;
- Area of burnt ground and corrugated iron sheeting.

Ground Investigation Findings

Chemical Analysis - Soils

13.63 The results of the assessment undertaken by RPS of the available data indicates that exceedances, when compared to human health criteria, of lead, benzo(b)fluoranthene, benzo(a)pyrene and dibenzo(a,h)anthracene were recorded in samples for Made Ground between 0.0 and 3.0 m bgl.

13.64 Asbestos fibres were also recorded in a total of 18 samples of Made Ground. Asbestos fibres were recorded as been chrysotile and amosite.

13.65 Petroleum hydrocarbons were recorded in a number of Made Ground and natural soils samples however, none have been recorded above the relevant human health generic assessment criteria. Overall concentrations of petroleum hydrocarbons were considered to be low.

Chemical Analysis - Groundwaters

13.66 The results of the controlled waters risk assessment undertaken by RPS utilising the 2018 dataset indicates that groundwaters beneath the site contain elevated concentrations of chromium, lead, zinc and trichlorobenzene at discrete locations across the site.

13.67 Concentrations of petroleum hydrocarbons recorded in most groundwater samples are considered to be low.

13.68 Some uncertainties remain in relation to the fracturation of the bedrock, the movement of groundwater, the tidal influence on groundwater and associated observed concentrations of groundwater contaminants. Groundwater salinity measurements provide evidence to suggest that mixing of groundwater and surface water is occurring. This mixing process will reduce concentrations of contaminants in the surface watercourse. It is not possible to quantify the degree of mixing at this stage.

13.69 Based on the results of the assessment and the current CSM, the risks to controlled waters are considered to be low.

Ground Gas Risk Assessment

13.70 Based on the gas monitoring undertaken by RPS, the site could potentially be classified as Characteristic Situation 1 (very low risk) however, previous third party monitoring recorded maximum carbon dioxide concentrations of 7.0%. Therefore, it is recommended that a classification of Characteristic Situation 2 (low risk) is adopted.

13.71 The presence of Volatile Organic Compounds (VOCs) in the soils and groundwaters and the recording of carbon monoxide and hydrogen sulphide during the monitoring periods indicates that protection measures for these are required. It has been recommended that a gas membrane resistant to VOCs and protective of carbon monoxide and hydrogen sulphide is incorporated into the design of building floor slabs.

13.72 Consideration should also be given to the possibility of creating a pathway for naturally occurring carbon dioxide to migrate from the limestone bedrock into buildings via any potential foundation piles.

13.73 The site is located within a higher probability radon area, where 10% to 30% of homes are estimated to be at or above the action level. Full radon protection measures are therefore likely to be required in the construction of new buildings or extensions.

Future Baseline Conditions

13.74 Assuming that there is no further development in the vicinity of the site, it is anticipated that there will be minimal changes to baseline conditions. Based on current site use, no significant changes to contamination levels are expected at the current time.

13.75 It is not anticipated that future climate change would result in any change to the baseline conditions reported.

Mitigation Measures Adopted as Part of the Project

13.76 Any demolition works required at the site as part of the proposed development would require the floor slab and foundations of each building to be removed prior to future construction. A pre-demolition audit of each building would be undertaken, which would include the removal of any hazardous material.

13.77 The demolition and construction phases would be carried out in accordance with the measures outlined in a Code of Construction Practice (CoCP) and implemented through a Construction Environmental Management Plan (CEMP). Measures to be included within the CEMP would include those consistent with current industry good practice for construction on brownfield sites. As a minimum, the contractor would ensure that his statutory obligations under environment, health and safety legislation are fulfilled. Measures would include the following:

- The provision of appropriate personal protective equipment (PPE) for construction workers and provision of guidance regarding high levels of personal hygiene;
- The implementation of dust suppression measures in accordance with guidance provided by the Institute of Air Quality Management e.g. dampening/sheeting of stockpiles and exposed soils;
- Site personnel to be vigilant for any unusual visual or odorous characteristics of soils and groundwater which could indicate the presence of previously unknown contamination;
- Any excavated previously unidentified contaminated soils should be placed within a suitably constructed bunded laydown area and covered to prevent migration of contaminants of concern via rainwater run-off;
- Maintenance of a 'clean/dirty area' regime, if contamination identified. A high standard of hygiene to be maintained at all times;

- A secure site with respect to the safety of docks staff and visitors;
- Appropriate disposal of waste soil generated during construction and demolition;
- Imported soils for use would be certified 'clean' and suitable for use for the landscaping areas;
- Appropriate storage of potentially polluting materials and chemicals in accordance with the Control of Pollution (Oil Storage) Regulations;
- Any areas for the storage of bulk materials including oils, fuels and chemicals would be designated and managed according to current best practice and in compliance with prevailing legislation and NRW/Environment Agency guidance; and
- Leaks or spillages of potentially polluting substances to be contained, collected then removed from site in an appropriate manner, e.g. use of absorbent material, bunding or booms. An emergency action plan would be formulated which all site personnel would be required to read and understand.

13.78 With specific reference to any unforeseen contamination, the following measures would be taken and included within a discovery strategy (to form part of the CEMP):

- Where significant unforeseen contamination is identified during the course of the demolition or construction work, work would stop and further investigation would be undertaken to establish the level of contamination.
- Stockpiling of any contaminated materials would be avoided where practicable. Where it is necessary, stockpiles would be located on areas of hardstanding or plastic sheeting to prevent contaminants infiltrating into the underlying ground.
- Where remediation is required, on-site treatment, including bioremediation, would be carried out wherever practicable.
- Demolition and excavation works would be carried out in such a way to enable effective segregation of clean materials for reuse on site wherever practicable. It is anticipated that ‘clean’ concrete and masonry could be crushed for reuse for backfilling and other purposes or would be sent off-site for recycling or recovery with disposal only as a final resort. Material would only be re-used on site in accordance with the Environmental Permitting Regulations or appropriate approved Code of Practice e.g. Contaminated Land: Application in Real Environments (CL:AIRE) or Waste Resource Action Plan (WRAP).

13.79 For demolition activities, potential risks to human health would be reduced as much as is reasonably practicable prior to undertaking the works by undertaking the works in accordance with approved health and safety plan including comprehensive method statements and risk assessments for the proposed activities.

13.80 Risks from accidents may be mitigated by the formulation of an Emergency Response Plan to minimise, contain and remediate contamination from the accidental release of contaminating substances

13.81 Mitigation measures for residual risk associated with identified contamination in the shallow soils would be required following construction. The hardstanding and buildings proposed across the majority of the site will break the pathways and further mitigation is not required. However, in areas of soft landscaping a cover system would be required, alternatively source removal of the contaminated Made Ground.

13.82 The gas risk assessment concluded that the site should be classified as Characteristic Situation 2 and basic gas protection measures will be required in all new buildings. The gas protection measures should also be designed to protect against VOCs, carbon monoxide and hydrogen sulphide. As the site is situated in a higher probability radon area, radon protection measures will also be required in all new buildings and extensions.

13.83 During the earthworks phase, mitigation will be required to minimise the risk associated with the potential mobilisation of asbestos fibres as a result of soil disturbance. An Asbestos in Soils Management Plan (as part of the CEMP) should be implemented to manage the risks and provide appropriate mitigation.

Assessment of Construction Effects

Demolition Effects

13.84 Demolition effects at the site (prior to construction) are considered to be largely similar to the construction effects with regards to groundwater quality, groundwater availability, dust generation and effects on human health. These effects have been considered in the section below.

13.85 The magnitude and significance of effect are considered to be the same for both demolition and construction for the proposed development.

Construction Effects

Effects of Construction on Soil and Geology

13.86 There are no designated geological receptors that would be affected by the project.

13.87 There are no geological features, such as outcrops, at the site that would be damaged or lost during construction. Shallow soils on site could be impacted by the construction works. However, these are not identified as of any particular sensitivity and are not therefore considered to be a sensitive receptor.

- Receptor sensitivity: Low;
- Impact magnitude: No impact;
- Significance of effect: No effect.

Effects of Construction on Groundwater Quality

13.88 Excavation of subsurface foundations is likely to encounter shallow groundwater in the Made Ground and weathered bedrock, which is considered to be in hydraulic continuity to the Pembroke Limestone Group. Groundwater within the Pembroke Limestone Group is a Principal Aquifer.

13.89 The removal of hardstanding and excavations in the subsurface will expose soils to rainfall and potentially mobilise any unknown contamination within the soil and/or shallow groundwater through increased recharge and groundwater through flow. There is also the potential for accidental spillages during construction to impact shallow groundwater.

13.90 Based on the information currently available, there is an absence of gross contamination in soils and groundwater on site. The CoCP will include measures to control pollution/deal with spillages and to allow for appropriate procedures to be put in place in the event of unknown contamination being encountered. These would be implemented through the CEMP.

13.91 There are no groundwater abstractions within close proximity of the site and the site is not within Source Protection Zone. Due to the proximity of the estuary, the groundwater is likely to be impacted by saline intrusions.

- Receptor sensitivity: Medium;
- Impact magnitude: Negligible;
- Significance of effect: Negligible.

Effects of Construction on Surface Water Quality

13.92 The Timber Pond will be infilled as part of the proposed development therefore this feature is not considered as part of this assessment.

13.93 Excavations in the subsurface are likely to encounter groundwater within the Made Ground and weathered Bedrock. These are likely to be in hydraulic connectivity with the Milford Haven Waterway to the north of the site.

13.94 The removal of hardstanding and excavations in the subsurface will expose soils to rainfall and potentially mobilise any unknown contamination within the soil and/or shallow groundwater through increased recharge and groundwater through flow. There is also the potential for accidental spillages during construction to impact shallow groundwater. The groundwater body beneath the site will extend off site to the surface water receptors.

13.95 In addition, demolition and construction works have the potential to increase contaminated surface water runoff through the stockpiling of soils and the potential removal of surface water drainage systems.

13.96 In the absence of gross contamination in soils and generally low levels of organic contamination in soil and shallow groundwater, short-term construction effects are considered unlikely to result in a measurable effect on surface quality. In addition, the implementation of the CoCP and CEMP to

suitably manage surface water runoff would further reduce the potential for surface water quality to be impacted.

- Receptor sensitivity: Medium;
- Impact magnitude: Low;
- Significance of effect: Minor.

Dust Generation (Human Health)

13.97 It is possible that contaminated soils dusts may be generated during excavations to remove building foundations and other ground disturbance, particularly if the works are undertaken in dry weather. Airborne dust has the potential to cause adverse health effects on construction workers, dock workers and site visitors in the vicinity of the site. Implementation of measures in line with industry best practice, including damping of soils in dry weather, would help control any potential dust generation.

13.98 Based on current understanding, concentration of contaminants within the soils and groundwater are low. However, asbestos fibres were recorded within the Made Ground.

13.99 Residual risks to human health posed by the presence of localised soil contamination and the presence of asbestos fibres can be mitigated through the implementation of an engineered capping layer in areas of proposed soft landscaping to minimise exposure to any such contaminants by future site uses.

- Receptor sensitivity: High;
- Impact magnitude: Low;
- Significance of effect: Minor.

13.100 During the earthworks phase mitigation will be required to minimise the risk associated with the potential mobilisation of asbestos fibres as a result of soil disturbance. An Asbestos in Soils Management Plan (as part of the CEMP) should be implemented to manage the risks and provide appropriate mitigation.

Further Mitigation

13.101 The assessment of demolition and construction effects has been undertaken based upon the ground investigation information currently available. The above assessment demonstrates that no significant effects are likely, provided mitigation measures to manage risks to groundwater/surface water and to ground/demolition/construction workers, in line with industry best practice are implemented.

13.102 Based on current understanding, concentrations of contaminants within the soil and groundwater across the site are low, however localised areas of minor contamination and asbestos fibres within the Made Ground have been identified within the general area around the site.

13.103 Any residual risks to human health posed by the presence of localised areas of soil contamination may be mitigated through the implementation of an engineered capping layer to landscape areas to minimise exposure to any such contamination by future site users.

13.104 Low risks to controlled waters are anticipated to be present, based upon the information available and further mitigation is therefore not considered to be necessary from a controlled waters perspective.

Future Monitoring

13.105 Consideration to implementation of a groundwater monitoring programme of on-site boreholes would be prudent during and following the demolition and construction works to demonstrate that baseline quality is not significantly affected during the works. The programme would include measures to be implemented to address any changes in quality, in the event that this was deemed necessary.

Accidents and/or Disasters

13.106 During demolition and construction activities, there is potential for accidents to occur that may impact on the ground conditions at the site through the spillage or leakage of oils/fuels/chemicals resulting in contamination of the ground, groundwater or surface water.

13.107 Risks from accidents may be mitigated by the formulation of an emergency response plan to minimise, contain and remediate contamination from the accidental release of contaminating substances.

Assessment of Operational Effects

Effects on Soil and Geology

13.108 There are no designated geological receptors that would be affected by the project.

13.109 There are no geological features, such as outcrops, at the site that would be damaged or lost during construction. Shallow soils on site could be impacted by the construction works. However, these are not identified as of any particular sensitivity and are not therefore considered to be a sensitive receptor.

- Receptor sensitivity: Low;
- Impact magnitude: No impact;
- Significance of effect: No effect.

Effects on Groundwater Quality

13.110 It is anticipated that the operational use of the site would not include any dewatering or abstraction activities. Therefore, the groundwater levels would remain largely unchanged.

13.111 Following construction, it is understood that the proposed development will largely compile buildings and hardstanding as per the proposed masterplan layout (Figure 2.2). It is not anticipated

that soakaway drainage will be utilised at the site. Infiltration of rainwater into the subsurface is likely to remain low and therefore there will be little change to the water balance of the shallow aquifer.

13.112 There is a potential risk of accidental spillage or emissions of contaminants based on the proposed industrial end use. However, potential risks to groundwater quality are considered to be low based upon appropriate mitigation measures being in place.

- Receptor sensitivity: Medium;
- Impact magnitude: Low
- Significance of effect: Minor.

Effects of Operation on Surface Water Quality

13.113 It is anticipated that the surface water drainage on site will continue to be discharged to the Milford Haven Waterway via a licence discharge.

13.114 Generally low levels of contaminants have been encountered within shallow groundwater in the general site area. There is a potential risk of accidental spillage or emissions of contaminants based on the proposed industrial end use which have the potential to enter the surface drainage systems or the Milford Haven Waterway via surface water run-off.

13.115 It is envisaged that procedures will be in place monitor and prevent such incidents in line with current best practise.

- Receptor sensitivity: Medium;
- Impact magnitude: Low;
- Significance of effect: Minor.

Effects on Human Health

13.116 Generally low levels of contaminants have been encountered within soils in the general site area, although localised elevated concentrations of some contaminants have been encountered during previous ground investigations. Asbestos fibres have been recorded in a number of Made Ground samples across the site. Risks to human health during the operational phase are likely to be similar to those currently present at the site and will unlikely be exacerbated by the development. The implementation of a discovery strategy during construction would also mitigate potential risks to human health. The implantation of an engineered capping layer in areas of soft landscaping will minimise the risk to future users.

- Receptor sensitivity: High;
- Impact magnitude: Low;

- Significance of effect: Minor.

Further Mitigation

13.117 Any residual risks to human health posed by the presence of localised areas of soil contamination may be mitigated through the implementation of an engineered capping layer to minimise exposure to any such contamination by future site users.

Future Monitoring

13.118 Assuming that no gross contamination of groundwater is encountered during construction that requires remediation in line with the discovery strategy, it is considered that no future monitoring would be required during the operational phase of the project. Should gross groundwater contamination be identified and remediated in line with the discovery strategy, the requirement for future monitoring would be determined at that juncture.

Unplanned Events

13.119 During the operational phase, there is potential for accidents to occur that may impact on the ground conditions at the site through the spillage or leakage of oils/fuels/chemicals resulting in contamination of the ground, groundwater or surface water.

13.120 Risks from accidents may be mitigated by the suitable management and storage of hazardous substances in line with best practice and also the formulation of an emergency response plan to minimise, contain and remediate contamination from the accidental release of contaminating substances.

Potential Changes to the Assessment as a Result of Climate Change

13.121 It is considered unlikely that there would be any significant change to impact magnitude and significance of effects detailed in this section due to potential changes to future environmental baseline conditions as a result of climate change.

Assessment of Cumulative Effects

13.122 The potential cumulative developments identified at Scoping stage are detailed in Appendix 4.5. None are considered to have potential cumulative effects in relation to geology, hydrogeology or contamination. In addition, a review of the Pembrokeshire County Council planning website has confirmed that there are no known significant proposed developments within close proximity of the site that would have a cumulative effect in association with the proposed development.

13.123 Similarly, no cumulative effects in relation to geology, hydrogeology or contamination are anticipated to arise from any small-scale residential development and/or extensions within the vicinity of the site.

13.124 Any future significant developments within the vicinity of the site would be required to undergo assessments in accordance with relevant environmental and planning regulations and policy.

Inter-relationships

13.125 It not anticipated that there would be any inter-relationships between other topics contained within this ES beyond those already considered within this chapter (e.g. contaminated dust). Effects in relation to dust are considered in the Air Quality Chapter (Chapter 9). Effects on surface water are considered in the Hydrology and Flood Risk Chapter (Chapter 15) and effects on marine ecology are considered in the Marine Ecology Chapter (Chapter 6).

Summary of Effects

13.126 The baseline geology, hydrogeology and contamination conditions in the vicinity of the project site have been considered. This involved reviewing the history, geology and hydrogeology of the site as well as available ground investigation information from previous investigations undertaken on the site. The assessment is based upon the available data and the authors experience and professional judgement.

13.127 The potential for localised areas of contamination in soil and groundwater has been identified across the site, although gross contamination has not been identified.

13.128 Construction is anticipated to be undertaken in accordance with a CoCP and CEMP. This would include a discovery strategy to set out procedures in the event of encountering any previously unknown areas of contamination.

13.129 Implementation of a groundwater monitoring programme of on-site boreholes may be prudent prior to, during and upon completion of the proposed works, to demonstrate the absence of adverse effects on groundwater during the development works.

13.130 It is anticipated that during the demolition and construction phase, effects would largely be controlled through the measures proposed. There could be minor effects which would not be significant. Effects would, however, be controlled through the CoCP and CEMP.

13.131 During the operational phase, there could be minor effects, which would not be significant. Any residual risks to human health posed by the presence of localised soil contamination and asbestos fibres within the Made Ground may be mitigated through the implementation of an engineered capping layer in areas of soft landscaping to minimise exposure to any such contamination by future site users.

References

Legislation

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The Water Act 2003;

The Environment Act 1995;

Environmental Liability Directive 2004;

Environmental Protection Act (EPA) 1990 (as amended);

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Table 13.4: Summary of Likely Environmental Effects on Ground Conditions (Geology, Hydrogeology and Contamination)

Receptor	Sensitivity of receptor	Description of impact	Short/ medium/ long term	Magnitude of impact	Significance of effect	Significant / Notes Not significant
Construction Phase						
Soil and Geology	Low	Impact on soil and geology from remobilisation of contamination	Short term	No impact	No Effect	Not significant
		Impact from spillages/accidents during construction	Short term	Negligible	Negligible	Not significant
Pembroke Limestone Principal Aquifer	Medium	Impact on shallow groundwater quality remobilisation of contamination	Short term	Negligible	Negligible	Not significant
	Medium	Impact on shallow groundwater quality remobilisation of contamination and lateral transport off site	Short term	Negligible	Negligible	Not significant
	Low	Impact on shallow groundwater resource from excavation dewatering	Short term	Negligible	Negligible	Not significant
	Medium	Impact from spillages/accidents during construction	Short term	Negligible	Negligible	Not significant
Milford Haven Waterway	Medium	Impact of surface water run off	Short tern	Low	Minor	Not significant
		Impact on surface water quality remobilisation of contamination	Short tern	Low	Minor	Not significant
Construction Works/Site Workers	High	Impact on health of human from exposure to soil contamination	Long Term	Low	Minor	Not significant
		Impact on human health from generation contaminated dust during demolition/construction	Long Term	Low	Minor	Not significant
Operational phase						
Soil and Geology	Low	Impact on soil and geology from soil and groundwater contamination from the proposed development	Short term	No impact	No effect	Not significant
Pembroke Limestone Principal Aquifer	Medium	Impact on shallow groundwater quality from soil and groundwater contamination from the proposed development	Short term	Low	Minor	Not significant
	Low	Impact on shallow groundwater resource from dewatering	Short term	Low	Minor	Not significant
Milford Haven Waterway	Medium	Impact on surface water quality from residual soil and groundwater contamination from the proposed development	Short term	Low	Minor	Not significant
Future Site Users	High	Impact on health of human future site users from exposure to soil contaminants	Long Term	Low	Minor	Not significant