SECTION 4

ENVIRONMENTAL RISK ASSESSMENT
4 ENVIRONMENTAL RISK ASSESSMENT

4.1 Introduction

4.1.1 Part of the objectives for this study are to assess the risks to the environment, human health and the local amenity posed by inundation of the various areas of the landfill, in accordance with procedures set out within the EA R&D Report CLR 11, and to identify any areas where the landfill material poses the greatest threat to the environment, human health and the local amenity in the event of inundation.

4.1.2 CLR11 identifies the model procedures for the management of land contamination and provides the technical framework for structured decision making about land contamination.

4.1.3 CLR11 has identified that the overall approach in dealing with land contamination is one of “Risk Management” - implying “all the processes involved in identifying, assessing and judging risks, taking actions to mitigate or anticipate them, and monitoring and reviewing progress”.

4.2 Managing risks from land contamination

4.2.1 The term risk is widely used in different contexts and circumstances, often with differing definitions. In government publications about the environment, it has been given the following standard definition:

“Risk is a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.”

4.2.2 This is the definition used in CLR11, in the specific context of risks to health and the environment from land contamination.

4.2.3 In the context of land contamination, there are three essential elements to any risk:

- A contaminant – a substance that is in, on or under the land and has the potential to cause harm or to cause pollution of controlled waters;

- A receptor – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property, or a water body; and

- A pathway – a route or means by which a receptor can be exposed to, or affected by, a contaminant.

4.2.4 Each of these elements can exist independently, but they create a risk only where they are linked together, so that a particular contaminant affects a particular receptor through a particular pathway. This kind of linked combination of contaminant–pathway–receptor is described as a pollutant linkage.

4.2.5 On any individual site, there may be only a single pollutant linkage or there may be several. Different pollutant linkages may be related, for example, the same contaminant may be linked to two or more distinct types of receptor by different pathways, or different contaminants and/or pathways may affect the same receptor. Not all receptors will be relevant in every context, and new pollutant linkages may be
created by changes over time. Each pollutant linkage needs to be separately identified, understood and dealt with if appropriate.

4.2.6 Without a pollutant linkage, there is not a risk – even if a contaminant is present. But even where there is a pollutant linkage, and therefore some measure of risk, the question still needs to be asked as to whether the level of risk justifies remediation.

4.2.7 The government policy for dealing with past land contamination focuses on taking action where there are “unacceptable risks to human health and the environment” in relation to the use of the land and its environmental setting – the “suitable for use approach”. This is carried forward into the definition of contaminated land under the regulatory regime in Part 2A of the Environmental Protection Act (EPA) 1990 which considers risk in relation to the current use of the land and defined receptors. In planning and development control, the aim is to ensure that there are no unacceptable risks to either the receptors relevant to Part 2A or to others that may be covered by other regimes, but again taking into account the use of the land.

4.2.8 Under Part 2A of the EPA 1990, the statutory definition of contaminated land is:

“land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused.”

4.2.9 The Statutory Guidance provided in the Department for Environment, Food and Rural Affairs (DEFRA) Circular 01/2006 lists the following categories of significant harm:

- death, disease, serious injury, genetic mutation, birth defects or the impairment of reproduction functions in human beings;
- irreversible adverse change, or threat to endangered species, affecting an ecosystem in a protected area (i.e. SSSI);
- death, serious disease or serious physical damage to pets, livestock, game animals or fish;
- a substantial loss in yield or value of crops, timber or produce; and
- structural failure, substantial damage or substantial interference with right of occupation to any building.

4.2.10 Contaminated land will only be identified when a ‘pollutant linkage’ has been established.

4.2.11 Therefore, this report presents an assessment of the potential pollutant linkages that may be associated with the site, in order to determine whether additional investigations are required to assess their significance.

4.2.12 A preliminary risk assessment (PRA) has been prepared for the site. In order to achieve this, the information collected has been assessed highlighting the potential sources, pathways and receptors linkages following the guidance provided in CLR11.
4.3 Potentially Contaminative Historic Land Uses

4.3.1 Table 4.1 lists all potentially contaminative historic land uses identified both on and adjoining the study site, and highlights the contaminants potentially present beneath the site as a result.

Table 4.1: Potentially Contaminative Historic Land Uses

<table>
<thead>
<tr>
<th>Process/ Land use</th>
<th>Contaminant Groups Potentially Present On Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste recycling, treatment and</td>
<td>Metals: Barium (Ba), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Vanadium (V), Zinc (Zn); Semi-metals and non-metals: Arsenic (As), Selenium (Se); Inorganic chemicals: (NO$_3^-$); Others: Asbestos, pH; Phenol (C$_6$H$_5$OH) Chlorinated Aliphatic Hydrocarbons; $\alpha$, $\beta$ and $\gamma$ hexachlorocyclohexane, Dieldrin, Chlorinated Aromatic Hydrocarbons, PCBs. Landfill Gas: Methane (CH$_4$), Carbon Dioxide (CO$_2$), Oxygen (O$_2$), Carbon Monoxide (CO), Hydrogen Sulphide (H$_2$S), Volatile Organic Contaminants (VOCs).</td>
</tr>
<tr>
<td>Disposal Sites: hazardous waste treatment plants.</td>
<td></td>
</tr>
<tr>
<td>Waste recycling, treatment and</td>
<td>Metals: Barium (Ba), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Vanadium (V), Zinc (Zn); Semi-metals and non-metals: Arsenic (As), Selenium (Se); Inorganic chemicals: (NO$_3^-$); Others: Asbestos, pH; Phenol (C$_6$H$_5$OH) Chlorinated Aliphatic Hydrocarbons; $\alpha$, $\beta$ and $\gamma$ hexachlorocyclohexane, Dieldrin, Chlorinated Aromatic Hydrocarbons, PCBs. Landfill Gas: Methane (CH$_4$), Carbon Dioxide (CO$_2$), Oxygen (O$_2$), Carbon Monoxide (CO), Hydrogen Sulphide (H$_2$S), Volatile Organic Contaminants (VOCs).</td>
</tr>
<tr>
<td>Disposal Sites: landfills and other waste treatment or waste disposal sites.</td>
<td></td>
</tr>
</tbody>
</table>

4.4 Conceptual Site Model (CSM)

4.4.1 On the basis of the information summarised above, a Conceptual Site Model (CSM) has been developed for the site based on current land use. The CSM is used to guide the investigation activities at the site and identifies potential contaminants, receptors (both on and off-site) and exposure pathways that may be present. The identification of such potential “pollutant linkages” is a key aspect of the evaluation of potentially contaminated land.

4.4.2 Potential pollutant linkages identified at the site are detailed within Table 4.2.
Table 4.2: Potential Pollutant Linkages

<table>
<thead>
<tr>
<th>Contaminant(s)</th>
<th>Pathway(s)</th>
<th>Receptor(s)</th>
</tr>
</thead>
</table>
| Metals (Barium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Vanadium, Zinc) | Inhalation, ingestion and dermal:  
  - contact with contaminated soil and landfill material  
  - wind blown dust and landfill material.  
|                        | Vertical migration of dissolved and free-phase contaminants                 | Neighbouring site users (visitors to the country park, Golfers at the Royal North Devon Golf Club), future site users, wildlife in the SSSI, the environment within the AONB.  
|                        | Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff. | Grazing Animals  
|                        | Groundwater in Minor Aquifer                                                | Perched groundwater within Made Ground.  
|                        | Vertical migration of dissolved and free-phase contaminants                 | Neighbouring site users (visitors to the country park, Golfers at the Royal North Devon Golf Club), future site users, wildlife in the SSSI, the environment within the Area of Outstanding Natural Beauty.  
|                        | Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff. | Grazing animals  
|                        | Groundwater in Minor Aquifer                                                | Perched groundwater within Made Ground.  
|                        | Vertical migration of dissolved and free-phase contaminants                 | On site pond, the Skern mudflats and sands, the Estuary of Rivers Taw and Torridge, land drains.  
|                        | Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff. | Neighbouring site users (visitors to the country park, Golfers at the Royal North Devon Golf Club), future site users, wildlife in the SSSI, the environment within the AONB.  
|                        | Groundwater in Minor Aquifer                                                | Grazing animals  
|                        | Vertical migration of dissolved and free-phase contaminants                 | Perched groundwater within Made Ground.  
|                        | Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff. | Neighbouring site users (visitors to the country park, Golfers at the Royal North Devon Golf Club), future site users, wildlife in the SSSI, the environment within the AONB.  
|                        | Groundwater in Minor Aquifer                                                | Grazing animals  
|                        | Vertical migration of dissolved and free-phase contaminants                 | Perched groundwater within Made Ground.  
|                        | Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff. | Neighbouring site users (visitors to the country park, Golfers at the Royal North Devon Golf Club), future site users, wildlife in the SSSI, the environment within the AONB.  
|                        | Groundwater in Minor Aquifer                                                | Grazing animals  
|                        | Vertical migration of dissolved and free-phase contaminants                 | Perched groundwater within Made Ground.  
|                        | Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff. | Neighbouring site users (visitors to the country park, Golfers at the Royal North Devon Golf Club), future site users, wildlife in the SSSI, the environment within the AONB.  
|                        | Groundwater in Minor Aquifer                                                | Grazing animals  
|                        | Vertical migration of dissolved and free-phase contaminants                 | Perched groundwater within Made Ground.
### Table 4.2: Potential Pollutant Linkages

<table>
<thead>
<tr>
<th>Contaminant(s)</th>
<th>Pathway(s)</th>
<th>Receptor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others (Asbestos, pH, Phenol, PCBs, Dioxins and furans)</td>
<td>Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff.</td>
<td>On site pond, the Skern mudflats and sands, the Estuary of Rivers Taw and Torridge, Land drains.</td>
</tr>
<tr>
<td></td>
<td>Inhalation, ingestion and dermal:</td>
<td>Neighbouring site users (visitors to the country park, Golfers at the Royal North Devon Golf Club), future site users, wildlife in the SSSI, the environment within the AONB.</td>
</tr>
<tr>
<td></td>
<td>– contact with contaminated soil and landfill material</td>
<td>Grazing animals</td>
</tr>
<tr>
<td></td>
<td>– wind blown dust and landfill material.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical migration of dissolved and free-phase contaminants</td>
<td>Groundwater in Minor Aquifer</td>
</tr>
<tr>
<td></td>
<td>Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff.</td>
<td>Perched groundwater within Made Ground.</td>
</tr>
<tr>
<td>Oil/Fuel hydrocarbons, PAHs, Chlorinated Aliphatic Hydrocarbons, α, β and γ- hexachlorocyclohexane, Dieldrin, Chlorinated Aromatic Hydrocarbons</td>
<td>Inhalation, ingestion and dermal:</td>
<td>Neighbouring site users (visitors to the country park, Golfers at the Royal North Devon Golf Club), future site users, wildlife in the SSSI, the environment within the AONB.</td>
</tr>
<tr>
<td></td>
<td>– contact with contaminated soil and landfill material</td>
<td>Grazing animals</td>
</tr>
<tr>
<td></td>
<td>– wind blown dust and landfill material.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical migration of dissolved and free-phase contaminants</td>
<td>Groundwater in Minor Aquifer</td>
</tr>
<tr>
<td></td>
<td>Lateral migration of aqueous and free-phase contaminants in shallow groundwater system and surface runoff.</td>
<td>Perched groundwater within Made Ground.</td>
</tr>
<tr>
<td>Landfill Gas (Components of methane, carbon dioxide, carbon monoxide and H2S )</td>
<td>Inhalation of gas flux.</td>
<td>Neighbouring site users and future site users, wildlife in the SSSI.</td>
</tr>
<tr>
<td></td>
<td>Pressure driven flow of gas through Made Ground and underlying geology.</td>
<td>Grazing animals</td>
</tr>
<tr>
<td></td>
<td>Explosive risk</td>
<td>Neighbouring site users and future site users.</td>
</tr>
</tbody>
</table>
4.4.3 The identification of potential pollutant linkages does not indicate that they are significant in any way or that the site is unsuitable for its current/proposed use. It does however act as a way of focusing any further data collection at the site, as explained in Section 5.

4.4.4 The current land use comprises common land, which is open to the public and grazing of live stock also takes place on the burrows. The site is also part of a SSSI and a UNESCO Biosphere Reserve. Due to the environmental sensitivity of the area the land use is of relatively high sensitivity.