BGS INFORMATICS

User Guide: Radon Potential for Great Britain

Open report OR/24/026

British Geological Survey

BRITISH GEOLOGICAL SURVEY

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BRITISH GEOLOGICAL SURVEY

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The British Geological Survey is a component body of UK Research and Innovation.

British Geological Survey offices

Nicker Hill, Keyworth,
Nottingham NG12 5GG
Tel 0115 936 3100

BGS Central Enquiries Desk
Tel 0115 936 3143
email enquiries@bgs.ac.uk

BGS Sales
Tel 0115 936 3241
email sales@bgs.ac.uk

The Lyell Centre, Research Avenue South,
Edinburgh EH14 4AP
Tel 0131 667 1000
email scotsales@bgs.ac.uk

Natural History Museum, Cromwell Road,
London SW7 5BD
Tel 020 7589 4090
Tel 020 7942 5344/45
email bgslondon@bgs.ac.uk

Cardiff University, Main Building, Park Place,
Cardiff CF10 3AT
Tel 029 2167 4280

Maclean Building, Crowmarsh Gifford,
Wallingford OX10 8BB
Tel 01491 838800

Geological Survey of Northern Ireland, Department of Enterprise, Trade & Investment, Dundonald House, Upper Newtownards Road, Ballymiscaw,
Belfast, BT4 3SB
Tel 01232 666595
www.bgs.ac.uk/gsni/

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon SN2 1EU
Tel 01793 411500 Fax 01793 411501
www.nerc.ac.uk

UK Research and Innovation, Polaris House,
Swindon SN2 1FL
Tel 01793 444000
www.ukri.org

Website www.bgs.ac.uk
Shop online at www.geologyshop.com

Foreword

The British Geological Survey (BGS) is a world-leading geological survey, focusing on public-good science for government, and research to understand earth and environmental processes.

We are the UK's premier provider of objective and authoritative geoscientific data, information and knowledge to help society to:

- use its natural resources responsibly
- manage environmental change
- be resilient to environmental hazards

We provide expert services and impartial advice in all areas of geoscience. As a public sector organisation, we are responsible for advising the UK Government on all aspects of geoscience as well as providing impartial geological advice to industry, academia and the public. Our client base is drawn from the public and private sectors both in the UK and internationally.

The BGS is a component body of the Natural Environment Research Council (NERC), part of UK Research and Innovation (UKRI).

DATA PRODUCTS

The BGS produces a wide range of data products that align to government policy and stakeholder needs. These include baseline geological data, engineering properties and geohazards datasets. These products are developed using in-house scientific and digital expertise and are based on the outputs of our research programmes and substantial national data holdings.

Our products are supported by stakeholder focus groups, identification of gaps in current knowledge and policy assessments. They help to improve understanding and communication of the impact of geo-environmental properties and hazards in Great Britain, thereby improving society's resilience and enabling people, businesses, and the government to make better-informed decisions. The radon potential data represents a collaboration between UK Health Security Agency (formerly Public Health England) and the British Geological Survey.

Acknowledgements

This report is the published product of a study by the British Geological Survey (BGS) and UK Health Security Agency (UKHSA (formerly Public Health England, PHE)) to produce a digital dataset depicting radon potential for Great Britain. The method used to derive the data was critically assessed at the time of creation and its fitness for purpose determined by Dr A. Ferreira (BGS), Dr H. Taylor - Curran (BGS), D Rees (UKHSA) and Dr Z Daraktchieva (UKHSA).

A large number of individuals in BGS and UKHSA have contributed to the project. This assistance has been received at all stages of the study. In addition to the collection of data, many individuals have freely given their advice, and provided expert knowledge. Of the many individuals who have contributed to the project, we would particularly like to thank the following: K. Linley, R. Lawley, J. D. Appleton, C. Scheib, A. Bevan, D. Daley, J. Bradley, T. Gooding, N. Hutt, and Neil McColl.

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Summary

Developed by the British Geological Survey (BGS) and UK Health Security Agency (UKHSA, formerly Public Health England (PHE)), the radon potential data informs about the likelihood of a property having a radon level being at or above the Action Level for dwellings in Great Britain. The data provides information about ground conditions relating to health protection of the occupants (dwellings).

This product was developed as studies have shown that long-term exposure to elevated levels of radon, the biggest source of ionising radiation dose to the average UK citizen, increases the risk of lung cancer. The dataset combines Indoor Radon Measurements (560740 records) and Geology (at 1:50 000 scale). The output provides an assessment of the likelihood of a dwelling having a radon concentration at or above the Action Level based on its location. The data does not provide the actual radon level within a specific dwelling.

The outputs are classified using the Affected Area levels defined by UKHSA and Radon Protection levels (based on BR 211 guidance (Radon: Guidance on protective measures for new buildings BRE 211 (Scivyer 2015)) indicating where it may be necessary to apply preventative measures in new buildings and extensions.

The dataset citation, metadata and overview can be found here: British Geological Survey, UK Health Security Agency (2021): Radon potential for Great Britain version 3.0. British Geological Survey. (Dataset). https://doi.org/10.5285/0a2a29b5-ac3f-4909-9d48-d08c12572c35

The information provided in this User Guide is intended to provide a quick-start guide to using and understanding this UKHSA/BGS data product version 3. This user guide was last updated 1st May 2024.

1 Introduction

The Radon Potential data classifies areas based on their likelihood of a property having a radon level at or above the Action Level in Great Britain (Figure 1).

Radon is a natural radioactive gas, which enters buildings from the ground and persists or accumulates where ventilation is poor. Prolonged exposure to elevated levels of radon increases the risk of lung cancer. Indoor radon is the biggest source of long-term human exposure to ionising radiation in the UK. On average, for the UK population, indoor radon is responsible for an estimated 1100 lung cancer deaths a year (McColl et al., 2010).

The UK is required to set a reference level for the exposure of members of the public to indoor radon (The Ionising Radiation (Basic Safety Standards) (Miscellaneous Provisions) Regulations 2018, SI 482/2018). The Action Level for UK homes is 200 Bq/m^3. UKHSA recommends that radon levels should be reduced in homes where the annual average radon concentration is equal to, or greater than, the Action Level. The Radon Potential data was developed in order to meet these UKHSA definitions.

The dataset combines indoor radon measurements (560740 records) provided by UKHSA and geology provided by the BGS. A simplified geology was derived from the *bedrock* and the *superficial* units of BGS Geology 50000 version 8 (formerly known as DiGMapGB-50) at 1:50000 scale. The Radon Potential is calculated from statistics (namely geometric mean and geometric standard deviation) of indoor radon measurements collected over each simplified geology unit. The output provides an estimate of the probability of a dwelling having a radon concentration at or above the Action Level based on its location.

The Radon Potential is shown in six discrete Radon Classes (RnC 1 to RnC 6) with increasing Radon Potential (RnP, see Table 1). The areas classified as RnC 2 (Radon Potential equal or above 1% and less than 3%) up to RnC 6 (Radon Potential greater than 30%) are considered by the UKHSA as Radon Affected Areas. These Radon Classes are used to identify areas where a further radon measurement is recommended by UKHSA, and also for building regulation purposes to determine the level of radon protection required in new or renovated buildings.

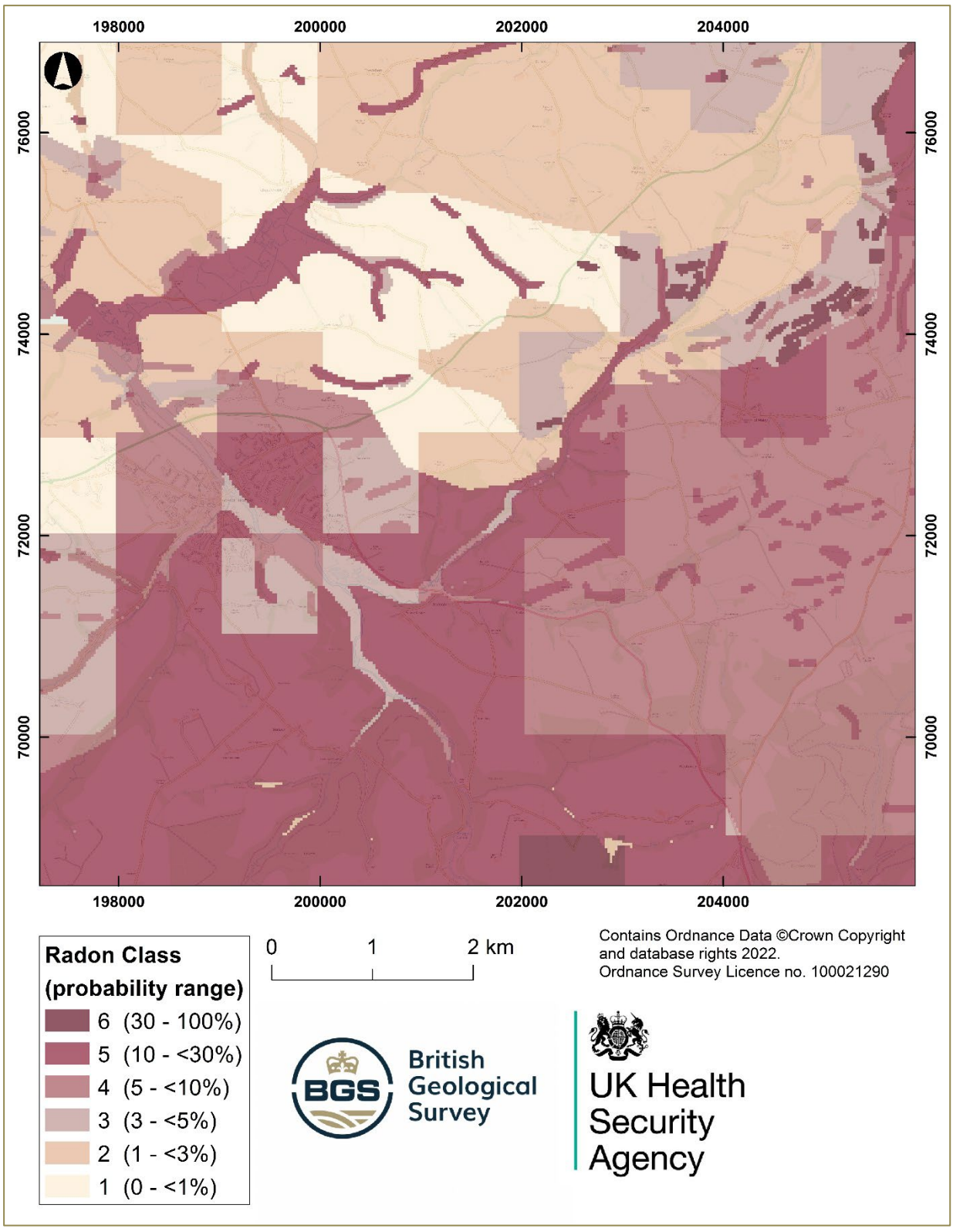

Figure 1 Example radon data (Radon Potential version 3)

2 Case Study: New housing development proposals in England

Local planning authorities require the implementation of radon gas preventative measures for new buildings when granting permission for a new housing development. These requirements are defined in the Ministry of Housing, Communities and Local Government Building regulations (supporting guidance for the regulations is provided in BR 211 (Scivyer 2015)).

2.1 WHY DOES RADON POTENTIAL MATTER?

Radon gas is a recognised health hazard with a link identified between long-term exposure and lung cancer. Preventing radon gas accumulation in residential dwellings is subject to building regulation guidance (BRE 211, Scivyer 2015). There is therefore a need for wider and more effective use of national environmental information such as mapping of 'radon potential' for strategic planning policy (e.g. Local Development Plans) and to inform developers.

2.2 HOW DO LOCAL AUTHORITIES AND CONSTRUCTION COMPANIES USE RADON POTENTIAL DATA?

In England, proposals for a new housing development are typically submitted to the local planning authority for approval. In drafting the proposal, the planning officer and the developer will have to preview via the online service provided by UKHSA (https://www.ukradon.org/information/ukmaps) and BGS (https://www.bgs.ac.uk/datasets/radon-data-indicative-atlas-of-radon/) (see Figure 2A). The Indicative Atlas uses a 1 km x 1 km grid to provide a generalised overview (at an approximate scale of 1:1 000 000) indicating the maximum radon gas potential observed in each grid square.

The developer is most likely to have used the free online service to preview the maximum radon potential. The planning officer may have also used the same online resource, or may have used a more detailed licensed version available from BGS (https://www.bgs.ac.uk/datasets/radon-data-radon-potential-dataset/, see Figure 2B). From the Indicative Atlas, the planning officer and developer can independently determine that the new development area lies within an area of maximum Radon Class 5 (Radon Potential from 10 to 30 %), and, that the specific class at the given location of the site can be anywhere from RnC1 to RnC5.

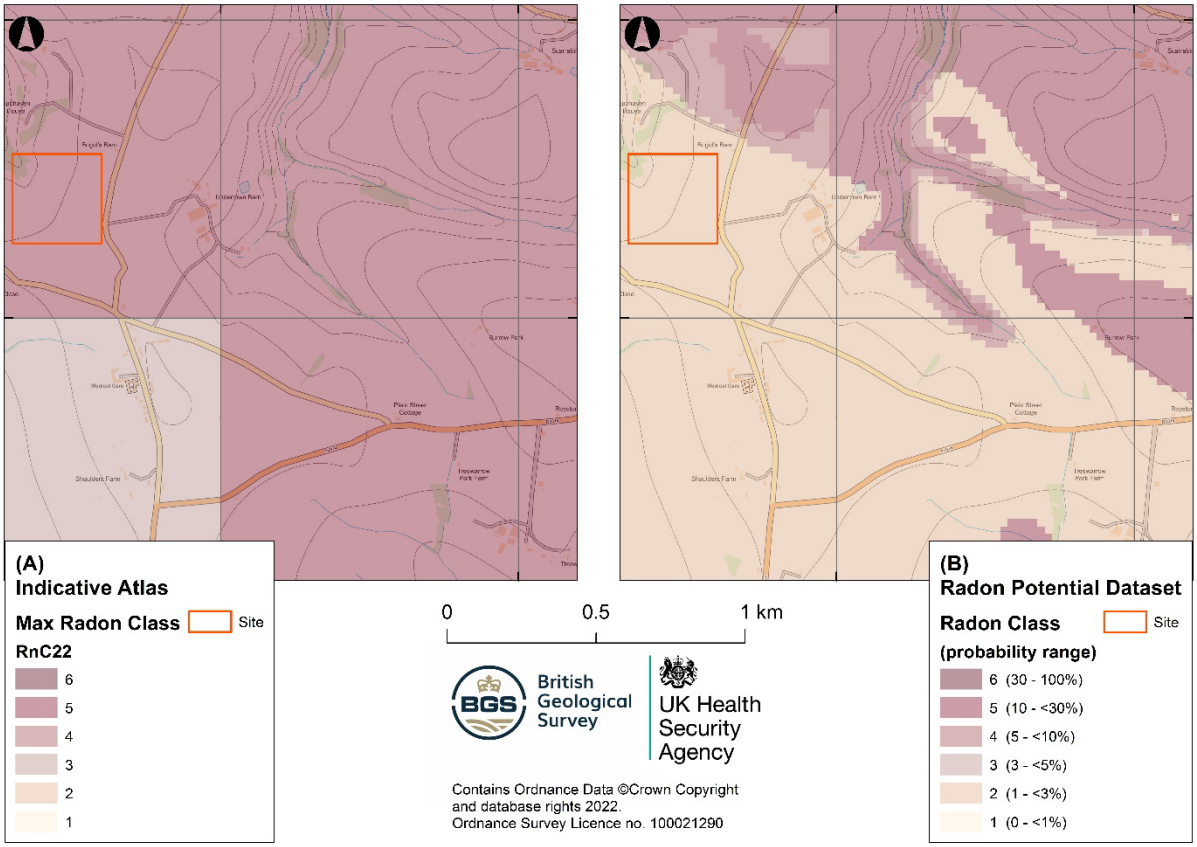

Figure 2 Proposed site (red square)
(A) Indicative atlas (1:100000 scale) (B) Licence Radon Potential data (1:50000 scale)

The information contained within the licensed Radon Potential Dataset is provided at a greater spatial resolution than the free Indicative Atlas, revealing the variation in radon potential within a given kilometre grid square (Figure 2B) at 1:50 000 scale.

The Planning Officer can now re-assess the proposed development site against the higher resolution Radon Potential Dataset and see that the site is actually within Radon Class 2 (1-3% probability of exceeding the Action Level). This additional information enables the planning officer to advise the developer further on managing specific aspects of construction, or to request further actions as conditions of the development receiving permission.

Since the proposed development site is not located in the lowest Radon class (i.e. Class 1: radon potential from 0 to 1%), and so is identified as a Radon Affected Area (Table 1).

Radon Guidance on protective measures for new buildings BR 211 (Scivyer 2015) states that developers are mandated to consult the Radon Potential Dataset (jointly developed and approved by BGS and UKHSA) in all areas of Class 2 or above (i.e. radon potential greater than 1%).

2.3 HOW DOES THE DATA PROVIDE A SOLUTION?

In the example given in Figure 2, the development site is located in a Radon Affected Area, as defined by UKHSA. One to three percent of dwellings in this site are estimated to have indoor radon concentrations above the Action Level.

Although the site lies within an area identified as intermediate probability for radon, the planning officer and developer now know that radon protective measures are not required as this site is in England (see Table 1 for how the action levels are classified, and which protection measures are required for England, Wales and Scotland). Still, according to UKHSA, testing existing buildings and fitting radon prevention in new buildings might be considered, particularly if there is a high-risk location such as a routinely occupied basement.

Table 1 Radon Potential Classes (RnC)

Radon CLASS (RnC)	Radon affected area?	Nominal estimated percentage band of dwellings exceeding the Radon Action Level (Radon Potential, RnP)	Actual estimated percentage band of dwellings exceeding the action Action Level (RnP)	Level of Protection Required	
				England & Wales	Scotland
1	No	0-1	0 < RnP < 1	None	None
2	Yes	1-3	1 ≤ RnP < 3	None	Basic
3	Yes	3-5	3 ≤ RnP < 5	Basic	Basic
4	Yes	5-10	5 ≤ RnP < 10	Basic	Basic
5	Yes	10-30	10 ≤ RnP < 30	Full	Full
6	Yes	30-100	RnP ≥ 30	Full	Full

≤ less than or equal to
< less than
≥ greater than or equal to

Note that the developer can accept the preview provided by the Indicative Atlas as it provides a conservative radon class (equal to, or higher than, the actual Radon class), and apply the corresponding preventive measures which may be higher than necessary. Figure 2 shows an example of such a case, with a site in Radon Class 2 (Figure 2B) but within a kilometre square with maximum Radon Class 5 (Figure 2A). If the developer accepts the result from the Indicative Atlas without consulting the detailed Radon Potential Dataset, they will apply full radon preventive measures (Table 1) for a site that the detailed Radon Potential Dataset shows to be Radon Class 2, for which preventive measures are not compulsory in England and Wales, and are basic in Scotland (Table 1).

Access to the Radon Potential Dataset ensures Local Authorities and developers are better informed. This dataset ensures that local authorities can recognise the importance of radon and its potential long-term impact on human health, while developers can more effectively plan new buildings, taking into account the radon risk of the area and adjusting the needs of their development accordingly.

The data offers two options in terms of planning: either the identification of 'lower' radon potential areas for targeted housing development, or invoking BR 211 guidance requiring radon preventative measures to be put in place during the construction phase for areas in Radon Class 2 and above.

2.4 WHAT ARE THE OUTCOMES AND VALUE?

The use of BGS/UKHSA information in their data analysis provides Local Authorities with early strategic knowledge of key discernible regional variations in land characteristics and potential land-supply, as well as potential constraints across Local Authority areas. These include zones classed as Radon Affected Areas. Use of the BGS/UKHSA datasets provides Local Authorities with greater leverage and capacity to forward plan risk and investment approaches with multiple stakeholders. Examples include:

- The need for different spatial strategies across the Local Authority area to overcome different development challenges
- The likely need for different investment models to deliver housing infrastructure in different parts of the Local Authority area.
- Enabling the Local Authority to request early, appropriate and proportionate requests for site investigation from developers and construction teams through successive stages of the planning and development process.

Ultimately, the Local Authority and developers can use this data to plan more effective and safer building of dwellings, optimising design to suit available land.

Data used in this example are the BGS/UKHSA Radon Data in its two forms: the open-access Indicative Atlas of Radon https://doi.org/10.5285/d481830d-d9b3-4a1d-9a14-9be52311db74, and the licenced Radon Potential Dataset https://doi.org/10.5285/0a2a29b5-ac3f-4909-9d48-d08c12572c35

3 Methodology

3.1 OVERVIEW

Previously, the potential for high radon levels in UK dwellings has been mapped on the basis of either grouping the results of radon measurements in dwellings by grid squares (by UKHSA), or by geological units (by BGS).

In both cases, lognormal modelling of the distribution of radon concentrations was applied to allow the estimated proportion of dwellings at or above the UK Radon Action Level (200 Bq/m^3) to be mapped. Combining the grid square and geological mapping methods gives a more accurate map than either method can provide separately (Miles and Appleton, 2005).

A data processing workflow (Figure 3) was devised which iterates through a series of steps. The land area is first divided up into simplified geologies, a combination of bedrock and superficial geological characteristics, derived from BGS Geology-50 (1:50 000 scale) digital geological map data. A bedrock/superficial (BS) code is assigned to each of them. Each simplified geology may appear at the land surface in many discontinuous locations across the country.

Each simplified BS geology is then divided in 1 km squares using the OS British National Grid to produce a list of spatially referenced KMBS (a simplification of 1 km^2/BS) polygons containing information about both the simplified geology and the British National Grid 1 km square.

UKHSA has a database of over 560 740 dwellings for which long-term (3 to 6 months) measurements of radon concentration have been made, and locations are accurately known. Each radon measurement is allocated to its KMBS polygon followed by the measurement coordinates; the precise location of the measurement is then removed. This procedure removes any recognisable personal data in line with General Data Protection Regulation guidelines.

Taking each simplified geology in turn, the spatial variation of radon potential is mapped, treating the BS as if it were continuous over the whole land area. Bedrock, stratigraphic (order in which rock layers are laid down) or lithological (rock characteristics) generalisations of the simplified geologies may be required to assure that the number of radon measurements is sufficient to estimate the radon potential.

All maps of radon potential within different simplified geologies are then combined to produce a map of variation in radon potential over the whole Great Britain land surface. This dataset formed the raw data on which processing was carried out to ensure all end-users would achieve consistent results. All data processing was carried out using ESRI ArcGIS 10.7 software.

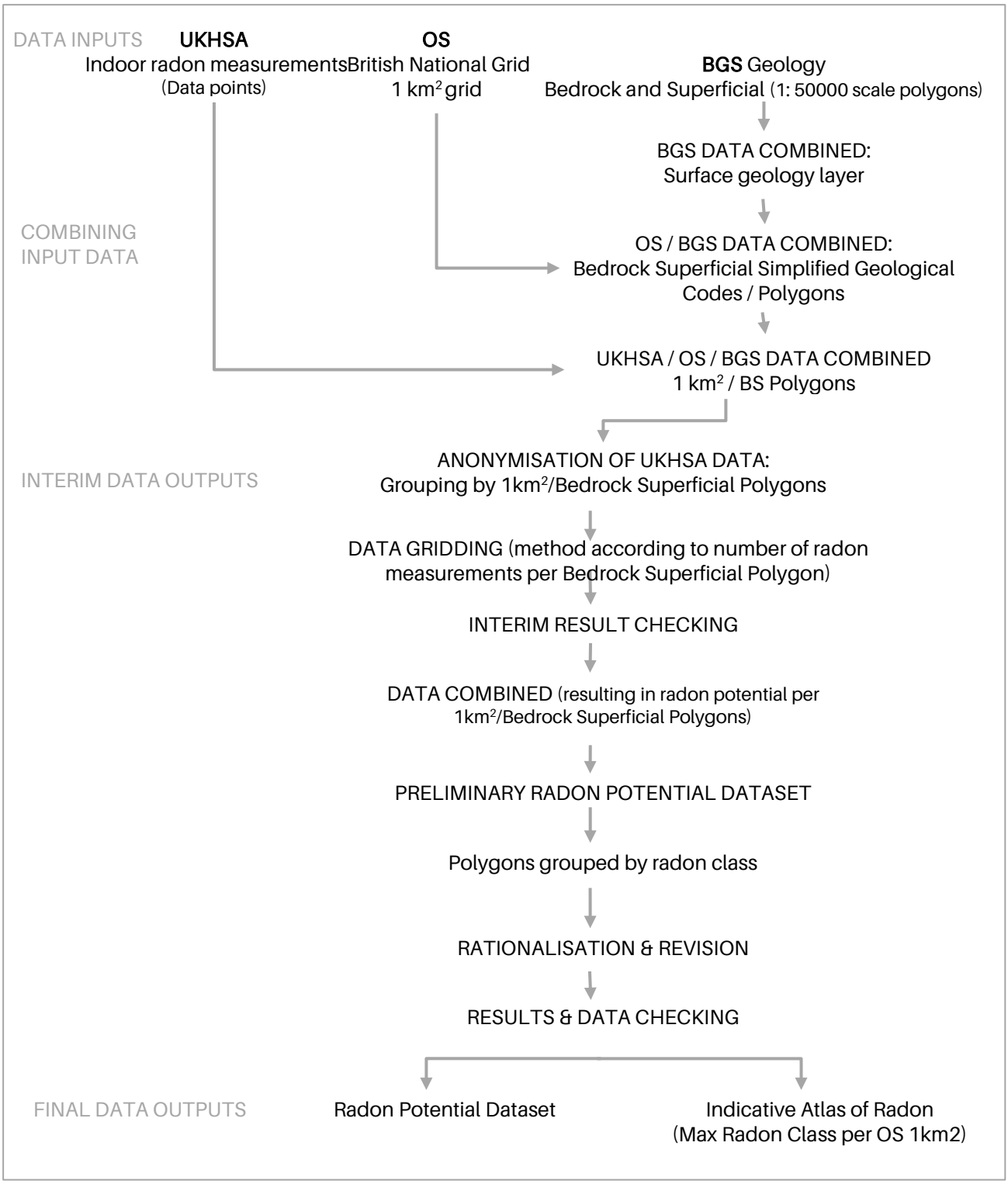

Figure 3 Simplified radon potential workflow.
See text for definition of abbreviations.

3.2 SOURCE DATASETS

The following source datasets are compiled into the Radon Potential Dataset:

- BGS Geology 50K (Bedrock and Superficial).
- UKHSA Indoor Radon Measurements.
- Ordnance Survey 1 km British National Grid.
- Ordnance Survey Coastline (Boundary line product)

4 Technical Information

This section provides more information on the data product its content and advice on best use, as well as highlighting some important considerations.

4.1 SCALE

The Radon Potential Data is based on 1:50,000 scale geological mapping, as such the underlying geological linework is considered accurate to +/- 50m. Please note that the Radon data is created with a built-in 25m buffer (relative to the original geological mapping) to compensate for the spatial variability in UK address locations (as used to incorporate the in-home radon measurements held by UKHSA).

If a property has an uncertain or imprecise location, or when assessing sites that may be in close proximity to a geological boundary, users may consider adding an additional search buffer of 50m to their site to establish if the proximity of the geological boundary has an impact on the Radon classification.

4.2 COVERAGE

The dataset covers Great Britain i.e. England, Scotland and Wales (see Figure 4). Data for Northern Ireland is available separately.

Figure 4 Radon Potential Dataset: geographical coverage

4.3 ATTRIBUTE DESCRIPTIONS

The Radon Potential Dataset and the Radon Indicative Atlas have the attributes described in Table 2 and Table 3 (respectively) as shown below.

Table 2 Radon Potential Map attribute table: field names and descriptions

Field Name	Field Type	Description	Field content
CLASS	Numeric-integer	Radon Potential Class	Range: 1 to 6*
Potential (shown only in the layer file)	String	Nominal percentage band of dwellings estimated to exceed 200 Bq/m^3	0-<1; 1-<3; 3-<5; 5-<10; 10-<30 or 30-100
VERSION	String	Dataset title and version number	Radon_GB_V3
REGION	String	Area covered	Great Britain **

*A given area of land is assigned to one of six discrete Radon Classes 1 to 6 with increasing Radon Potential.

** Data for Northern Ireland is available separately

Table 3 Indicative Atlas attribute table: field names and descriptions

FIELD NAME	FIELD TYPE	DESCRIPTION	FIELD CONTENT
TILE	String	Ordnance Survey 1-km grid square identifier	e.g. NUO547
CLASS_MAX	Numeric-integer	Radon potential class (Maximum potential class for the 1km grid square)	Range: 1 to 6*
Potential (shown only in the layer file)	String	Nominal percentage band of dwellings estimated to exceed 200 Bq/m^3	0-<1; 1-<3; 3-<5; 5-<10; 10-<30 or 30-100
VERSION	String	Dataset title and version number	Radon_GB_Atlas_V3

* Each given 1km^2 area of land is assigned to one of six Radon Classes 1 to 6. The value is derived from the highest Radon Potential class scored anywhere within that 1km^2.

4.4 DATA FORMAT

The Radon Potential Dataset has been created as vector polygons and is available in ESRI shapefile (.shp) and Geopackage (.gpkg) formats. More specialised formats may be available but may incur additional processing costs. Please email BGS Enquiries (enquiries@bgs.ac.uk) to request further information.

4.5 DATASET HISTORY

In 2007, BGS in collaboration with the then Health Protection Agency (HPA) published its first radon potential map covering England and Wales (Miles et al 2007).

Further work was carried out with data for Scotland (2011). The first amalgamation of these source datasets, delivering a comprehensive dataset for Great Britain, was published in 2011 (Miles et al 2011).

Northern Ireland was released as a separate dataset in 2015 (Appleton *et al*, 2015).

This version of the Radon Potential dataset and Indicative atlas provides an update to our understanding of radon for Great Britain. The new maps incorporate over 80,000 additional measurements gathered from dwellings by UKHSA; as well as cumulative changes made to the geological maps by BGS between June 2007 and January 2017 (see Figure 5 in the appendix).

A modified interpolation approach (based on the original methodology) has also been applied to allow for improved analysis of the in-dwelling measurements.

As a result of the changes to input data and methods, there are some areas of Great Britain that exhibit a difference in new estimated Radon Potential class, compared with that shown by the earlier versions of the datasets.

4.5.1 Impact of new measurements

Obtaining additional measurements allows for better research of radon in dwellings and enables better modelling of where radon is present and may pose a risk to health. Typically, a new measurement will make a difference to our research in one or more of the following ways:

- A new measurement identifying radon in dwellings above 200 Bq/m^3
- A new measurement identifying radon in dwellings below 200 Bq/m^3
- A collection of results indicating a rise, or fall, in the number of dwellings where radon is present (or absent)
- An association of observations with certain areas/types of geological materials (data clustering of samples that indicates either a potential receptor-source relationship with underlying geology, or an absence of geological source.

The new measurement evidence may indicate that an area of dwellings is at the same risk of exposure, an increased risk of exposure, or a reduced risk of exposure to radon, compared with previous observations or modelling.

Obtaining new mapping of geology, particularly via improvement of positional accuracy and resolution, allows for a better understanding of the spatial distribution of rocks and soils that are acting as source materials for radon. Typically, a new map, or a revised original map will make a difference to our research in the following ways:

- A new, reclassified or spatially modified area of potential source rocks or soil.
- A new, reclassified or spatially modified area of rock or soil that can act as a pathway for radon to reach ground surface
- A new, reclassified or spatially modified area of rock or soil that can act as a barrier to radon reaching the ground surface

The new mapping may indicate that source rocks and soils are still present in area (but now possibly identified with better precision, or a revised geometry), or that rocks and soils acting as a barrier or preferential pathway to radon are now present.

Used in conjunction, the UKHSA and BGS datasets help us understand where radon is present, where it might have originated from (or is absent from), and how it may have migrated in the subsurface.

4.6 DISPLAYING THE DATA

It is recommended that data is displayed based on the CLASS field in the attribute table. This indicates the estimated percentage of dwellings exceeding the Radon Action Level shown in Table 4. An ESRI layer file is provided with the dataset, but for users of other GIS software, the colour palette values are shown in Table 4.

Table 4 Colour palette for Radon Potential Class.

RADON CLASS*	RADON POTENTIAL BAND	RED	GREEN	BLUE	HEX	LOOKS LIKE
1	0-<1	254	240	217	#FEF0D9	
2	1-<3	231	188	159	#E7BC9F	
3	3-<5	197	162	159	#C5A29F	
4	5-<10	176	108	114	#B06C72	
5	10-<30	154	60	82	#9A3C52	
6	30-100	118	46	63	#762E3F	

5 Dataset Limitations

5.1 DATA CONTENT

The Radon Potential Dataset has been constructed by combining BGS Geology 50K and UKHSA indoor radon measurements. Consequently, the values within this dataset are limited by the components on which they are based. Given the method described within this document (see 3.1), the values are provided here to the best of our knowledge and current data holdings.

The Radon Potential Dataset for Great Britain is associated with radon potential related to natural geological radon sources only. The data do not cover the impacts of man-made features, except for ironstone mining over the Northamptonshire Sand Formation.

All users should be aware that when properties are being built it is not unusual for ground levels to be altered, or for trenches to be dug for infrastructure such as foundations, drains, piping and cabling, such features can influence shallow ground water and soil gas flows.

The Radon Potential dataset for Great Britain is based on, and limited to, an interpretation of the records in the possession of BGS and UKHSA (formerly HPA, then PHE) at the time the base radon potential dataset was created (2018).

The Radon Potential map is a probabilistic model of a property being at, or exceeding, the action value of 200 Becquerels/m^3. An indication of high radon potential on the map does not mean that an individual property **will definitely** have a high radon concentration when subsequently measured (it is a map of probability, not absolute measurement); equally, an indication of low radon potential does not mean that an individual property **will** have a low radon concentration when subsequently measured. The only way to determine whether a property is in fact above, at, or below the Action Level is to carry out a radon measurement. Guidance on measuring radon can be obtained from UKHSA (www.ukradon.org).

5.2 SCALE

The radon potential data is delivered at 1:50 000 scale i.e. 1 millimetre on the map represents 50 metres in real terms.

5.3 ACCURACY/UNCERTAINTY

The cartographic accuracy associated with the Radon potential dataset is nominally +/-1 mm, which equates to +/-50 m in real terms. Please note, the dataset has been created with a built-in 25m buffer (relative to the geology map) to compensate for the +/-25m variability in UK address locations (this is also used to incorporate the in-home radon measurements held by UKHSA, into the underlying geology mapping).

Users should apply an appropriate buffer to their searches if their location is uncertain or imprecise (use of a detailed site plan is recommended for as yet unbuilt properties).

When assessing sites that may be in close proximity to a geological boundary, users may consider adding an additional search buffer of 50m to their site to establish if the proximity of the geological boundary has an impact on the Radon classification.

The indoor radon measurements are derived from individual delivery point locations (x/y coordinates) which are processed to give a spatial average across a 1 km grid square. The spatial variation of the measurements is calculated and resolved using statistical methods, which may result in some uncertainty. This is inherent in any form of spatial interpolation.

All geological and soil materials vary naturally in their composition and characteristics. The depiction of a boundary on a geological map does not necessarily represent a fixed line of transition from one rock/soil type to another. The nature of geological boundaries can be complex and diffuse, therefore the depiction of boundary by a line on a geology map may represent a zone of transition rather than a specific ‘linear boundary’ of change. This is particularly the case where the boundary is known to be inferred, or conjectural (because it is hidden from sight and not exposed at surface), or postulated only from subsurface data such as

boreholes. This is an inherent form of spatial uncertainty with geological mapping and is unavoidable.

Radon is a gas and can be highly mobile within fractures and pores in rocks and soils. It is also known to migrate within groundwater systems (including shallow groundwater). It is not possible within the current Radon Potential map to fully demonstrate the complexity of very shallow rock/soil gas pathways, or groundwater pathways, especially where a site has been affected by anthropogenic disturbance (such as mining/quarrying, levelling, artificial drainage or installation of buried infrastructure). This is an inherent form of spatial uncertainty with modelling gas/fluid flow in the shallow subsurface and is unavoidable.

5.4 ARTEFACTS

Inconsistencies in the underlying geological mapping may result in mismatched legacy sheet boundaries resulting in unexpected changes in Radon Potential Class.

6 Frequently Asked Questions

The questions and answers below have been provided to address any potential issues relating to how the product can be used or how it can be interpreted. If you have any additional questions, please contact enquiries@bgs.ac.uk

Q: How is this data supplied?

A: The data is provided as GIS files in a range of formats (ESRI *.shp, and GeoPackage *.gpkg being the most common). Users will need GIS software in order to view the vector data. There are free-to-view services for the indicative Atlas (see www.ukradon.org)

Q: What area do these datasets cover?

A: These datasets are for Great Britain and cover Scotland, England and Wales. A separate dataset is available for Northern Ireland. The spatial coverage is based on the extent of the BGS Geology 50k bedrock map (which incorporates an open-data coastline derived from the Ordnance Survey), but includes a 25m buffer (as part of the data aggregation process used to compile radon measurements). Users should be aware that some coastal addresses may lie outside the coverage of the radon maps.

Q: What is the resolution of the datasets?

A: The indicative Atlas represents the highest modelled radon probability within a 1km square (based upon the Ordnance Survey National grid reference system). The Radon Potential map is based on 1:50 000 scale geological mapping with an estimated cartographic accuracy of +/1 mm, equivalent to +/- 50m in real terms. Please note that whilst the data appears to be based on 25m ‘pixels’, this is simply an artefact of processing. The underpinning data is 1:50 000 scale.

Q: Should I apply a buffer to my building site when using the Radon Potential Map?

A: Users should apply an appropriate buffer to their searches if their location is uncertain or imprecise (use of a detailed site plan is recommended for as-yet unbuilt properties). When assessing sites that may be in close proximity to a geological boundary, users may consider adding an additional search buffer of 50m to their site to establish if the proximity of the geological boundary has an impact on the Radon classification (increasing the search radius is useful if you want to determine a possible ‘worst-case’ classification).

Q: Is there also a new dataset for Northern Ireland?

A: No. The dataset for Northern Ireland (published in 2015), has not been revised for content. However, it will now be provided with updated supporting documentation and a revised colour scheme to enable ease of use when comparing information across the United Kingdom.

Q: Has the dataset changed in structure or format compared with previous versions?

A: Fundamentally, no. Radon Potential Class, and Radon Potential Class-maximum (for the Indicative atlas), are still presented as an integer between 1 and 6 (see table 1 for class descriptions), and there are no changes to class boundaries or definitions. The Radon Potential dataset now identifies ‘Great Britain’ as its region of coverage, because the revised input and modelling is integrated across the nations of England, Wales and Scotland (previously the various datasets were compiled individually. Attribution fields remain unchanged in terms of type and definition.

Q: Has the new dataset changed in content compared with previous versions?

A: The new dataset has incorporated over 80,000 additional in-dwelling radon measurements, and a significant number of changes to the underlying geology map, which is now based on BGS Geology 50 Version 8 (published in 2017). Please see the Data history section above for further details

Q: How often will this data be updated?

A: The datasets are currently updated on an ad-hoc basis, reflecting the complexity of the modelling, and the need to gather sufficient new evidence of the presence of radon in dwellings. This version is an update to previous datasets released in 2007 and 2011.

Q: Is my property in a Radon Affected Area as defined by UK Health Security Agency (formerly Public Health England (PHE)) and, if so, what percentage of homes are estimated to be above the Action Level?

A: The Radon Potential dataset can be used to identify whether a property is in a Radon Affected Area and the percentage of homes that are estimated to be at, or above, the radon Action Level. The Radon class for an area is shown in the dataset, along with text describing the nominal estimated percentage band of dwellings exceeding the Radon Action Level (see table below). Being in a Radon Affected Area does not mean there is a specific radon level in the property; the only way to determine whether a dwelling is above or below the Action Level is to carry out a radon measurement. UKHSA (formerly PHE) provides a validated radon testing service, which can be accessed at www.ukradon.org.

Table 5 Radon classes (Q&A)

Radon Class	*Is the property in a Radon Affected Area?*	*Additional information (Radon potential)*
1	*No*	The property is in an area where less than 1% of homes are estimated to be at or above the Action Level. The property is not in a radon Affected Area.
2	*Yes*	The property is in a radon Affected Areas where 1 to 3% of homes are estimated to be at or above the Action Level.
3	*Yes*	The property is in a radon Affected Area where 3 to 5% of homes are estimated to be at or above the Action Level.
4	*Yes*	The property is in a radon Affected Area where 5 to 10% of homes are estimated to be at or above the Action Level.
5	*Yes*	The property is in a radon Affected Area where 10 to 30% of homes are estimated to be at or above the Action Level.
6	*Yes*	The property is in a radon Affected Area where 30% or more of homes are estimated to be at or above the Action Level.

The UK is required to set a reference level for the exposure of members of the public to indoor radon (The Ionising Radiation (Basic Safety Standards) (Miscellaneous Provisions) Regulations 2018, SI 482/2018). The Action Level for UK homes is 200 Bq/m^3. UKHSA (formerly PHE) recommends that radon levels should be reduced in homes where the annual average radon concentration is at, or above, the Action Level.

Q: If the property is in a radon-affected area what should be done.

A: UKHSA advises that radon gas should be measured in all properties within Radon Affected Areas and that homes with radon levels at or above the Action Level (200 Bq/m^3) should be remediated, and where achievable to below the Target Level of 100 Bq/m^3. The probability result is only valid for properties above ground. **All basement and cellar areas are considered to be at additional risk from high radon levels. If an underground room such as a cellar or basement makes up part of the living or working accommodation the property should be tested regardless of Radon Affected Area status**. Householders with levels between the Target Level and Action Level should seriously consider reducing their radon level, especially if they are at greater risk, such as if they are current or ex-smokers. Whether or not a home is in fact above or below the Action Level or Target Level can only be established by having the building tested. UKHSA provides a radon testing service which can be accessed at www.ukradon.org.

The information in this dataset and user guide provides an answer to one of the standard legal enquiries on house purchase in England and Wales, known as Law Society CON29 Enquiries of

the Local Authority (2016); 3.14 Radon Gas: Do records indicate that the property is in a “Radon Affected Area” as identified by the UK Health Security Agency. The data can also be used to advise house buyers and sellers in Scotland.

If you are buying a currently occupied property in a Radon Affected Area, you should ask the present owner whether radon levels have been measured in the property. If they have, ask whether the results were at or above the radon Action Level and if so, whether remedial measures were installed, radon levels were re-tested, and the results of re-testing confirmed the effectiveness of the measures.

Further information on radon is available from UKHSA at www.ukradon.org.

Q: Is my property in an area where radon protective measures are required for new buildings, or extensions to existing ones, as described in publication BR 211 (2023 edition) Radon: Guidance on protective measures for new buildings?

A: When extensions are made to existing buildings in Radon Affected Areas, or new buildings are constructed in these areas, the Building Regulations for England, Wales and Scotland stipulate that protective measures should be taken against radon entering the building.

Depending on the probability of buildings having radon levels associated with one of six defined classes, the regulations may stipulate either:

1. No protective measures
2. Basic protective measures
3. Full protective measures

Table 6 Radon classes and protective measures (Q&A)

Radon Class	What level of radon protective measures are required for new buildings or extensions in England and Wales?	What level of radon protective measures are required for new buildings or extensions in Scotland?
1	None	None
2**	None	Basic
3	Basic	Basic
4	Basic	Basic
5	Full	Full
6	Full	Full

**Note that the requirement for basic measures in radon class 2 differs between England/Wales and Scotland. Users should establish which region their dwelling resides in using appropriate boundary/jurisdiction information such as the Ordnance Survey Boundary line dataset (https://www.ordnancesurvey.co.uk/business-government/products/boundaryline). For details about measures in Northern Ireland, please refer to the separate dataset and user guide for Radon potential in Northern Ireland.

More details of the protective measures required are available in BR 211 Radon: Guidance on protective measures for new buildings (Scivyer 2015).

Whether or not a building has a radon concentration that is above or below the radon Action Level can only be established by having the building tested. UKHSA provides a radon testing service, which can be accessed at www.ukradon.org

Q: What are the risks of radon?

A: Radon is a radioactive gas, which occurs naturally. It has no taste, smell or colour. Special devices are needed to measure it. Radon comes out of the ground. In an outdoor setting, it is quickly diluted to very low levels by the atmosphere. However, in some cases for indoor settings, radon can build up to high concentrations. In such cases, it poses a serious risk to health. A particular concern is its link to lung cancer.

Q: What is the Action Level for radon?

A: UKHSA recommends that radon levels should be reduced in homes where the average is at or above 200 Becquerels per cubic metre of air (Bq m^{-3}). This recommendation has been endorsed by UK Government.

The Action Level refers to the annual average concentration in a home. To assess this, radon measurements are carried out with two detectors (in a bedroom and living room) over three months, to average out short-term fluctuations.

Also see 'How can radon levels be reduced?' for Target Level

Q: What is a Radon Affected Area?

A: UKHSA defines radon Affected Areas as those with a 1% probability or more of a home having radon at or above the Action Level. UKHSA recommends that people in Affected Areas should test their homes for radon.

Q: How can radon levels be reduced?

A: Indoor radon levels can usually be substantially reduced at a cost comparable to many home improvements. Details of methods of reducing radon levels are available from https://www.ukradon.org/information/reducelevels.

UKHSA advises that radon gas should be measured in all properties within radon Affected Areas. UKHSA recommend that homes with radon levels at or above the Action Level (200 Bq/m^3) should be remediated, preferably to below the Target Level of 100 Bq/m^3. Householders with levels between the Target Level and Action Level should seriously consider reducing their radon level, especially if inhabitants are at greater risk, such as if they are current or ex-smokers.

Q: Is information available about radon in the workplace?

A: Information on radon measurement in the workplace and in the home is available at

https://www.ukradon.org/sectors/employers

https://www.ukradon.org/sectors/householders

Additional advice on radon in the workplace can be found at http://www.hse.gov.uk/radiation/ionising/radon.htm.

Glossary

Term	Description
Action Level	UKHSA recommends that radon levels should be reduced in homes where the annual average radon concentration is equal to, or greater than, the Action Level, set for the UK as 200 Bq/m^3.
ArcGIS	Geographic information system (GIS) software for working with maps and geographic information maintained by the Environmental Systems Research Institute (ESRI).
Becquerel	The SI (from Système International) derived unit of radioactivity. One becquerel is defined as the activity of a quantity of radioactive material in which one-nucleus decays per second.
Bedrock	The main mass of rocks forming the earth, laid down prior to about 2.6 million years ago. Present everywhere, whether exposed at the surface in rocky outcrops or concealed beneath superficial deposits, artificial ground or water. Formerly called solid.
BR 211	Radon Guidance on protective measures for new buildings (Scivyer 2015). https://www.brebookshop.com/details.jsp?id=327584
ESRI	Environmental Systems Research Institute (ESRI®) is an international supplier of geographic information system (GIS) software, web GIS and geodatabase management applications.
GeoPackage	The GeoPackage format (.gpkg) is an open standard geospatial vector data format for geographic information system (GIS) software. It is developed and regulated by Open Geospatial Consortium ® as an open standard and is supported by a range of GIS software products.
Lithology	Rocks may be defined in terms of their general characteristics of appearance: colour, texture and composition. Some lithologies may require a microscope or chemical analysis for the composition to be fully determined.
Polygon	Polygons are a representation of areas. A polygon is defined as a closed line or perimeter completely enclosing a contiguous space and is made up of one or more links.
Scale	The relation between the dimensions of features on a map and the geographic objects they represent on the earth, commonly expressed as a fraction or a ratio. A map scale of 1:100,000 means that one unit of measure on the map equals 100,000 on the earth.
Shapefile	The shapefile format (.shp) is a geospatial vector data format for geographic information system (GIS) software. It is developed and regulated by ESRI® as a mostly open specification for data interoperability among ESRI and other GIS software products.
Source data	Source data is raw data (sometimes-called atomic data) that has not been processed for meaningful use to become Information.
Spatial data	Data describing anything with spatial extent i.e. size, shape or position. In addition to describing things that are positioned relative to the Earth, spatial data may also describe things using other coordinate systems that are not related to position on the Earth, such as the size, shape and positions of cellular and sub-cellular Spatial Things described using the 2D or 3D Cartesian coordinate system of a specific tissue sample.
Stratigraphy/Stratigraphic sequence	Rocks are often deposited in layers or strata, and the sequence of these strata can be correlated from place to place. These sequences of different rocks are used to establish the changing geological conditions or geological history of the area through time.
Superficial	The youngest geological deposits, formed during the most recent period of geological time, the Quaternary. They date from about 2.6 million years ago to the present.

Target Level	The Target Level of 100 Bq m^{-3} is defined by UKHSA as the ideal outcome for remediation works in existing buildings and protective measures in new buildings. If the result of a radon assessment is between the Target and Action Levels, action to reduce the level should be considered, especially if there is a smoker or ex-smoker in the home.

References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: https://envirolib.apps.nerc.ac.uk/olibcgi.

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7 Appendix

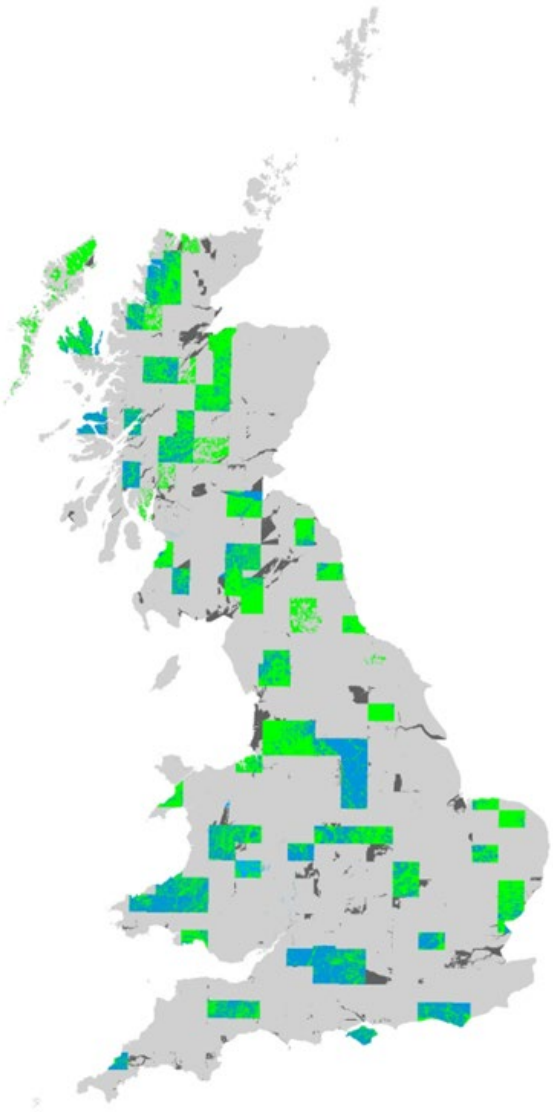

Figure 5 Geology map updates incorporated into this version of the Radon Potential Datasets. Unchanged Geological mapping (dark grey), new bedrock mapping (blue), new superficial mapping (green), modified mapping or amended rock description (pale grey)