# GeoHazard Potential

This module provides

- **An Automated Assessment of Natural Subsidence**: An indication of the potential for significant natural ground instability generated automatically from BGS's GeoSure dataset, which is based on 1:50 000 scale digital data. It comprises:
    - A summary table of search results
    - Maps of the natural geological hazards
    - Keys to the table and maps, with generalised advice

- **A Geologist's Assessment of Geohazard Potential:** A geologist's analysis of geological hazard potential for the site of interest, based on available geological information.

- **Definitions and limitations:** an explanation of what this report provides

- **General explanations of the hazards**: a brief description of each hazard considered by this report

**Automated Assessment of Natural Subsidence**

This is an automated assessment that indicates the potential for a geological hazard to occur within the site and a 50 m-wide buffer zone around it, or where a site boundary is not available, within a search area centred upon the site. It is not based on detailed site-specific information such as an on-site survey or site investigation. This assessment is intended for use by suitably-qualified professionals involved in conveyancing or development of low-rise properties. If in doubt users should consult a suitably-qualified professional about the results in this report before making any major decisions based upon it.

**Search Results:**

The following table provides answers to a series of questions about any potential natural ground instability found in the search area and assesses how significant they are.

| **Question 1** | **Answer** | |
|---|---|---|
| | **Hazard** | **Hazard level** |
| **Which natural geological hazards could be contributing to ground instability in the area?**<br><br>**NOTE: The hazard levels are described as A (least) to E (greatest), or as 'No Hazard'. Levels A and B are not considered significant and are not shown on the maps.**<br><br>**See key tables for fuller explanations** | **Shrink-Swell:**<br>Clays that can swell when wet and shrink when dry, causing the ground to rise and fall | C |
| | **Landslides (slope instability):**<br>Weak or unstable rocks that could slide downhill (usually slopes over 5 degrees) | C |
| | **Soluble Rocks (dissolution):**<br>Rocks that can dissolve and develop underground cavities that may lead to surface collapses and hollows | A |
| | **Compressible Ground:**<br>Very soft ground that might compress and progressively sink under the weight of a building or other load | D |
| | **Collapsible Deposits:**<br>Material that is prone to collapse when it is water-saturated and a load is placed on it | B |
| | **Running Sand:**<br>Sand that can wash away or flow into holes or fissures due to presence of water | C |

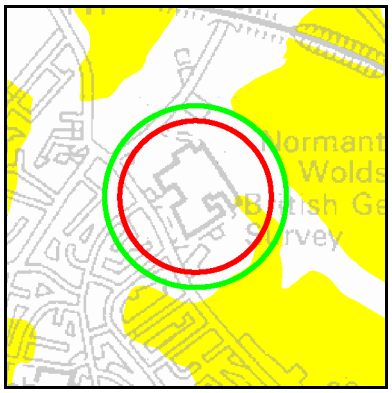
| Question 2 | Answer |
|---|---|
| **What action should be taken?** | If natural geological hazards at level C, D or E have been indicated this means there is potential ground instability in your area that may cause some properties to suffer subsidence damage. However, it does not necessarily mean that your property will be affected, and in order to find out if this is the case or not, you should obtain further advice from a qualified expert, such as a building surveyor. Show them this report and ask them to evaluate the property and its surroundings for any signs of existing subsidence damage and for advice on the likelihood for subsidence to occur in the future. The notes at the end of this report module may be useful in this regard.<br>Note that the type of building and its surroundings (e.g. the presence of trees) are also very important when considering subsidence risk. Many types of properties, particularly newer ones, are well constructed and unlikely to be affected by subsidence, even in areas of significant ground movements. |

| Question 3 | Answer |
|---|---|
| **Where could the natural geological hazards occur in the area?** | See the maps that follow |

**Automatically generated maps of near-surface natural geological hazards**

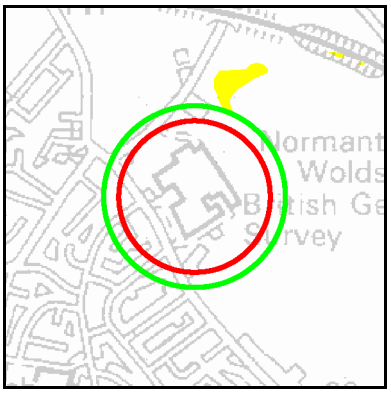
The following maps show where significant natural ground instability at or near the surface could occur in relation to each of six geological hazards: shrink-swell, landslide (slope instability), soluble rocks (dissolution), compressible ground, collapsible deposits and running sand. The relative level of potential is indicated in colour and described in the key. Please note that a hazard is reported as significant for the property if it occurs within the specified site or the surrounding buffer zone.

### Shrink-Swell



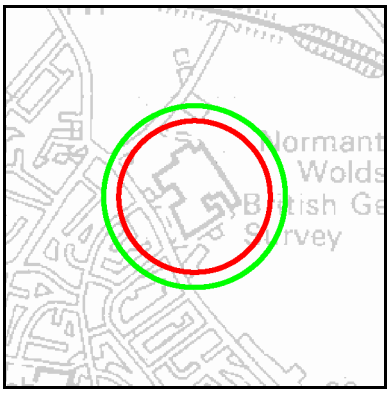


### Landslides (slope instability)



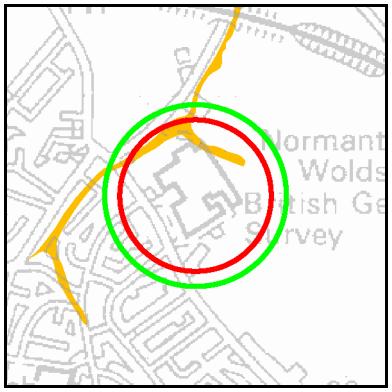


### Soluble Rocks (dissolution)



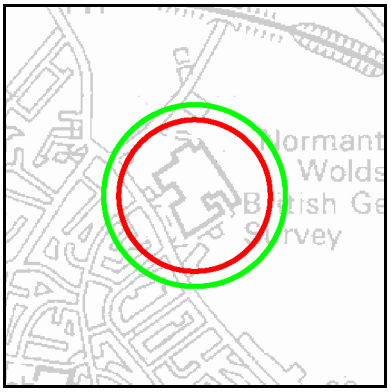


### Compressible Ground



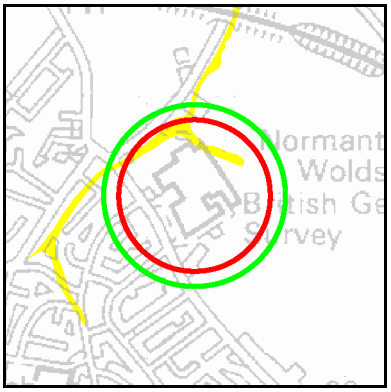


### Collapsible Deposits





### Running Sand





**Search area indicated in red**

**50 m buffer indicated in green**

**For the key to relative level of potential for natural geological hazards see over the page**

The unshaded (white) areas on the map (levels A, B or 'No hazard') represent areas where the conditions that cause natural ground movements due to the six natural geological hazards are considered to be absent or unlikely to be significant.

### *Key to Shrink-Swell Hazard:*

| Level | Hazard description | Advice for public | Advice for specialist |
|---|---|---|---|
| C | Ground conditions predominantly medium plasticity. | Do not plant trees with high soil moisture demands near to buildings. Avoid increased infiltration and seek specialist advice before disposing of large amounts of water to the ground through soakaways. | **New build** – Test for plasticity index is recommended. Possible increase in construction cost to remove potential shrink-swell problems. **Existing property** – Possible increase in insurance risk in droughts or where high moisture demand vegetation is present due to shrink-swell clay problems if foundations are not suitable. |
| D | Ground conditions predominantly high plasticity. | Do not plant or remove trees or shrubs near to buildings without expert advice about their effect and management. Seek specialist advice before disposing of large amounts of water to the ground through soakaways. | **New build** – Test for plasticity index is necessary. Probable increase in construction cost to remove potential shrink-swell problems. **Existing property** – Probable increase in insurance risk in droughts or where high moisture demand vegetation is present due to shrink-swell clay problems if foundations are not suitable. |
| E | Ground conditions predominantly very high plasticity. | Do not plant or remove trees or shrubs near to buildings without expert advice about their effect and management. Seek specialist advice before disposing of large amounts of water to the ground through soakaways. | **New build** – Test for plasticity index is essential. Definite increase in construction cost to remove potential shrink-swell problems. **Existing property** – Significant increase in insurance risk in droughts or where high moisture demand vegetation is present due to shrink swell clay problems if foundations are not suitable. |

### *Key to Landslides (slope instability) Hazard:*

| Level | Hazard description | Advice for public | Advice for specialist |
|---|---|---|---|
| C | Slope instability problems may be present or anticipated. Site investigation should consider specifically the slope stability of the site. | Ask about implication for stability if large changes to drainage or excavations take place near to buildings. Seek specialist advice if major changes in ground conditions are likely and before disposing of large amounts of water to the ground through soakaways. | **New build** – Consider possibility of trench side or slope movement during excavations, or consequence of changes to drainage. Possible increase in construction cost to remove potential slope stability problems. **Existing property** – No significant increase in insurance risk due to natural slope instability problems. |
| D | Slope instability problems are probably present or have occurred in the past. Land use should consider specifically the stability of the site. | Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not undercut or place large amounts of material on slopes without technical advice. | **New build** – Assess slope stability of site and consequences of excavation, loading and water content changes during and after construction. **Existing property** – Probable increase in insurance risk due to natural slope instability after changes to ground conditions such as a very long, excessively wet winter. |
| E | Slope instability problems almost certainly present and may be active. Significant constraint on land use. | Seek expert advice about stability of the ground and its management to maintain and increase its stability. | **New build** – Slope stability assessment necessary, special design may be necessary, construction may not be possible. **Existing property** – Significant increase in insurance risk in some cases. Site-specific consideration is necessary to separate cases where landslide s are stabilised or ancient and stable from those that may be active or may fail. |

### *Key to Soluble Rocks (dissolution) Hazard:*

| Level | Hazard description | Advice for public | Advice for specialist |
|---|---|---|---|
| **C** | Soluble rocks are present within the ground. Some dissolution features may be present. Potential for difficult ground conditions are at a level where they may be considered; localised subsidence need not be considered except in exceptional circumstances. | Consider implications for stability when changes to surface drainage or new construction are planned. Seek specialist advice before disposing of surface drainage to the adjacent ground. | **New build** – Site investigation should consider potential for dissolution problems on the site and its surroundings. Care should be taken with local drainage into the adjacent bedrock. **Existing property** – Possible increase in insurance risk due to soluble rocks. Some possibility of potential liability due to groundwater pollution may be present. |
| **D** | Soluble rocks are present within the ground. Many dissolution features may be present. Potential for difficult ground conditions are at a level where they should be considered. Potential for subsidence is at a level where it may need to be considered. | Consider obtaining specialist advice before loading the land or undertaking building work. Seek specialist advice before disposing of surface drainage to the adjacent ground. Maintain drainage infrastructure. | **New build** – Specialist site investigation and stability assessment may be necessary before construction. Construction work may cause subsidence. Isolate surface drainage from the karst system and groundwater. Increased construction costs are possible. **Existing property** – Possible increase in insurance risk due to soluble rocks. Some possibility of potential liability due to groundwater pollution may be present. |
| **E** | Soluble rocks are present within the ground. Numerous dissolution features may be present. Potential for difficult ground conditions should be investigated. Potential for localised subsidence is at a level where it should be considered. | Obtain specialist advice on need for stabilisation work and/or land management plan to maintain stability. Do not dispose of surface drainage into the adjacent ground. Maintain drainage infrastructure. | **New build** – Specialist land stability assessment necessary. Investigation, remediation and/or mitigation works may be necessary to stabilise the area. Construction work may cause subsidence. Isolate surface drainage from the karst system and groundwater. Increased construction costs. **Existing property** – Probable increase in insurance risk due to soluble rocks. Probable potential liability due to groundwater pollution. |

### *Key to Compressible Ground Hazard:*

| Level | Hazard description | Advice for public | Advice for specialist |
|---|---|---|---|
| **C** | Compressibility and uneven settlement potential may be present. Land use should consider specifically the compressibility and variability of the site. | Take technical advice regarding settlement when planning extensions to existing property or when retrofitting soakaways. | **New build** – Consider possibility of settlement during construction due to compressible deposits. Unlikely to be increase in construction costs due to potential compressibility problems. **Existing property** – No significant increase in insurance risk due to compressibility problems. |
| **D** | Compressibility and uneven settlement hazards are probably present. Land use should consider the compressibility and variability of the site. | Avoid large differential loadings of ground. Do not drain or dewater ground near the property without specialist advice. | **New build** – Assess the variability and bearing capacity of the ground. May need special foundations to avoid excessive settlement during and after construction. Consider effects of changes to drainage regime and groundwater level. Extra construction costs are likely. **Existing property** – Possible increase in insurance risk from compressibility if groundwater levels drop due to drought or dewatering. |
| **E** | Highly compressible strata present. Significant constraint on land use depending on thickness. | Avoid large differential loadings of ground. Do not drain or dewater ground near the property without specialist advice. | **New build** – Assess the variability and bearing capacity of the ground. Probably needs special foundations to avoid excessive settlement during and after construction. Consider effects of changes to drainage regime and groundwater level. Construction may not be possible at economic cost. **Existing property** – Probable increase in insurance risk from compressibility due to drought or dewatering unless appropriate foundations are present. |

## *Key to Collapsible Deposits Hazard:*

| Level | Hazard description | Advice for public | Advice for specialist |
|---|---|---|---|
| C | Deposits with potential to collapse when loaded and saturated are possibly present in places. | Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not increase loading on existing foundations without technical advice. | Contact local authorities for information on local occurrence of damage due to collapsible ground.<br>**New build** – Assess the possibility of collapsible (loessic) deposits by ground investigation. If present do not exceed safe bearing capacity during or after construction and maintain site drainage, or carry out ground stabilisation.<br>**Existing property** – Possible increase in insurance risk if collapsible deposits are present and if the load on the ground is increased or ground saturated by leakage or localised flooding. |
| D | Deposits with potential to collapse when loaded and saturated are probably present in places. | Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not increase loading on existing foundations without technical advice. | Contact local authorities for information on local occurrence of damage due to collapsible deposits.<br>**New build** – Assess the possibility of collapsible deposits by ground investigation. If present do not exceed safe bearing capacity during or after construction and maintain site drainage, or carry out ground stabilisation.<br>**Existing property** – Possible increase in insurance risk if collapsible deposits are present and if the load on the ground is increased or ground saturated by leakage or localised flooding. |
| E | Deposits with potential to collapse when loaded and saturated have been identified. | Avoid large amounts of water entering the ground through pipe leakage or soakaways. Do not increase loading on existing foundations without technical advice. | Contact local authorities for information on local occurrence of damage due to collapsible ground.<br>**New build** – Assess the possibility of collapsible deposits by ground investigation. If present do not exceed safe bearing capacity during or after construction and maintain site drainage, or carry out ground stabilisation.<br>**Existing property** – Possible increase in insurance risk if collapsible deposits are present and if the load on the ground is increased or ground saturated by leakage or localised flooding. |

### *Key to Running Sand Hazard:*

| Level | Hazard description | Advice for public | Advice for specialist |
|---|---|---|---|
| **C** | Running sand conditions may be present. Constraints may apply to land uses involving excavation or the addition or removal of water. | Normal maintenance to avoid leakage of water-bearing services or water bodies (ponds, swimming pools) should avoid any problems due to running sands. Seek specialist advice before disposing of large amounts of water to the ground through soakaways | **New build** – Consider possibility of running sands into trenches or excavations if water table is high. Avoid concentrated water inputs to site. Unlikely to be increase in construction costs due to potential for running sand problems. **Existing property** – No significant increase in insurance risk due to running sand problems. |
| **D** | Running sand conditions are probably present. Constraints may apply to land uses involving excavation or the addition or removal of water. | Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not dig (deep) holes into saturated ground near the property without technical advice. | **New build** – Assess the need for close-boarded sides to excavations and the consequences of soil and groundwater conditions during and after construction. **Existing property** – Possible increase in insurance risk from running conditions due to service leakage, high rainfall events or localised flooding. |
| **E** | Running sand conditions are almost certainly present. Constraints will apply to land uses involving excavation or the addition or removal of water. | Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not dig (deep) holes into saturated ground without technical advice. | **New build** – Assess the need for close-boarded sides to excavations and the consequences of soil and groundwater conditions during and after construction. Possible extra cost during construction and requirement for basements to be water proofed. **Existing property** – Possible increase in insurance risk from running conditions due to service leakage, high rainfall events or localised flooding. |

## Geologist's Assessment of Geohazard Potential

This module lists some of the principal geological hazards that may affect the specified site. It is a geologist's interpretation of data available at the time of compilation; additional information may be available in BGS files. The assessment is designed to identify potential ground stability hazards at or close to the site and should not be used in place of a detailed site investigation.

Note that the assessment given here may differ from that in the Automated Assessment of Natural Subsidence or other reports that have been automatically generated from digital datasets such as GeoSure.

Descriptions of the geological units that are associated with the stated potential hazards are given in preceding parts of the report. Definitions and general explanations of the hazards are given in the next part of the report.

| Geological hazard | May be significant within site area (Yes/No)? | Comments |
|---|---|---|
| **Potential Natural Ground Stability Hazards** | | |
| Shrink-Swell | No | Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances. |
| Landslides (slope instability) | No | Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances. |
| Soluble Rocks (dissolution) | No | Potential for hazard to be active either zero or insignificant. |
| Compressible Ground | Yes | Significant potential for hazard to become active that requires site-specific advice on the level of hazard related to building type and environment.<br>Hazard associated with alluvium and Made Ground. |
| Collapsible Deposits | No | Potential for hazard to be active either zero or insignificant. |
| Running Sand | Yes | Significant potential for hazard to become active that requires site-specific advice on the level of hazard related to building type and environment.<br>Hazard associated with alluvium. |
| **Other Potential Hazards** | | |
| Mining | No | Records show that underground mining has not taken place here. |
| Flooding | No | Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances. |
| Natural Land Gas | No | Unlikely to encounter gas from bedrock and coal mining; unlikely to encounter gas from peat. |
| Radon | | Level of protective measures: None required |

**Definitions:**

- **Natural Geological Hazards** are shrink-swell, landslides (slope instability), soluble rocks (dissolution), compressible ground, collapsible deposits and running sand. This does not include mining related subsidence. Note that these geological hazards may occur in either natural or man-made deposits.
- **Natural Ground Instability** refers to the propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological hazards. Some movements associated with particular hazards may be gradual and of millimetre or centimetre scale, whilst others may be sudden and of metre or tens of metres scale.
- **Significant** natural ground instability has the potential to cause damage to some weaker buildings and structures. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of significant ground movement.
- Where significant natural ground instability is indicated, its relative **level** of significance is expressed on a scale of C to E ('low' to 'high'), relating to its potential to cause subsidence damage in low-rise buildings.

**Limitations:**

- The maps in this module provide an indication of potential near-surface ground instability related to particular natural geological hazards. These are shrink-swell clay, landslides, soluble rocks (ground dissolution), compressible ground, collapsible deposits, and running sand. They do not give an indication of potential hazards at depth as might be encountered in a borehole, for example.
- The search results in the Automated Assessment of Natural Subsidence are generated automatically from BGS's GeoSure dataset, based on 1:50 000 digital geological maps and the interpretation of other records in the possession of BGS at the time. Their scope and accuracy is limited by the methods used to create the dataset and they may differ from the geologist's interpretation in the Geologist's Assessment of Geohazard Potential.
- The information is intended for use by suitably-qualified professionals involved in conveyancing or development of low-rise domestic properties. If in doubt users should consult a suitably-qualified professional about the search results in this report before making any major decisions based upon it.
- An indication of natural ground instability does not necessarily mean that a building will be affected by subsidence. Such an assessment can be made only by inspection of the building itself by a suitably-qualified professional. This will take into account a variety of other contributing factors, such as building type and build quality, and nearby vegetation (in particular, the proximity and type of trees).

# General explanation of geological hazards

This is a general description of the hazards that might be described in the Geohazard Potential module.

**Shrink-Swell**
A shrinking and swelling clay changes volume significantly according to how much water it contains. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Most foundations are designed and built to withstand seasonal changes. However, in some circumstances, buildings constructed on clay that is particularly prone to swelling and shrinking behaviour may experience problems. Contributory circumstances could include drought, tree roots drying-out the ground, leaking service pipes, or changes to local drainage such as the creation of soakaways. Shrinkage may remove support from the foundations of a building, whereas clay expansion may lead to uplift (heave) or lateral stress on part or all of a structure; any such movements may cause cracking and distortion.

**Landslides (slope instability)**
A landslide is a relatively rapid outward and downward movement of a mass of rock or soil on a slope, due to the force of gravity. A slope is under stress from gravity but will not move if its strength is greater than this stress. If the balance is altered so that the stress exceeds the strength, then movement will occur. The stability of a slope can be reduced by removing ground at the base of the slope, increasing the water content of the materials forming the slope or by placing material on the slope, especially at the top. Property damage by landslide can occur through the removal of supporting ground from under the property or by the movement of material onto the property.

The assessment of landslide hazard refers to the stability of the present land surface. It does not encompass a consideration of the stability of excavations.

**Soluble Rocks (dissolution)**
Some rocks are soluble in water and can be progressively removed by the flow of water through the ground. This process tends to create cavities, potentially leading to the collapse of overlying materials and possibly subsidence at the surface. The collapse of the materials above a cavity can be aggravated by natural or induced ingress of surface of subsurface water into the ground. Collapse can also be aggravated by groundwater abstraction.

**Compressible Ground**
Many ground materials, including artificial deposits, can be compressed when a load, such as a building, is placed upon them. If ground is extremely compressible the building may sink. If the ground is not uniformly compressible, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion.

**Collapsible Deposits**

Collapsible deposits consist of certain fine-grained loessic (wind-blown) materials that have relatively large spaces between the solid particles. Such deposits are prone to collapse (they may undergo rapid subsidence) when they are loaded and then saturated with water. If the material below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. This hazard is most likely to be encountered in parts of southern England.

**Running Sand**

Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation, borehole or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. This can lead to subsidence of the surrounding ground.

If sand below a building runs it may remove support and the building may sink. Different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion.

**Mining**

If the site is located above geological formations that have been mined for coal or other commodities, it might be prone to subsidence. Modern extraction activities will include the construction of underground roadways, shafts and adits. Past mining activities that were not documented may also include shafts, adits and, in the case of shallow mining, bell-pits and pillar-and-stall workings. Any of these activities can give rise to general subsidence and fracturing of the ground, and shallow mining may additionally cause voids at shallow or intermediate depths, which may lead to the formation of crown-holes in the ground above. The voids created by shallow underground mining activity may pose a potential hazard to both life and assets and the associated risk of ground movement can reduce property values. Further, spoil from mineral workings can present a pollution hazard.

For more information regarding underground and opencast **coal mining** or **brine extraction**, the location of mine entries (shafts and adits) and matters relating to subsidence or other ground movement induced by coal mining please contact the Coal Authority, Mining Reports, 200 Lichfield Lane, Mansfield, Nottinghamshire, NG18 4RG; telephone 0845 762 6848 or at www.coal.gov.uk .

**Flooding**

Flooding due to natural causes can occur following run-off or ponding of surface water (pluvial flooding, which is not considered by this report), or overflow from a river or stream (fluvial flooding), or because of rising groundwater levels (groundwater flooding), or because of inundation by the sea (coastal flooding), or through a combination of these factors. The table indicates whether there is geological evidence that flooding has occurred in this vicinity and the susceptibility to groundwater flooding.

For further information on flood-risk, the likely frequency of its recurrence in relation to any proposed development of the site, and the status of any flood prevention measures in place, you are advised to contact the local office of the Environment Agency (England and Wales) at www.environment-agency.gov.uk/homeandleisure/floods/ or the Scottish Environment Protection Agency (Scotland) at www.sepa.org.uk.

Groundwater flooding occurs when the level of water in the ground rises to the surface. Ratings of susceptibility to groundwater flooding given in this report are based on a computer model that indicates whether the rocks below the site have the potential to contain shallow groundwater that may enter excavations or basements, or even rise above the ground surface. This computer model does not indicate whether groundwater flooding will necessarily occur at a particular site in the future: the risk of this happening also depends on considerations such as the past history of flooding and the mode of construction at the site.

**Natural Land Gas**

The table indicates whether or not there is any potential susceptibility of the site to emissions of methane or carbon dioxide, or both, from natural sources. Most methane and carbon dioxide emissions appear to originate from abandoned shallow coal mines although a number originate from peat and other natural deposits of organic materials, such as in buried ponds or river channels. The exact extent of potential sources of natural land gas, particularly that of peat, can be difficult to predict.

The relatively rare incidence of gas emission from natural sources in most areas of the UK suggests that the hazard is of relatively minor and local significance, except in some parts of the coal fields. An indication of potential for gas emissions does not necessarily indicate that there is a problem. Although accumulations of methane and carbon dioxide can cause severe and, sometimes, expensive or dangerous problems, most gas emissions from natural sources and mining can usually be dealt with readily if they do arise.

A site-specific coal mining search from the Coal Authority (http://www.coal.gov.uk/services/propertysearch/index.cfm) will indicate whether any shafts or adits, which may act as pathways for gas, are located within 20 m of the site. Where the Coal Authority is aware that a site which is the subject of a search has been affected by mine gas, this information will be included in the Coal Mining Search Report.

The information in this report should not be used in place of a site investigation. The

existence of gas emissions at specific sites can be established only by detailed site investigation. The level of risk from methane or carbon dioxide in a particular building or underground cavity can be established only by monitoring the spaces in which it may accumulate.

**Radon**

Radon is a naturally-occurring radioactive gas. It diffuses from the ground and occurs in greater concentrations in some areas, depending on the local geology. It can accumulate in buildings, unless measures are taken to prevent this, and can then cause ill-health.

The above table indicates the level of Radon Protective Measures required at the site during the construction of new buildings or extensions to existing buildings. This determination complies with information set out in *BR211 Radon: Guidance on protective measures for new dwellings (2007 edition)*, which also provides guidance on what to do if the result indicates that protective measures are required (please see BRE Website for more details: www.bre.co.uk/radon ). This assessment is based on the Radon Potential Dataset produced jointly by the BGS and the Health Protection Agency (for more information please see the BGS website at www.bgs.ac.uk/radon).