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Introduction

Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international and European standards, comments will be reviewed by the relevant UK national committee before submitting the consensus UK vote and comments. If the draft standard is approved, it is usual for the resulting published standard to be adopted as a British Standard.

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Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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BS 10175, Investigation of potentially contaminated sites – Code of practice

DRAFT

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on XX Month 202X. It was prepared by Technical Committee EH/4, *Soil quality*. A list of organizations represented on this committee can be obtained on request to the committee manager.

Supersession

This British Standard supersedes BS 10175:2011+A2:2017, which is withdrawn.

Relationship with other publications

This British Standard is intended to be read in conjunction with BS 8576 which deals with investigations for ground gas, and BS 10176, BS ISO 18400-102, BS ISO 18400-103, BS ISO 18400-104, BS ISO 18400-105, BS ISO 18400-106, BS ISO 18400-107, BS ISO 18400-201, BS ISO 18400-202, BS ISO 18400-205, BS ISO 18400-206 and BS ISO 21365 which deal with various aspects of investigation and sampling of soil and soil materials to determine quality, not only on land potentially affected by contamination, but also agricultural, natural and near-natural sites, and BS 5930:2015 + A1:2020 for ground investigations for construction and civil engineering purposes.

Information about this document

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at knowledge.bsigroup.com, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

This is a full revision of the standard, and introduces the following principal changes:

- consolidation of Amendments 1 and 2 into the text;
- updating of external references to guidance and regulatory regimes;
- revision with regard to some technical and wider issues, including climate change and sustainability;
- insertion of Clause 4, which introduces various issues including sustainability, safety, wellbeing and welfare and personnel (more detail for some of these topics is provided in other parts of the text);
- division of the former Clause 5 into Clause 6, Developing an investigation strategy, and Clause 7, Scope and application of investigations; and
- thorough revision of informative annexes: Annex C (Health and safety), Annex E (Rapid field measurement methods), and Annex F (Laboratory analysis); and addition of a new informative Annex G (Leaching tests).

This edition is consistent with current methodologies and has been updated.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

As a code of practice, this British Standard takes the form of recommendations and guidance. It is not to be quoted as if it were a specification. Users are expected to ensure that claims of compliance are not misleading.

Users may substitute any of the recommendations in this British Standard with practices of equivalent or better outcome. Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

This British Standard is primarily intended for use by those with an understanding of the risk-based approach to the assessment of sites (as described in the Environment Agency's guidance on land contamination risk management (LCRM) [1]).

Test laboratory accreditation. Users of this British Standard/part of BS XXXX are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word "should" is used to express recommendations of this standard. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Where words have alternative spellings, the preferred spelling of the *Shorter Oxford English Dictionary* is used (e.g. "organization" rather than "organisation").

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Introduction

The recommendations and guidance in this British Standard are applicable to the investigation of all land affected by contamination and land where potentially harmful substances are naturally present.

The management of land potentially affected by contamination involves identifying risks arising from the presence of contaminants in order that appropriate action can be taken. The risk assessment of a potentially contaminated site requires a variety of information, including:

- a) details of the historical uses of the site and surrounding area and the potential for the presence of contaminants (the potential sources);
- b) identification of who or what could be affected by the contaminants (i.e. receptors); and
- c) information on the pathways by which contaminants could migrate or come into contact with receptors (including details of any physical characteristics of the site that will affect contaminant movement).

This information is gathered by a process of site investigation as set out in this British Standard.

The results of the investigation are used to delineate all known aspects of the site that could impinge upon or affect source-pathway-receptor scenarios defined within the conceptual site model.

The conceptual site model is a synthesis of all relevant information about a site, incorporating what is known about the ground and groundwater conditions; the actual and potential contamination; the physical conditions and environmental setting; the receptors; and potential pathway linkages between contamination sources and receptors with interpretation as necessary and recognition of uncertainties. Depending upon the objectives of the investigations, it could be relevant to consider new future receptors associated with the construction and completion of a new development, as well as existing receptors and to take foreseeable events such as changes in groundwater or surface water levels into account. The conceptual site model leads to the formulation of contamination-related hypotheses, which the investigation process examines through the collection of relevant data.

The conceptual site model is first formulated formally during the preliminary investigation (desk study and site reconnaissance) and informs subsequent investigations, if these are necessary, to meet the objectives of the overall investigation. One of the objectives is reduction of uncertainty in the conceptual site model.

The process of investigation involves several phases and typically begins with setting the objectives of the investigation. At the end of each phase of investigation, the information obtained is reviewed to determine whether the objectives have been met or there is a need for further investigation, and to address data gaps or uncertainties in the conceptual site model. Where further investigation is necessary, the design of the next phase is based on, and utilizes, the information previously obtained.

The use of the conceptual site model to assess the need for remedial action of land affected by contamination is a part of the risk assessment process. Guidance on how to carry out a risk assessment is outside the scope of this standard.

Users of this standard should be careful in their use of terms (e.g. soil – see Annex H) which commonly have different meanings for different professions and in different contexts, for example, when writing reports. Terms should be defined and explained as necessary for clarity and the benefit of readers.

NOTE 1 The Environment Agency provides guidance for England on “Contaminated Land Risk Management” (LCRM [1]) on its website: <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm/lcrm-before-you-start>

The environmental agencies for the three other UK jurisdictions (National Resources Wales (NRW), Northern Ireland Department of Agriculture, Environment and Rural Affairs (NIDAERA), Scottish Environmental Protection Agency (SEPA)) either follow the LCRM with additional guidance or provide separate parallel guidance to take account of differing legal and regulatory requirements. For example, in Northern Ireland guidance can be found in the NIDAERA *Practice guide – redeveloping land affected by contamination* [2] on its “Development of land potentially affected by contamination” webpage, and for Wales on the NRW website, <https://naturalresources.wales/guidance-and-advice/business-sectors/planning-and-development/advice-for-developers/land-contamination/?lang=en>. Some local authorities and groups of authorities provide additional guidance specific to their areas.

NOTE 2 Some requirements for investigation lie beyond the needs of a risk assessment, for example, a sampling scheme for remediation verification or the selection and detailed design of a remediation scheme. In such situations the procedures and methods described in this standard can be used to design the relevant investigation.

NOTE 3 Guidance on investigations for volatile organic compounds (VOCs) and permanent gases such as methane and carbon dioxide, is provided in BS 8576, which has been prepared to be used in conjunction with this British Standard.

NOTE 4 The ISO 18400 series of standards is intended to cover all situations where soil samples are to be collected for determination of soil quality. The standards in the series are not only relevant to the investigation of potentially contaminated sites but also, for example, to the investigation of natural, near-natural and agricultural sites (see for example BS ISO 18400-205). In the case of agricultural sites, the intent could be to assess soil fertility and in the case of natural sites to determine properties related to carbon sequestration. The thinking underlying the series and the structure of the series is described in BS ISO 18400-100.

NOTE 5 ISO 18400-203, ISO 18400-204 and ISO 18400-301 have not been adopted as British Standards because they overlap respectively with this standard, BS 8576 and BS 10176. The guidance the three standards contain is generally compatible with the guidance in the corresponding British Standard.

NOTE 6 Some of the terminology used in the ISO 18400 series differs from that in BS 10175. Some of these differences are noted in the text. There are also some differences in how terms are used in BS 10175 and BS 5930:2015 + A1:2020 and some minor editorial differences between the formal definitions for some terms in different members of the ISO 18400 series of standards.

1 Scope

This British Standard gives recommendations for, and guidance on, the investigation of land potentially affected by contamination and land with naturally elevated concentrations of potentially harmful substances, to determine or manage any risks. In order to obtain scientifically robust data on soil, groundwater, surface water and ground gas contamination it covers:

- a) setting the objectives of an investigation;
- b) developing a strategy for the investigation;
- c) designing the different phases of the investigation;
- d) sampling and field testing;
- e) laboratory analysis; and
- f) reporting.

The relevant recommendations and guidance within this standard are intended to ensure that the objectives of an investigation are achieved and that appropriate data for the risk assessment are obtained. However, it is not feasible to provide detailed guidance for every possible investigation scenario.

This British Standard does not give:

- a) guidance on certain constraints or problems that can affect a site, such as geotechnical aspects (which are covered by BS 5930:2015+A1);
- b) detailed guidance for the investigation and assessment of radioactively contaminated sites (see Note 1);

NOTE 1 Guidance on the investigation and assessment of radioactivity in soils is given in the BS ISO 18589 series. The appropriate methodology for such works will be dependent on the nature of the contamination and the site conditions and ought to be discussed with the regulator in advance.

- c) procedures for the formal assessment of the potential risks posed by land potentially affected by contamination (see Note 2);

NOTE 2 See the guidance published for England by Defra and the Environment Agency in LCRM [1] and by the respective ministries and environment agencies for the other UK jurisdictions.

- d) guidance on sampling from stockpiles (see Note 3); and

NOTE 3 Guidance on sampling stockpiles is given in BS ISO 18400-102 and BS ISO 18400-104.

- e) detailed guidance on investigations for ground gases, i.e. VOCs and permanent gases such as methane and carbon dioxide (these are dealt with in BS 8576).

NOTE 4 Guidance on the investigation of uncontaminated natural, near-natural and agricultural sites, for example to determine factors relevant to assessment of potential productivity, is provided in BS ISO 18400-205.

NOTE 5 Further guidance on assessment of soil quality in relation to particular purposes can also be found in BS EN ISO 11504, BS EN ISO 15175, BS ISO 15176, BS EN ISO 15799, ISO 15800 and BS EN ISO 19258. Guidance is also available on the assessment of soil quality in relation to climate change, e.g. BS ISO 23400. This last standard can be useful whenever the bulk properties are to be determined over an extended area of land.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions, or limits the application, of this document. ¹⁾ For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 10176, *Taking soil samples for determination of volatile organic compounds (VOCs) – Specification*

BS 5930:2015+A1:2020, *Code of practice for ground investigations*

BS 6187, *Code of practice for full and partial demolition*

BS 8485:2015+A1:2019, *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*

BS 8576, *Guidance on investigations for ground gas – Permanent gases and volatile organic compounds (VOCs)*

BS EN 124, *Gully tops and manhole tops for vehicular and pedestrian areas*

BS EN 12457 (all parts), *Characterisation of waste – Leaching – Compliance test for leaching of granular waste materials and sludges*

BS EN ISO 11074, *Soil quality – Vocabulary*

BS EN ISO 14688, *Geotechnical investigation and testing*

BS EN ISO 16637, *Radiological protection – Monitoring and internal dosimetry for staff members exposed to medical radionuclides as unsealed sources*

BS EN ISO 16720, *Soil quality – Pretreatment of samples by freeze-drying for subsequent analysis*

BS EN ISO 21268 (all parts) – *Soil quality – Leaching procedures for subsequent chemical and ecotoxicological testing of soil and soil-like materials*

BS EN ISO 21365, *Soil quality – Conceptual site models for potentially contaminated sites*

BS EN ISO 5667-1, *Water quality: Sampling – Part 1: Guidance on the design of sampling programmes and sampling techniques*

BS EN ISO 5667-3, *Water quality: Sampling – Part 3: Guidance on the preservation and handling of samples*

BS EN ISO 5667-6, *Water quality – Sampling – Part 6: Guidance on sampling of rivers and streams*

BS EN ISO 5667-14, *Water quality – Sampling – Part 14: Guidance on quality assurance and quality control of environmental water sampling and handling*

BS EN ISO 11074:2015+A1:2020, *Soil quality – Vocabulary*

BS ISO 11464, *Soil quality – Pretreatment of samples for physio-chemical analysis*

BS ISO 14507, *Soil quality – Pretreatment of samples for the determination of organic contaminants*

BS ISO 14686, *Hydrometric determinations – Pumping tests for water wells – Considerations and guidelines for design, performance and use*

BS ISO 18400-102, *Soil quality – Sampling – Part 102: Selection and application of sampling techniques*

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

BS ISO 18400-103, *Soil quality – Sampling – Part 103: Safety*

BS ISO 18400-105, *Soil quality – Sampling – Part 105: Packaging, transport, storage and preservation of samples*

BS ISO 18400-106, *Soil quality – Sampling – Part 106: Quality control and quality assurance*

BS ISO 18400-107, *Soil quality – Sampling – Part 107: Recording and reporting*

BS ISO 18400-201, *Soil quality – Sampling – Part 201: Physical pretreatment in the field*

BS ISO 18400-202, *Soil quality – Sampling – Part 202: Preliminary investigations*

BS ISO 18400-206, *Soil quality – Sampling – Part 206: Collection, handling and storage of soil under aerobic conditions for the assessment of microbiological processes, biomass and diversity in the laboratory*

BS ISO 18512, *Soil quality – Guidance on short and long term storage of soil samples*

BS ISO 23909, *Soil quality – Preparation of laboratory samples from large samples*

BS ISO 3534-2, *Statistics – Vocabulary and symbols – Applied statistics*

BS ISO 5667-4, *Water quality – Sampling – Part 4: Guidance on sampling from lakes, natural and man-made*

BS ISO 5667-5, *Water quality – Sampling – Part 5: Guidance on sampling of drinking water from treatment works and piped distribution systems*

BS ISO 5667-11, *Water quality – Sampling – Part 11: Guidance on sampling of groundwaters*

BS ISO 5667-12, *Water quality. Sampling – Part 12: Guidance on sampling of bottom sediments from rivers, lakes and estuarine areas*

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

DIN 19747, *Investigation of solids – Pre-treatment, preparation and processing of samples for chemical, biological and physical investigations*

PAS 128, *Underground utility detection, verification and location – Specification*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS ISO 11074 apply, together with the following.

3.1.1 accuracy

closeness of agreement between a measurement result and the true value of the measurand

NOTE The term “accuracy”, when applied to a set of measurement results, describes a combination of random components and a common systematic error or bias component.

3.1.2 anthropogenic ground

deposits which have accumulated through human activity

NOTE These could consist of natural materials e.g. clay, or artificial materials, e.g. refuse.

[SOURCE: BS 5930:2015+A1, 3.1]

3.1.3 cluster sample

composite sample for which the increments are taken over a small area around a predefined sampling point

NOTE 1 Sampled area is typically about 0.5 m² to 1.0 m².

NOTE 2 Material sampled is taken from within the same stratum or from material with the same characteristics.

[SOURCE: BS ISO 18400-102:2017, 3.1]

3.1.4 composite sample

sample made of a number of increments (3.1.12) cluster sample (3.1.3) or spatial composite sample (3.1.29)

3.1.5 conceptual site model

characteristics of a site that are relevant to the occurrence and potential effects of ground contamination that describe:

- a) the nature and sources of contamination;
- b) the ground, groundwater, surface water, ground gases and volatile organic compounds (VOCs) that could be present;
- c) the environmental setting;
- d) potential migration pathways; and
- e) potential receptors with interpretation as necessary and recognition of uncertainties

NOTE A conceptual site model is usually presented in a tabular, textual and/ or diagrammatic form.

3.1.6 contamination

presence of a substance or agent, as a result of human activity, in, on or under land, which has the potential to cause harm or to cause pollution

NOTE There is no assumption in this definition that harm results from the presence of the contamination.

3.1.7 controlled waters

inland freshwater, water contained in underground strata, and any coastal water subject to regulation

NOTE In law there are alternative definitions which vary depending on the regulatory context.

3.1.8 disturbed sample

sample obtained from the ground without any attempt to preserve the soil structure

EXAMPLE Sample obtained by using a hand auger.

[SOURCE: BS ISO 18400-102:2017, 3.3]

3.1.9 fill

anthropogenic ground (3.1.2) in which the material has been selected, placed and compacted in accordance with an engineering specification

[SOURCE: BS 5930 2015+A1, 3.4]

3.1.10 harm

measurable adverse effect on a receptor

NOTE This definition is broader than that given in Section 7(A)(4) of the Environmental Protection Act [3].

3.1.11 hazard

property or situation that in particular circumstances could lead to harm or pollution

[SOURCE: Land Contamination Risk Management (LCRM) [1]]

3.1.12 increment

material forming part of a composite sample (3.1.4) obtained by a single operation of a sampling device, for instance, the filling of a scoop or auger

3.1.13 judgemental sampling/targeted sampling

process of taking samples from particular zones or features of a site taking into account existing knowledge, including what is known about the history and layout of a site or a zone within a site

NOTE 1 Judgemental sampling could be required, for example, around underground storage tanks or pipelines where there might have been leaks, above ground storage tanks where there might have been spills, and for areas where raw materials or wastes have been stored or deposited.

NOTE 2 Sampling locations are usually predetermined based on what is known about the target area but some locations can be selected in the field in response to on-site observations.

3.1.14 kubiēna tin

metal box with removable top and base which can be forced into the surface of exposed soil to obtain an undisturbed sample (3.1.33)

NOTE Usually made to desired size from aluminium, galvanized steel, or stainless steel sheet. Size varies, but a typical example might have an area of about 55 mm × 75 mm with a depth of 40 mm. The sample, once obtained, can be used to determine bulk density or might be impregnated with resin prior to the production of thin sections for microscopic examination.

[SOURCE: BS ISO 18400-102:2017, 3.4]

3.1.15 made ground

anthropogenic ground (3.1.2) comprising material placed without engineering control and/or manufactured by man in some way, such as through crushing or washing, or arising from an industrial process

[SOURCE: BS 5930:2015+A1, 3.10]

3.1.16 measurement uncertainty

estimate attached to a test result which characterizes the range of values within which the true value is asserted to lie

3.1.17 pathway

mechanism or route by which a contaminant could come into contact with, or otherwise affect, a receptor

3.1.18 potentially harmful substance

substance which due to its form, or biological activity, can be dangerous for humans or the environment including other defined receptors

NOTE It can be present naturally or as a result of human activity.

3.1.19 probabilistic sampling

sampling to ensure that the entire population is reasonably represented.

NOTE Sampling for example could be random, stratified, stratified-random or herringbone

3.1.20 receptor

entity that could be adversely affected by a contaminant(s)

NOTE Examples of receptors include persons, other living organisms, ecological systems, controlled waters, atmosphere, structures and utilities.

3.1.21 regular sampling

process of taking samples at the nodes of a regular pattern, such as a square or triangular grid, i.e. the sampling locations are evenly spaced

3.1.22 risk

combination of the probability, or frequency of occurrence, of a defined hazard and the magnitude of the consequences of the occurrence

[SOURCE: LCRM [1]]

3.1.23 risk assessment

formal process of identifying, assessing and evaluating the health and environmental risks that could be associated with a hazard

[SOURCE: LCRM [1]]

3.1.24 sampling pattern

set of predetermined sampling points

3.1.25 sampling uncertainty

part of the total measurement uncertainty attributable to sampling

[SOURCE: INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY (IUPAC). (2005) [5]]

3.1.26 selective sample

sample deliberately chosen or formed, based on some specific characteristic(s) of the material to be sampled

NOTE Examples include appearance, odour, particle sizes.

3.1.27 soil

topsoil and subsoils; deposits such as clays, silt, sand, gravel, cobbles, boulders and organic matter and deposits such as peat; material of human origin such as wastes; ground gas and moisture; and living organisms

NOTE This is the meaning ascribed through ground engineering and encompasses fills and deposited wastes.

3.1.28 source

location or feature from which contamination is, or was, derived

3.1.29 spatial composite sampling

composite sample formed from small incremental point samples taken over an area (such as a field)

NOTE The general premise is that the distribution of soil constituents is relatively homogeneous. The increments might be located according to a regular grid, random, or other pattern. In agricultural/horticultural land investigations "N", "S", "W" and "X" sampling patterns are commonly used. Along the outline of such a pattern, numerous increments are taken which are bulked and mixed to provide one [composite] sample for analysis.

3.1.30 spot sample

sample from a discrete location

NOTE 1 Sample can be formed from one or more contiguous portions of material.

NOTE 2 Sample might be a disturbed (3.1.8) or undisturbed sample (3.1.33).

3.1.31 systematic sampling

process of taking samples from locations that have been pre-designated according to a geometric pattern

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NOTE 1 Systematic sampling can include a random positioning component.

NOTE 2 Some systematic sampling patterns are regarded as “probabilistic” (3.1.19).

NOTE 3 This definition is wider than the usual definition found in the literature, where systematic sampling commonly means regular sampling.

3.1.32 uncertainty

lack of knowledge about specific factors

3.1.33 undisturbed sample

sample obtained from the ground with soil structure unaltered during sampling procedure

NOTE Special sampling equipment is used so that the soil particles and voids cannot change from the distribution which exists in the ground before sampling (these can provide volume-proportional or mass-proportional results).

[SOURCE: BS ISO 18400-102:2017, 3.7]

3.2 Abbreviated terms

For the purposes of this document, the following terms and definitions apply.

AGS	Association of Geotechnical and Geoenvironmental Specialists
bgl	below ground level
BGS	British Geological Survey
BOD	biochemical oxygen demand
CDM	The Construction (Design and Management) Regulations 2015 [6]
CLO	contaminated land officer (of a local authority)
CLR	Contaminated Land Report
COD	chemical oxygen demand
COSHH	Control of Substances Hazardous to Health Regulations 2002 [7]
Defra	Department for Environment, Food and Rural Affairs
DO	dissolved oxygen
DQRA	detailed quantitative risk assessment
EA	Environment Agency
ECD	electron capture detector
EPA (1990)	Environmental Protection Act (1990) [3]
FAAS	flame atomic absorption spectrometry
FID	flame ionization detectors
FP-XRF	field portable X-ray fluorescence
FTIR	Fourier-transform infra-red spectroscopy
GC/MS	gas chromatography/mass spectrometry
HSE	Health and Safety Executive
HSENI	Health and Safety Executive for Northern Ireland
HPLC	high performance liquid chromatography
ICP-MS	inductively coupled plasma – mass spectrometry
ICP-OES	inductively coupled plasma – optical emission spectrometry
LCRM	Land Contamination Risk Management guidance
MCERTS	Environment Agency's Monitoring Certification Scheme
MTBE	methyl-tert butyl ether
NIEA	Northern Ireland Environment Agency
NISMR	Northern Ireland Sites and Monuments Record
NRW	Natural Resources Wales
OS	Ordnance Survey
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PET	polyethylene terephthalate
PID	photo-ionization detector
PPS	Planning Policy Statement
PPC	Pollution prevention and control
QA	quality assurance
QC	quality control
RAMS	risk assessment and method statement
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
RCAHMW	Royal Commission on the Ancient and Historical Monuments of Wales
RFMMs	rapid field measurement methods
SEPA	Scottish Environment Protection Agency
SuRF-UK	UK Sustainable Remediation Forum
SVOC	semi-volatile organic compound

TCE	trichloroethene
TPHs	total petroleum hydrocarbons
UKAS	United Kingdom Accreditation Service
UKHSA	United Kingdom Health Security Agency
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
VOC	volatile organic compound
XRF	X-ray fluorescence

4 General considerations

4.1 General

The procedures and methods described in this standard should be used to design investigations required for the collection and analysis of information necessary for risk assessment, the design and execution of remedial works, verification of remedial works, and the design and execution of development when this is to be carried out.

NOTE 1 The management of land potentially affected by contamination, including remediation if required and subsequent beneficial use or reuse requires identification of risks arising from the presence of contaminants. It also requires the gathering of other relevant information as the overall project proceeds to completion.

The development of appropriate site conceptual site model(s) (CSMs) should be treated as critical to all project stages of investigation, assessment, remediation, and development of land potentially affected by contamination.

NOTE 2 There does not exist a single CSM for all time and purposes.

For the purposes of risk assessment, the CSM should include a dynamic synthesis of all information about a potentially contaminated site relevant to the task in hand incorporating what is known about the ground, ground gas (including VOCs), and groundwater conditions; the actual and potential contamination; the physical conditions and environmental setting; the receptors; and potential pathway linkages between contamination sources and receptors, with interpretation as necessary and recognition of uncertainties

NOTE 3 Further discussion of CSMs is given in 8.3 and BS ISO 21365:2020.

The overall aim of site investigation should be to reduce uncertainties as the overall project proceeds.

The risk assessment of a potentially contaminated site requires at least:

- a) details of the historical uses of the site and surrounding area and the potential for the presence of contaminants (the potential sources);
- b) identification of who or what could be affected by the contaminants (i.e. receptors); and
- c) information on the pathways by which contaminants could migrate or come into contact with receptors (including details of any physical characteristics of the site that will affect contaminant movement).

The results of the investigation should delineate all known aspects of the site that could impinge upon or affect source-pathway-receptor scenarios defined within the CSM. The CSM should lead to the formulation of contamination-related and other hypotheses, which the investigation process should examine through the collection of relevant data.

The use of a CSM to assess the need for remedial action on land affected by contamination should form part of the risk assessment process.

NOTE 4 Guidance on how to carry out a risk assessment is outside the scope of this standard.

Depending upon the objectives of the investigations, future receptors associated with the construction and completion of a new development should be assessed alongside existing receptors and the possible impact of foreseeable events which could affect contaminant impacts or create new exposure pathways.

NOTE 5 New exposure pathways include those such as rising groundwater levels or surface water levels, flooding, uncontrolled vegetation growth, change of use of neighbouring sites, and the possible consequences of climate change.

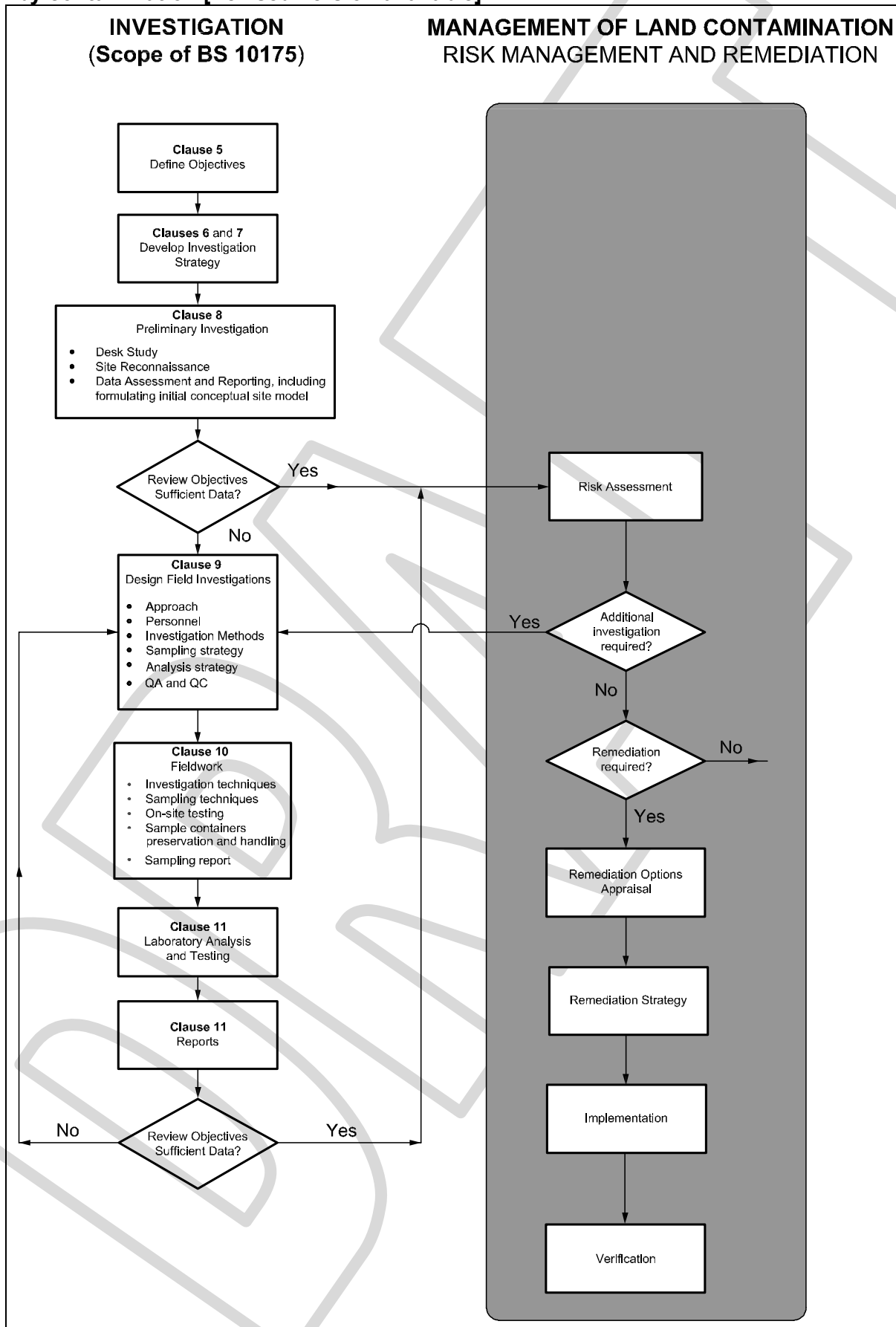
The process of investigation involves several phases and should begin with setting the objectives of the investigation. At the end of each phase of investigation, the information obtained should be reviewed to determine whether the objectives have been met or if there is a need for further investigation, and to address data gaps or uncertainties in the CSM.

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Where further investigation is necessary, the design of the next phase should be based on, and should utilize, the information previously obtained.

NOTE 6 The process of investigation, and how it relates to the management of land potentially affected by contamination, is illustrated in Figure 1. The recommendations of this standard are presented in the sequence of steps that are to be followed in the investigation process, and Figure 2 indicates which clause refers to each step. Annex A provides examples of how the recommendations of this standard can be applied.

Figure 1 – Site investigation process in the management of land potentially affected by contamination [revised version available]



NOTE 5 The ISO 18400 series of standards is intended to cover all situations where soil samples are to be collected for determination of soil quality. The standards in the series are not only relevant to the investigation of potentially contaminated sites but also, for example, to the investigation of natural, near-natural and agricultural sites (see for example BS ISO 18400-205). In the case of agricultural sites, the intent could be to assess soil fertility and in the case of natural sites to determine properties related to carbon sequestration. The thinking underlying the series and the structure of the series is described in BS ISO 18400-100.

NOTE 6 Some of the terminology used in the ISO 18400 series differs from that in BS 10175. Some of these differences are noted in the text. There are also some differences in how terms are used in BS 10175 and BS 5930:2015+A1 and some minor editorial differences between the formal definitions for some terms in different members of the ISO 18400 series of standards.

4.2 Sustainability

Sustainable management practices for ground investigation planning and implementation should primarily be based on practical actions to reduce the impacts of the project on the environment and local community to achieve:

- a) a reduction in the carbon footprint including emissions to air, water and land;
- b) more efficient use of energy and natural resources;
- c) the minimization of waste; and
- d) mitigation of impacts to the local environment.

Sustainable management practices should include the selection of materials that are locally sourced using materials that are not harmful to the environment and that can be recycled or reused wherever possible. Sustainable management practices should include:

- 1) the use of energy-efficient equipment;
- 2) minimization of the use of fossil fuels wherever possible;
- 3) minimization of the use of water and/or recycling water wherever possible;
- 4) minimization of the production and disposal of waste; and
- 5) optimized recycling and re-use.

Waste streams should be managed and segregated on site, for example contaminated arisings segregated from general waste derived from site activities. Waste where possible should be managed through recycling or treatment which includes water and other fluids generated during ground investigation works, particularly where these fluids might be contaminated.

NOTE 1 Attention is drawn to the Duty of Care Regulations [7].

The potential impact of ground investigation on the local environment should be taken into account, which includes the impact on wildlife, vegetation, and other aspects of the ecosystem.

NOTE 2 BS ISO 18504 provides guidance on sustainable remediation. In particular, it provides standard methodology, terminology and information about the key components and aspects of sustainable remediation assessment and informative advice on the assessment of the relative sustainability of alternative remediation strategies. BS ISO 18504 is intended to inform practitioners about contemporary understanding of sustainable remediation. It does not prescribe which methods of assessment, indicators or weights to use. Rather, it is intended to inform consideration of the concept of sustainable remediation in a local legal, policy, socio-economic and environmental context.

NOTE 3 The UK Sustainable Remediation Forum (SuRF-UK) has prepared guidance entitled Sustainable management practices for management of land contamination [9] whereby these sustainability principles presented in the framework underpin all aspects of land contamination risk management including the planning and implementation of the investigation of potentially contaminated sites to promote sustainable actions as in the decision-making process. The SuRF-UK assessment includes a spreadsheet tool which in combination with the guidance document can be used to identify practices that, individually or collectively, might lead to project "sustainability gains".

4.3 Safety on investigation sites

COMMENTARY ON 4.3

Safety is of paramount importance for all persons involved in any and every activity in ground investigation and the general public.

Detailed guidance relating to intrusive investigations is provided in Clause 9.3 with further information provided in Annex C.

A summary of relevant health and safety regulations is given in BS 5930:2015+A1, Annex A.

Guidance can also be found in BS ISO 18400-103 and as indicated in 9.3 and Annex C in various industry documents. For example, the Association of Geotechnical and Geoenvironmental Specialists (AGS) and the British Drilling Association (BDA) have both produced a range of health and safety guidance documents available for download at www.ags.org.uk and www.britishdrillingassociation.co.uk respectively.

This British Standard describes procedures for site investigations which inevitably involve a potential risk to site personnel, the public and the environment. Risk assessments should be carried out and an appropriate health and safety plan should be prepared beforehand and implemented during all stages of the work.

The health and safety plan should be prepared before any physical work is carried out, including field reconnaissance. This plan should be maintained throughout the investigation and reviewed as and when any unexpected conditions are encountered.

The following should be carried out:

- a) any potential hazards that might exist when carrying out site investigations should be identified;
- b) a framework for safe working should be established following the principles of a hierarchy of controls comprising hazard removal, replacement or reduction in that order (this framework should be communicated to all workers before the start of works, and refreshed as appropriate through regular toolbox talks);
- c) working procedures to minimize risks from contaminants and physical hazards associated with the collection, transport, testing and disposal of samples and the use of machinery should be adopted;
- d) provision of personal protection equipment and cleaning facilities to minimize any risks; and
- e) establishment of procedures for response in the case of an accident.

Health and safety documentation and procedures should take into account that even risks which people are familiar with on an everyday basis can increase in a working environment that is unfamiliar.

Where the use of hand tools could cause vibration induced occupational health issues, e.g. in sampling or installation of instrumentation, appropriate control of risks should be implemented.

These steps cannot remove all risk from the site works and, therefore, the need for all personnel to exercise all due care and caution at all times should be emphasized.

NOTE 1 *This British Standard does not seek to address everyday hazards that might arise from the use of such items as sharp instruments, digging equipment, or the hazards of driving to and from a site. It is assumed that such hazards are satisfactorily dealt with by the personnel carrying out the investigation.*

Investigation sites should be kept secure at all times so that members of the public cannot be injured.

NOTE 2 *Making secure includes making sure that areas of the works such as excavations, boreholes and spoil materials are secure including being fenced off until restoration is complete.*

Instrument head works or reading cabinets should be secure, fenced off and highlighted.

WARNING. Some persons are allergic/sensitive to traces of some gases and are liable to adverse reactions and could require assistance if affected. This warning refers to work in the open and is not to be confused with the requirements for work in enclosed spaces.

Although unlikely, where exposure is possible and a site operative experiences ill health and medical treatment is necessary, this information should be provided to the relevant medical personnel.

WARNING. Various inorganic gases (e.g. carbon dioxide, carbon monoxide, hydrogen sulfide, hydrogen cyanide) and some organic compounds in the gas phase in soil can present toxicological risks of varying severity. Methane, hydrogen, hydrogen sulfide and some VOCs can form explosive mixtures with air. Large concentrations of carbon dioxide (in addition to being toxic) and methane can cause asphyxiation due to the associated reduction in oxygen concentrations. Oxygen concentrations in the ground can also be dangerously low in the absence of elevated carbon dioxide or methane concentrations.

WARNING. Injudicious choice of drilling method can cause risks to drillers due to gas coming out of boreholes. It could also cause risks to the public (e.g. the occupants and users of neighbouring buildings due to displacement of gas from the location where drilling is taking place and the creation of explosive atmospheres in the local drilling area).

NOTE 3 Injudicious choice of drilling method can cause risks to drillers due to gas coming out of boreholes. It can also cause risks to the public (e.g. the occupants and users of neighbouring buildings) due to displacement of gas from the location where drilling is taking place. A number of serious incidents have occurred as a result of surface emissions of toxic gases into occupied properties during the investigation and treatment of nearby former coal mine workings. Of particular concern are incidents where carbon monoxide has been measured or inferred as entering occupied properties from the mine workings below - see HSE Position Statement, Carbon monoxide [10]. Mine workings can also contain methane, hydrogen sulfide, carbon dioxide and oxygen-deficient-air, all of which can be hazardous to health if emitted at the surface. Coal Authority et al., 2012 [11] gives guidance on the general procedures to be adopted when drilling or piling into former coal mine workings (including mine entries) and unworked coal. Prior to carrying out works that have the potential to enter, disturb or change coal mines or coal managed or owned by the Coal Authority, the Coal Authority request that their permission for the proposed works are obtained in accordance with their permitting procedure. See <https://www.gov.uk/guidance/get-a-permit-to-deal-with-coal-or-coal-mines> [12].

4.4 Wellbeing and welfare

COMMENTARY ON 4.4

Regulations and much guidance for welfare are mainly concerned with the provision of facilities such as sanitary conveniences and washing facilities, drinking water, accommodations for clothing and facilities for changing and facilities for rest and to eat meals. However, in common usage, “welfare” typically has a broader meaning covering, for example, well-being, feeling safe, and not feeling under undue stress as discussed in an AGS guidance note on Safety Guidance – Mental Health (Work Related Stress) [13]. This provides guidance on the implementation of wellbeing measures in a geotechnical/geoenvironmental working environment.

“Wellbeing” is defined by the Oxford English Dictionary [14] as “the state of being comfortable, healthy, or happy”. Looking after employee wellbeing is good for people and organisations. Promoting wellbeing can help prevent stress and create positive working environments where individuals and organisations can thrive. Good health and wellbeing can be a core enabler of employee engagement and higher organisational performance, reduces staff turnover, improves staff morale, increases staff commitment and engagement and decreases the likelihood of sickness absence, grievance or discrimination claims. When people are in a state of wellbeing at work, they can develop their own potential, be productive, build positive relationships with others, better cope with stress, and make a meaningful contribution to the workplace [15].

4.4.1 General

As well as measures to promote good health and well-being, provision for suitable and sufficient welfare facilities should be provided to all personnel associated with the investigation, regardless of duration of activity, size of the workforce, their gender, religion, race, etc., time of year, weather or any other factor associated with the works or workforce.

NOTE 1 Although regulations require suitable and sufficient welfare to be provided regardless of the project, workforce and environmental conditions, the type, size, quantity and location of the welfare will be dependent on the proposed geotechnical and geoenvironmental activities, and those persons undertaking them. It is important therefore, to first understand what constitutes welfare provisions, before deciding to what scale and where the welfare is to be installed.

NOTE 2 AGS has provided guidance relating to compliance with regulations concerning “welfare” during geotechnical and geoenvironmental activities [15].

4.4.2 Principal legislation

COMMENTARY ON 4.4.2

The Health and Safety at Work Act 1974 [31] applies to all aspects of the working environment and requires employers to provide a workplace that is not only safe but also suitable for the duties that are being carried out within it.

Construction projects should provide welfare suitable for those working on the projects.

NOTE 1 Attention is drawn to as the Workplace (Health, Safety and Welfare) Regulations 1992 [16].

NOTE 2 Attention is drawn to the Construction (Design and Management) Regulations 2015 (CDM) Schedule 2 [6].

NOTE 3 Attention is drawn to HSE Construction Information Sheet No 59, Provision of welfare facilities during construction work [17].

4.5 Personnel

There are various roles that should be performed by one or a number of persons, including project leader, field manager, field investigator and skilled operatives (e.g. drillers). Tasks that should be carried out include direction, planning and execution, supervision in the field, sampling and measurement, formation of exploratory holes and logging of excavations and boreholes, etc. Whoever performs these roles should be competent with appropriate knowledge, qualifications, training and experience.

NOTE 1 The prescription of the qualifications, etc., required by those performing these roles is outside the scope of this standard, except for lead drillers, support operative drillers and the operators of excavating plants for whom the corresponding provisions of BS 5930:2015+A1, 6.8, apply.

NOTE 2 Further information regarding the roles to be performed and appropriate levels of qualification, etc. is given in BS 5930:2015 + A1, and related geotechnical standards (e.g. PD CEN ISO TS 24283-1, PD CEN ISO TS 24283-2) are useful by analogy.

NOTE 3 Those performing these various roles could work for the client, a consultant or a contractor.

NOTE 4 The titles/descriptions applied to those carrying out particular roles or tasks are likely to differ between organisations.

5 Setting the objectives of an investigation

5.1 General

The first step in any investigation of land potentially affected by contamination should be to set clear and appropriate objectives, taking into account:

- a) the client's reasons for requesting the investigation to be undertaken (these should be clearly set out by the client);
- b) the decisions that need to be made regarding the site;
- c) the confidence required for making these decisions;
- d) the findings of any investigations already carried out; and
- e) the findings of any risk assessment(s) completed to date.

NOTE 1 The client might require the investigation and/or risk assessment for their own use or to comply with a regulatory requirement.

The objectives should be set before the strategy of the investigation (Clause 5) is established and the investigation is designed and executed (Clause 6 to Clause 12).

NOTE 2 The objectives of a site investigation will vary, depending upon the stage in the process that has been reached and the underlying intentions for the land involved, but might, for example, be to:

- a) provide information on contamination of the ground, ground gas and groundwater;*
- b) provide information on the presence of naturally occurring potentially harmful substances;*
- c) gather the information needed to form, or further develop, a CSM, including identification of potential pathways and receptors for the purposes of the risk assessment;*
- d) provide information to support a risk assessment;*
- e) provide information for further stages of assessment including remediation options appraisal and the design of remedial works;*
- f) provide data for re-use of soils or their disposal as waste; and*
- g) meet a specific regulatory requirement.*

The formulation or refinement of a CSM should always be one of the investigation objectives and the model should be reviewed and revised in response to the additional information. The CSM should be produced following the guidance in this standard and BS ISO 21365.

NOTE 3 Attention is drawn to LCRM [1].

NOTE 4 Guidance on the preparation of CSMs is provided in BS ISO 21365. This defines the CSM as: “synthesis of all information about a potentially contaminated site relevant to the task in hand with interpretation as necessary and recognition of uncertainties”. It emphasises the dynamic nature of CSMs including the need to continuously revise as new information becomes available, and to produce a number of different CSMs for different purposes as projects progress. It also emphasises the need to have regard to models developed for other purposes including the geotechnical ground model and the ecological and archaeological aspects of the site.

In some circumstances benefits should be sought from undertaking investigations that combine the needs of contamination and geotechnical objectives. However, the use of an integrated investigation should not be allowed to compromise the objectives or requirements of either investigation (see 9.2).

A prospective investigator should inform the client or the client’s adviser of the likely regulatory requirements and ascertain whether enabling the client to meet specific regulatory requirements (e.g. a planning condition) is to be an objective of the investigation.

NOTE 5 Sometimes the primary purpose of an investigation can be to “benchmark” site conditions (e.g. contamination levels) for future reference.

NOTE 6 An investigation will often be carried out in one of the following contexts.

- a) In support of a planning proposal carried out on behalf of the client (who may or may not be the site owner).*
- b) In connection with the potential sale and purchase of a site to enable its value to be estimated, taking into account potential contaminated land liabilities and possible remediation requirements.*
- c) In support of an Environmental Permit application or to address conditions set out in an Environmental Permit.*
- d) In response to a pollution incident.*
- e) In connection with the potential determination of a site under the Part 2A regime [3,4] commissioned by the regulator or appropriate person.*

NOTE 7 When the investigation is carried out in connection with a planning application or discharge of a Planning Condition, the resulting report will be submitted to the planning authority and be reviewed by the local authority’s designated technical specialist, who is typically the “contaminated land officer” (CLO). When the investigation is carried out in connection with a Part 2A determination under the Environmental Protection Act 1990 [3], the resulting report will be submitted to the relevant regulator, usually the local authority, but the Environment Agency in England, and NRW in Wales in the case of Special Sites (in Scotland, local authorities are responsible for sites which pose a risk of pollution to the water environment and not all such sites will be designated Special Sites). In both these situations, early consultation with the primary regulator’s technical representative is advisable.

5.2 Setting investigation objectives

Answers to the following questions, amongst others, should be provided when setting the investigation objectives.

- a) What are the reasons for the investigation?
- b) What data gaps or uncertainties need to be addressed?
- c) What information is needed?
- d) What level of detail and accuracy of measurements are required?
- e) What are the spatial and temporal investigation boundaries?
- f) In the context of providing information for a risk assessment, what are the specific purposes of the risk assessment?

NOTE 1 Examples of typical investigation objectives that can be associated with different phases of investigation (see 6.2.2) are provided in Table 1. Further examples of typical objectives and applications are given in Annex B.

NOTE 2 For further discussion about setting investigation objectives see BS ISO 18400-104.

As information is developed during an investigation, the impact on the objectives and the objectives themselves should be reviewed to determine whether these require modification or extension.

Table 1 – Typical objectives of different phases of an investigation

Phase	Typical objectives
Preliminary investigation (desk study and site reconnaissance) (Clause 8)	To provide information on past and current uses of the site and surrounding area and the nature of any hazards and physical constraints. To identify current and likely future receptors, potential sources of contamination and likely pathways and any features of immediate concern, including those that could be introduced in the future. To identify any aspect of the site requiring immediate attention (e.g. insecure fences, potentially harmful substances accessible to trespassers or likely to be dispersed by wind or water). To provide information on the geology, geochemistry, soil, hydrogeology and hydrology of the site. To identify potentially different sub-areas (zones) of a site, based on differing ground conditions; potential contamination; and past, present and future uses. To produce an initial CSM for the site as a whole and/or for zones within the site. To provide information for the preliminary risk assessment (see 8.3.2). To identify areas where informed decisions are to be made using specialist assessment techniques or advisors, e.g. if there are ecological, unexploded ordnance (UXO) or archaeological considerations. To provide data to assist in the design of potential subsequent exploratory and detailed investigations and to give an early indication of possible remedial requirements. To provide information relevant to worker health and safety and to the protection of the environment during field investigations (4.3 and Annex C). To identify the need to involve regulatory bodies prior to intrusive investigation.
Exploratory investigation (optional) (Clauses 7.2, 8, 9, 10 and 11)	To test the CSM(s) of contamination and site characteristics. To obtain further information in relation to potential sources of contamination, likely

Table 1 – Typical objectives of different phases of an investigation

Phase	Typical objectives
	pathways and features of immediate concern. To obtain further information on the geology, geochemistry, soil, hydrogeology and hydrology of the site. To provide further information to aid the design of the detailed investigation, including health and safety aspects. To provide data for a review of the CSM and to update the risk assessment.
Detailed investigation (Clauses 7.3, 8, 9, 10 and 11)	To obtain data on the nature and extent of contamination, the geology, geochemistry, soil, hydrogeology and hydrology of a site. To provide data to review the CSM and to update the risk assessment. To provide data for the selection and design of remedial works.
Supplementary investigation(s) (if required) (Clauses 7.4, 8, 9, 10 and 11)	To provide clearer delineation of a particular area (zone) of contamination or a contamination plume. To address or clarify specific technical matters (e.g. to confirm the applicability and feasibility of potential remedial options or obtain information for their design).
NOTE 1 For the purposes of this British Standard, ‘geology’ includes ‘made ground’ and ‘fill’. NOTE 2 A phase of investigation might be undertaken in a number of stages if necessary to achieve the full objectives of the investigation and in response to the findings of the previous phase(s). NOTE 3 When an exploratory investigation is not carried out prior to a detailed investigation, the latter needs to embrace the relevant typical objectives listed here for the exploratory investigation.	

6 Developing an investigation strategy

6.1 General

Having set the objectives of the investigation, an overall strategy should be developed. This should address not only what to do, but also:

- how it is to be done;
- when it is to be done (including sequencing of works);
- who is to do it;
- what needs to be done to enable the work to be done (e.g. consultations, gaining access and preparation of documentation, including, for example, health and safety plans, method statements and specifications).

These and other relevant issues should be addressed as the strategies are developed for each phase of the work and zone.

NOTE 1 Recommendations for the development of the overall investigation strategy are given in 6.2. Guidance is also provided in BS ISO 18400-104.

More detailed strategies for each phase of the work should be developed as the work progresses. These should include where necessary development of a sampling (and field testing) strategy and an analytical and testing strategy.

NOTE 2 Clause 7, Clause 8, Clause 9 and Clause 10 describe the contexts in which the preliminary, exploratory, detailed and supplementary investigations are likely to be carried out and the important factors to be taken into account when developing the respective strategies. Subclause 7.5 refers specifically to the development of strategies for field investigations.

Decisions should be taken early in the project about:

- 1) what additional expertise (if any) is needed to develop the investigation strategy;
- 2) whether a formal project team is to be formed, for example to help develop the strategy; and
- 3) whether to assign specific tasks to specific individuals or organizations.

6.2 Overall strategy

Development of the overall strategy should include deciding which of the investigation types described in 7.1 to 7.4 are to be used, the timing and sequencing of the investigation works and who is to carry out various activities, and identifying what enabling works are required. It should also involve consultation and reporting arrangements during execution and on completion, and formal reviews of the data so that previous decisions taken can be reconsidered in the light of the newly obtained data and other information as the investigation proceeds. The process of identifying and quantifying risks should be ongoing and iterative.

The overall strategy should take into account, amongst other things:

- a) the objectives of the work;
- b) the site constraints;
- c) the suitability of available investigation techniques; and
- d) the availability of suitable analytical and other test methods.

6.3 Phases of investigation

Because the identification, quantification and delineation of contamination (or areas of naturally elevated concentrations of potentially harmful substances) and the assessment of human and environmental risks can be complex, a site investigation should usually be carried out in a series of phases, with each phase designed to achieve specific objectives.

The phases should typically comprise preliminary, exploratory, detailed and supplementary investigations. A preliminary investigation should always be included. The requirement for subsequent exploratory, detailed and supplementary field investigations should be assessed against the objectives. Each phase of subsequent field investigations should be split into a number of stages, when necessary, in order to obtain sufficient relevant data to characterize potential source-pathway-receptor scenarios.

NOTE 1 The terminology used in other contexts and by other professionals might differ from that used in this British Standard. For example, BS 5930:2015+A1 refers to “desk study and field reconnaissance” where “preliminary investigation” is used in this standard and applies the term “preliminary investigation” to what is called an “exploratory investigation” in this standard.

The approach to site investigations on potentially contaminated sites, including the various phases of investigation, should be in accordance with Figure 2. Data and information obtained during each phase should be reviewed in order to determine whether the strategy requires modification or the objectives have been met.

NOTE 2 This review process also enables the CSM to be revised, and the requirements of the risk assessment and the objectives of the site investigation to be reassessed.

Where unacceptable levels of uncertainty remain after completion of the preliminary investigation (Clause 8) and any preliminary risk assessment based on it, the investigation strategy should establish how further information (of an appropriate quality and amount) is to be obtained. The strategy for this further investigation should:

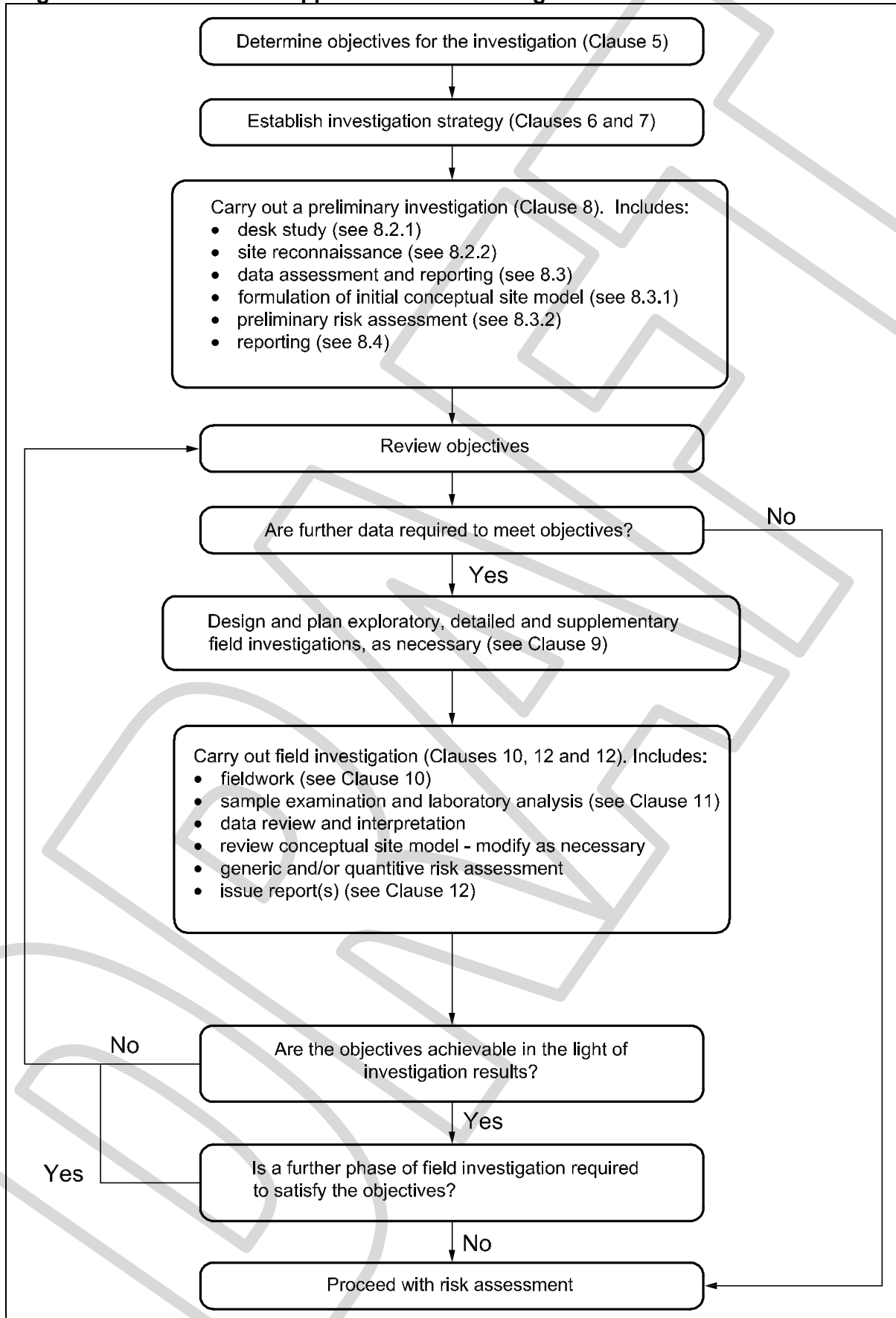
- a) be based on the CSM, the preliminary risk assessment if one has been prepared, the information available and the information that is not available but deemed essential; and
- b) take into account the requirements of the risk assessment and the objectives of the overall investigation and include non-intrusive (9.6.2) and/or intrusive (9.6.3) investigations as necessary.

The further investigation should comprise an exploratory investigation (7.2).

NOTE 3 An exploratory investigation provides information that helps to make the strategy for the detailed investigation (7.3) more cost-effective. However, in some cases, an exploratory investigation might be considered unnecessary, in which case the detailed investigation can then be implemented directly. A further supplementary investigation (7.4) might later be found to be necessary.

Sufficient time should be allowed between each phase of the overall investigation to enable the information from one phase to inform the design of the next.

Figure 2 – Recommended approach to site investigation



6.4 Zoning

Where logical and appropriate, the site should be divided into zones and separate strategies developed for each zone.

NOTE Zoning may be based, for example, on:

- a) near-surface geology (e.g. made ground or natural ground);
- b) deeper geology;
- c) topography;
- d) probable absence or presence of contamination;
- e) previous and current land uses;
- f) nature of probable contaminants (e.g. VOCs or inorganic compounds); and
- g) intended future use.

Separate CSMs should be developed for each zone. Zoning should be reviewed after each phase (and stage) of the investigation.

6.5 Preparing to investigate

It should be determined which actions need to be taken to enable the investigation to be carried out, including, for example, provision of resources, establishment of a suitable team including assigning roles (4.5), obtaining permissions and preparation of documentation. These activities should be integral components of the investigation.

NOTE 1 Formalizing them into a preparatory stage helps to ensure that everything that needs to be done is done.

NOTE 2 The following lists of activities are not intended to be exhaustive, but as aids to a systematic approach.

The following should be assessed in setting the strategy for the investigation:

- a) whether to set up a project team;
- b) what additional expertise is required, either off- or on-site (e.g. ecological specialists);
- c) whom to consult;
- d) site set up with regard to health and safety requirements including the provision of welfare facilities;
- e) physical access arrangements;
- f) legal access arrangements, including whether licences or permits are required;
- g) who should undertake which aspects of the investigation;
- h) how to carry out and, if necessary, procure the investigation in terms of appointment of consultants, contractors, subcontracting, etc.;
- i) what interim reports are to be prepared during the investigation (e.g. a sampling report/record, reports of ground gas, monitoring reports as the results are obtained); and
- j) what information is to be provided to members of the public (where necessary).

NOTE 3 Any field activities can attract the attention of neighbours and passers-by. Field operatives have therefore to be prepared to answer reasonable enquiries. This is an issue that can be discussed with the client and the information available could include appropriate contact details. Such people can be a source of useful anecdotal information; indeed, they might have worked on the site.

The following should be determined:

- 1) What necessary regulatory permits are required, if any;
- 2) Whether there are any formal requirements (e.g. conditions attached to planning permissions or environmental permits) for consultation and/or permissions from regulators; and

- 3) Whether an intrusive investigation requires planning permission (this could be required for large investigations considered by the planning authority to be “engineering works”).

The following should be prepared, as appropriate:

- i) A sampling plan (see Note 3 and BS ISO 18400-101) A sampling plan includes instructions to field staff as to where to sample, what samples to take and what measurements to make;
- ii) Health and safety documents including risk assessments and method statements (RAMS – Risk Assessment and Method Statements);
- iii) Environmental risk assessments;
- iv) Sustainability assessment (see Note 6);
- v) Specifications for site investigation and analysis and testing, etc.;
- vi) Contract documentation; and
- vii) Method procedures for particular activities.

NOTE 3 BS ISO 18400-101 provides guidance on how to prepare and apply a sampling plan. The sampling plan describes among other things what samples are to be taken, how they are to be taken and from where they are to be taken, in order that the objectives of the investigation programme can be achieved. A checklist to aid preparation of a sampling plan is provided in an annex to BS ISO 18400-101.

NOTE 4 General guidance on the management of projects on contaminated sites is provided in CIRIA SP111 [18] and on the selection of consultants in CLR 12 [19].

NOTE 5 A guidance paper describing the common areas of tension and disagreement and the compromise arrangements that might be adopted when contaminated land consultants are employed has been published jointly by the Association of Geotechnical and Geoenvironmental Specialists (AGS), the Environmental Industries Commission (EIC) and the Association of Consulting Engineers (ACE) [20]. The AGS has also published a number of client guides on aspects of site investigation. While these refer mainly to geotechnical investigations, they could be useful by analogy to clients commissioning investigations of potentially contaminated sites.

NOTE 6 The sustainability assessment required here is restricted to those activities that will form part of the planned investigation and which are largely in the control of those designing the site investigation – broader aspects regarding the overall project will be, or will have been, considered by others. Consideration might be given for example to the choice of intrusive exploration methods (see 9.6.3), the timing of the investigation with respect to potential environmental impact, the contribution that non-intrusive methods could make (see 9.6.2 & 10.2.2), use of field methods of testing and analysis (see 10.4) and careful statistical design of the investigations coupled with staged approaches (see 9.7.2.4 and, for example, Risk-based decision making case study: Application at a Superfund site [21] & Incremental Sampling Methodology (ISM) Update [22]).

7 Scope and application of investigations

7.1 Preliminary investigation (desk study and site reconnaissance)

The first phase in the overall investigation process should always be a preliminary investigation (see Clause 8) in accordance with the guidance below.

Guidance in BS ISO 18400-202 should be used as appropriate.

This should include reference to historical records (8.2.1) and other sources of information (8.2.1), consultation with relevant sources (8.2.1.3) and a site reconnaissance (8.2.2). However, the objectives might not require all the elements recommended in 8.2, in which case the strategy should identify what elements of the preliminary investigation are essential and those that do not need to be addressed.

Where elements of a preliminary investigation described in 8.1 are not to be included, these should be documented in the report, and any limitations on the final assessment arising from the omissions should be clearly understood by all parties involved and stated in the report.

The strategy should provide for a review of the information obtained at the conclusion of the preliminary investigation to determine if the objectives have been achieved (and are still

appropriate) and whether there is a need to carry out an exploratory investigation and/or detailed investigation (**7.2 & 7.3**).

Consideration should be given to whether the site should be divided into zones (see **6.2.3**) if this has not already been done. Separate CSMs should be developed for each zone that is identified.

The output from the preliminary investigation should include the initial CSM (**3.1.5**) and a preliminary risk assessment (**8.3.2**) based on the information available.

NOTE 1 Preparation of a preliminary risk assessment requires interpretation of the information gathered during the preliminary investigation. Although a preliminary risk assessment will usually be an essential prerequisite for the design of further phases of investigation, guidance on how to do this is outside of the scope of this standard, so reference needs to be made to LCRM [1] in England and equivalent guidance in the other UK jurisdictions.

NOTE 2 It is likely that there will be different requirements for further investigation of each zone.

NOTE 3 For sites where it is anticipated ground gases might be present and requires an investigation, additional guidance on preliminary investigations is provided in BS 8576.

NOTE 4 Further guidance on preliminary investigations is provided in BS ISO 18400-202 which provides guidance on the design and execution of preliminary investigations comprising desk studies and site reconnaissance, and where appropriate, preliminary risk assessment. It is applicable whenever sampling exercises or investigations are to be carried out to determine soil quality. For example, specific guidance is provided about the possible contamination of agricultural sites and wooded sites. An annex is included tabulating possible contamination/industry linkages.

NOTE 5 BS 5930:2015+A1, Clause 10 to Clause 14 provide comprehensive guidance for desk studies and field reconnaissance (the equivalent of the Preliminary Investigation here) for geotechnical ground investigations. BS 5930:2015+A1, Annex B gives general guidance for desk studies and BS 5930:2015+A1, Annex C provides information about sources of information.

7.2 Exploratory investigation

An exploratory investigation is a limited investigation and should be designed to:

- a) reduce uncertainty in knowledge of the site, including determining the accuracy or otherwise of contamination-related and other hypotheses developed in the preliminary investigation, thereby enabling the initial CSM to be refined; and
- b) provide information that helps the design of any subsequent detailed investigation.

NOTE 1 Depending on the objectives of the investigation, and such other considerations as site access, land ownership and project programme, a decision might be taken to not carry out an exploratory investigation, but to proceed directly with a detailed investigation (7.3).

Where an exploratory investigation is undertaken, it should comprise non-intrusive and/or intrusive elements as appropriate. The intrusive element should include as appropriate collection and analysis of soil (**9.7.2** and **10.3.3**), surface water (**9.7.3** and **10.3.7**), groundwater (**9.7.3** and **10.3.7**) and ground gas (**10.3.8**) samples, monitoring of ground gas including VOCs (**9.7.4** and **10.3.8**) and certain groundwater parameters and groundwater levels, and application of on-site methods of soil and groundwater analysis when appropriate (see **10.4** and Annex E).

*NOTE 2 A non-intrusive investigation technique (see **9.6.2**, **10.2.2** and Table 5) can be used, for example, as an aid to locating below-ground structures or other features of the site.*

Whether to apply a particular non-intrusive technique before or after some or all of any intrusive works have been carried out should be decided and justified, with the input of any necessary expert advice as appropriate.

Where the CSM output from the preliminary investigation identifies the likelihood of localized sources of contamination, and there is inadequate information to confirm the direction of groundwater flow, an appropriate strategy should be developed to investigate contamination at the suspect locations, the water table at several (triangulated) positions and groundwater quality. In this situation, the use of targeted sampling locations is likely to be most appropriate (see **9.7.2.2**).

The information obtained from the exploratory investigation should be used to refine the CSM and in the design of any subsequent investigation(s).

NOTE 3 An exploratory investigation is not intended to provide sufficient data to permit a site-wide detailed quantitative risk assessment (DQRA). It might, however, provide sufficient data for a DQRA on a particular part or zone of the site or on a specific element if the investigation is specifically designed with this intent in mind. It might also be sufficient (depending on the objectives and uncertainty reduction required) to fulfil a regulatory requirement.

NOTE 4 The exploratory investigation could indicate that the contamination pattern is more complex or the concentrations and/or the extent of contamination are greater than anticipated. In such situations it is likely that further investigatory work will be necessary in order to refine the CSM and provide adequate robust information for the risk assessment.

7.3 Detailed investigation

The detailed investigation should comprise, as far as is practical, collection of:

- a) all information necessary to test the accuracy or otherwise of contamination-related and other hypotheses developed in earlier phases of the overall investigation;
- b) all information necessary for the assessment of risks to all potential receptors; and
- c) information relevant to the selection, design and costing of remedial works.

NOTE 1 The detail required will depend upon the objectives of the investigation.

NOTE 2 When an exploratory investigation has not been carried out, it could be necessary to test a number of contamination-related and other hypotheses in the detailed investigation as would be done during an exploratory investigation.

The detailed investigation should include the use of non-intrusive investigation methods, as well as intrusive methods, as necessary. Expert advice should be obtained as to whether it is best to apply a particular non-intrusive technique before or after some or all of any intrusive works have been carried out.

The investigation should include, as appropriate, collection and analysis/testing of soil (**9.7.2** and **10.3.3**), surface water (**9.7.3** and **10.3.7**), groundwater (**9.7.3** and **10.3.7**) and ground gas including VOCs (**9.7.4** and **10.3.8**) samples, and the in-situ monitoring of ground gas, certain groundwater parameters and groundwater levels.

The design of the investigation should take into account all the information and hypotheses developed in the earlier phases of investigation and the objectives for this phase of the work. Particular attention should be paid to the sufficiency and quality of the data, taking full account of the historical and current use(s), likely heterogeneity and underlying stratigraphy.

NOTE 3 The amount and nature of the information required from the detailed investigation will vary according to the nature of the site and the possible requirements for remedial action. The implications of the decisions on what actions need to be implemented will vary from site to site. The amount and quality of information available will dictate the degree of confidence that can be attributed to the decision-making process.

During the subsequent assessment of risks and hazards, all possible migration pathways relevant to the contamination should be considered, and an appreciation in space and time of the contamination established. The possible migration pathways should inform the design of the detailed investigation, since detailed knowledge of physical and chemical soil properties and the local hydrology is essential for reaching defensible conclusions.

The risk assessment should take into account the risks of making incorrect decisions based on the amount and quality of information available.

All parties involved in the decision-making process should be fully informed as information is produced, to confirm that the information is sufficient for the purpose intended.

In a detailed investigation, the greater proportion of sampling locations should be non-targeted to aid the reliability of interpretation (see **9.7.2.3**) and the use of statistical methods for assessment of the data. However, targeted sampling should also be employed as

necessary, for example, to delineate or confirm an area of contamination detected during an exploratory investigation.

The relative density of sampling in each zone should take into account the findings of earlier phases of investigation, including the uncertainty associated with each zone.

7.4 Supplementary investigations

A review of the outcome of the detailed investigation should be carried out in order to identify aspects and areas where an unacceptable level of uncertainty or deficiency of information remains. Where such uncertainties or deficiencies are identified, a supplementary investigation should be carried out. This should be designed to produce specific information. It should use targeted and/or non-targeted sampling as appropriate.

NOTE A supplementary investigation could be required, for example:

- a) *to provide additional information to design and cost remedial works, for example, to delineate volumes of soil requiring remediation, or to carry out specific tests to evaluate the suitability of specific remedial treatment techniques;*
- b) *to provide chemical testing information for the classification of wastes;*
- c) *to monitor groundwater quality and levels, and/or ground gas conditions, after completion of the detailed investigation to determine any changes in site conditions and to provide additional data to assess risks and aid design of protective measures; and*
- d) *to monitor groundwater and ground gas conditions during and after construction or remediation to determine whether there have been any adverse changes in site conditions.*

7.5 Specific strategies for field investigations

When a field investigation (exploratory, detailed or supplementary) is to be carried out, decisions should be made and recorded (e.g. in an investigation and/or sampling plan – see **6.5**, Note 3) regarding:

- a) the objectives of the investigation;
- b) the form of the investigation [non-intrusive and/or intrusive (see **9.6**, **10.2** and Table 5 and Table 6)] necessary to obtain appropriate, suitably robust and defensible data in accordance with the objectives;
- c) the purposes for which samples are required (e.g. for chemical analysis or other tests);
- d) the locations from which samples are to be collected and the number of locations required (see sampling strategy in **9.7**);
- e) the number and type of samples to be collected (i.e. soil, water, gas) from each location, the depths at which they are to be collected (see **9.7.2.5**), whether replicate samples are to be taken [for example, to allow assessment and reporting of sampling uncertainty (see Annex D)], and any monitoring requirements (see sampling strategy in **9.7**);
- f) the techniques to be used to collect the samples (see Figure 2, Table 6, BS ISO 18400-102:2017, Table 3 and BS ISO 18400-102:2017, Table 4, and **10.3**), taking into account: the soil types, groundwater conditions, topography, services and access (e.g. soft landscape, tarmac, presence of buildings, etc), the quality of reinstatement necessary, the depths at which samples are to be collected (**9.7.2.5**), whether a ground gas investigation is included (**9.7.4**), whether water samples are to be collected (**9.7.3**), and the monitoring installations required (**9.7.3** and **9.7.4**) (see Note 1);
- g) how samples are to be taken to avoid or minimize cross-contamination (**10.2.3.3**);
- h) what provisions are to be made for cleaning field equipment between sampling points (**10.2.3.3**);
- i) quality assurance procedures to provide an auditable process to enable confirmation that sampling has been carried out in a satisfactory manner (**9.9**);

- j) the analyses and tests to be carried out on each sample, and whether these are to be carried out in a laboratory or in the field (see **9.7**, **10.4**, **11.4** and **11.6**), and the analytical and testing strategy – see Note 2;
- k) selection of a laboratory which can employ analytical and other test methods appropriate for the planned risk assessment process to the required standard and accommodate the anticipated workload (see Clause **11**)
- l) how samples are to be handled, stored, preserved and transported to the laboratory so as to minimize alteration prior to analysis or testing (**10.6**);
- m) the process for dispatch of samples to the laboratory, issue of instructions to the laboratory and the date by which the results are required; and
- n) requirements for field testing (e.g. methods and instrumentation) (**10.4**).

NOTE 1 Decisions should also be made about the programme for the fieldworks and the logistics of the site investigation, including the availability of relevant machinery and personnel, permission for site access, liaison with regulatory authorities, completion of health and safety and environmental risk assessments.

NOTE 2 Attention is drawn to the Construction Design and Management Regulations [6].

NOTE 3 The selection of the sampling technique might involve some compromise, for example due to access, headroom, underground services or other constraint. If samples are only required from 2 m to 3 m below ground level (bgl) and the location of buried services is known with sufficient certainty, trial pits might be regarded as the most appropriate technique. However, where there is over-site concrete which is still in use and a good standard of reinstatement is necessary in order, for example, to minimize disruption of the site and allow satisfactory reinstatement, coring through the concrete followed, for example, by use of a dynamic sampling tool could be the more appropriate approach (see Table 6, BS ISO 18400-102:2017, Table 3 and BS ISO 18400-102:2017, Table 4).

NOTE 4 Whilst decisions about the type of analyses and testing can usually be made during formulation of the investigation strategy, final decisions about what samples to analyse or test are often deferred until the samples have been obtained. This permits field observations to be taken into account.

8 Preliminary investigation

8.1 General

A preliminary investigation should always be carried out before any systematic sampling or analysis is specified or undertaken (see **7.1**).

The preliminary investigation should obtain information in order to:

- a) assess the likelihood of contamination, its nature and its extent;
- b) evaluate the environmental setting of the site and identify sensitive receptors;
- c) provide information from which likely source-pathway-receptor relationships can be identified, and which can then be used to formulate a CSM to enable the design of a field investigation (if required);
- d) determine the requirements for further investigation, if any; and
- e) identify any special procedures and precautions that will be necessary during subsequent sampling and examination of the site.

A preliminary investigation should be a two-step process involving data collection followed by interpretation and reporting (see Table 2).

The specific scope of each step of the preliminary investigation should be tailored according to the overall purpose of the investigation and objectives, the availability of existing information, the size and complexity of the site, known or projected future land uses and other relevant site-specific factors.

NOTE 1 Additional guidance on preliminary investigations for sites where it is anticipated ground gases might be present is provided in BS 8576.

NOTE 2 Further guidance on preliminary investigations is provided in BS ISO 18400-202 which provides guidance on the design and execution of preliminary investigations comprising desk studies and site reconnaissance, and where appropriate, preliminary risk assessment. It is applicable whenever sampling exercises or investigations are to be carried out to determine soil quality. For example, specific guidance is provided about the possible contamination of agricultural sites and wooded sites. An annex is included tabulating possible contamination/industry linkages.

NOTE 3 Buildings and plant could be present on the site to be investigated. Decommissioning, decontamination and dismantling of plant, and demolition of buildings prior to redevelopment of the site could form part of the overall project. Guidance on desk studies and site surveys prior to partial or full demolition is provided in BS 6187. Guidance on decommissioning, decontamination of plant and buildings, and demolition is provided in CIRIA SP102 [23].

Table 2 – Scope of a preliminary investigation

Step	Activity
Data collection	Desk study Documentary research (see 8.2.1.2): • site history; • site setting (location, surroundings, topography); • site usage (including adjacent areas); • site geology, hydrogeology, geochemistry, hydrology; • site ecology and archaeology when information is already available^{A)}; • future plans for the site. Consultations (see 8.2.1.3 and Table 3) Site reconnaissance (see 8.2.2): • detailed inspection; • interviews (where possible); • limited ad hoc sampling and field measurements (if appropriate).
Interpretation and reporting	Formulate initial CSM (see 8.3.1). Assess need for, and scope of, further investigation. Preliminary risk assessment (see 8.3.2) (outside the scope of this British Standard). Prepare preliminary investigation report (see 8.4).

^{A)} This refers to existing documents that can be scrutinized for pertinent information such as presence of protected species or archaeological remains that need to be taken into account when carrying out an intrusive investigation. Bat reports often contain useful information on any buildings on site.

8.2 Data collection

8.2.1 Desk study

8.2.1.1 General

The desk study should comprise a combination of documentary research (see **8.2.1.2**) and consultations (see **8.2.1.3**).

The desk study should include at least the following topics:

- a) the history of the site and adjoining areas, with particular attention to the nature of any industrial processes and other activities that could have been potentially contaminative or could have modified the ground structure to create potential migration pathways;
- b) review of any previous desk study or investigation of the site;
- c) the geological, geochemical, hydrogeological, hydrological, topographical, archaeological and ecological setting of the site;
- d) potential receptors of contamination (for example, trespassers, current and intended users, construction workers, surface waters, groundwaters or nearby water abstractions, ecological receptors, property);
- e) the proximity of waste management facilities and disposal sites or other sources of contamination that could have an impact on the site;
- f) the existence of naturally occurring potentially harmful substances including radon;
- g) the presence of any mining activities;
- h) any constraints on an intrusive site investigation (access or height limitations, underground and overhead services or obstructions, noise, working hours, etc.);
- i) the potential for the site to contain or have been affected by UXO (see CIRIA C681: *Unexploded ordnance (UXO): A guide for the construction industry* [24]);
- j) review of developers' designs and plans where the site is to have a change of use, with details recorded of the future use/characteristics of the site; and
- k) any foreseeable events or changes (e.g. flooding, rising groundwater, change of use of neighbouring sites) that could have an impact on the assessment.

8.2.1.2 Documentary research

8.2.1.2.1 Site location and historical setting

COMMENTARY ON 8.2.1.2.1

Table 3 gives a list of the types of information held by national and regulatory bodies with additional information on some sources provided in the text below. See also 8.2.1.3 for other organizations to be contacted and the type of information to be discussed.

Many of the publicly available datasets are made available in an electronic form which is compatible with common geographical information system (GIS) software packages which facilitates viewing, combining and analysing spatial datasets alongside maps and site plans. The terms of the licence should be reviewed to confirm that the purpose for which the dataset will be used is consistent with the applicable licence.

Reports can be purchased from a number of private companies which provide a collation of publicly available information relevant to characterizing a site's history, geology, hydrogeology and environmental setting and identifying the locations of potentially contaminative land uses, pollution incidents and other features of relevance to a preliminary investigation.

The site location and site boundaries should be accurately established before any investigatory work is commenced.

The site history should be determined using the following and any other appropriate sources of information.

- a) Ordnance Survey (OS) maps.
- b) Other published maps, for example, insurance, tithe, enclosure or parish maps.
- c) Aerial photographs.
- d) Documentary records, particularly any previous desk study or investigation reports held by the current (and former) owners of the land, trade directories, the local authority planning records and local libraries.

The level of historical research undertaken should be compatible with the objectives of the investigation.

NOTE The extent of research into the history of the site will depend upon a number of factors including the complexity of past potentially contaminative uses on and adjacent to the site, the vulnerability of the site geology and local water environment, and the degree of confidence required by the client.

The methods and extent of research should be agreed with the client in advance and modified as necessary according to the findings of the preliminary investigation.

Where the presence of tunnels or underground structures is a possibility, they should be taken into account. It should not be assumed that they are all shown on Ordnance Survey mapping. Information from transport and services/utility infrastructure owners should be requested as needed.

Table 3 – Types of information available from national and regulatory organizations

Organization	Information
Defra - England Defra data services platform	A range of datasets related to the environment via the Open Government Licence (OGL). The datasets available vary between the UK nations although generally include the following information:
NRW Natural Resources Wales / Access our data, maps and reports	Groundwater and surface water quality; aquifer designation; current groundwater abstraction licences, Groundwater Source Protection Zones, drinking water protection areas and groundwater vulnerability maps (some of these a licensed BGS datasets).
SEPA Environmental data Scottish Environment Protection Agency (SEPA)	Surface water catchment data, water quality designations (Water Framework Directive classifications), flooding and flood risk information including Flood Zones (for planning)
DAERA-NI Digital Datasets Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)	Environmental permits and licences (PPC and IPC in Scotland) including landfill and waste treatment facilities, exemptions, waste carriers, brokers and dealers, scrap metal dealers, information on pollution incidents
	Historical landfills, Special Sites under Part 2A of the Environmental Protection Act 1990.
Local authorities	Contaminated Land Inspection Strategy for their area, identifying potentially contaminated sites (required by Part 2A, EPA [3]). Public register of statutory “contaminated land” in their area. Information on remediation of land affected by contamination. Historical experience of environmental nuisances. Historical planning records which may include information on former land use, site layout and other diagrams, conditions of relevant planning consents. Closed landfill sites (former Local Authority sites) Private water supply abstractions (<20m ³ /day). Building control records, which may include diagrams of former layout of sites and actual or planned locations of underground and above ground storage tanks. Details of sites with Environmental Permits (Part B processes under LAPPC).

DEFRA - Multi-Agency Geographic Information for the Countryside (MAGIC)	Groundwater Source Protection Zones, drinking water protection areas, aquifer designation, groundwater vulnerability (England) Land based designations (Ramsar, SSSI, SPAs etc) Scheduled monuments and world heritage sites (England) Magic Map Application (defra.gov.uk)
Health and Safety Executive (HSE) (England, Scotland and Wales)	Records of the Control of Major Accident Hazards Regulations (COMAH) 2015 establishments accessed via the Public Information Search. HSE: Control of Major Accident Hazards (COMAH)
Northern Ireland Department of Agriculture, Environment and Rural Affairs (DERA-NI)	COMAH sites COMAH Public Information Northern Ireland Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)
Petroleum Enforcing Authority (normally located within the local authority/Trading Standards or Fire Service)	Petroleum Enforcing Authority (PEA) holds Petroleum Storage Certificate (PSC) accordance with the Petroleum (Consolidation) Regulations 2014, this could include the location, status, and age of petroleum storage tanks. <i>NOTE Information is usually only available with the permission of the site owner.</i>
British Geological Survey (BGS)	Geology (including boreholes records), hydrogeology, groundwater vulnerability (including Wales), groundwater levels, mining/coal information, G-Base geochemistry, geophysical information, environmental designations, various -other Data - British Geological Survey (bgs.ac.uk) (free and licensed datasets)
Coal Authority (BGS website)	Interactive map – coal mining records, location of mine shafts, high risk areas, brine extraction hazards. Interactive Map Viewer Coal Authority (bgs.ac.uk)
Northern Mine Research Society	Interactive Map with various mines includes non-coal mines (iron, non-iron, quarries, smelt mills, onshore oil and gas) Mines - Northern Mine Research Society (nmrs.org.uk)
UK Health Security Agency and British Geological Survey	Reports containing Radon Affected Area maps for the United Kingdom. An interactive map and address-specific reports available UK radon - UK maps of radon
The National Archives	Search website for information and plans of old military sites and other former government sites, National Monuments Record and wide range of other material. The National Archives
The National Library of Scotland	Old maps including military maps Scottish military maps, 20th century - National Library of Scotland (nls.uk)

Historic England	Historical aerial photographs and other documents Aerial Photo Explorer – Historic England
Historic Environment Scotland	A national record of historical and archaeological sites including photographs for Scotland including archive information of Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) Archives and Collections Historic Environment Scotland HES
Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)	A national record of historical and archaeological sites for Wales. RCAHMW Royal Commission on the Ancient and Historical Monuments of Wales
Northern Ireland Department for Communities	Northern Ireland Sites and Monuments Record (NISMR), a national record of historical and archaeological sites for Northern Ireland. Sites and Monuments Record Department for Communities (communities-ni.gov.uk)
Northern Ireland Department of Agriculture, Environment and Rural Affairs (DERA-NI)	COMAH sites COMAH Public Information Northern Ireland Department of Agriculture, Environment and Rural Affairs (dera-ni.gov.uk)

NOTE Some of the information from the above sources is licensed and may also be subject to copyright and permissions for use, in particular in a commercial capacity

8.2.1.2.2 Site usage

Details of the past and current usage of the site and its immediate environs, together with information on any incidents (such as spills or detected leakages), should be collated and used in the development of the initial CSM. Any available plans of the previous or current layout of different usages on the site should be inspected, as well as any plans of site drainage or underground services.

NOTE 1 Recent aerial views, and sometimes street-level views of the site, can be obtained on internet map sites. These can help establish the context of the site and recent condition. However, the date of the imagery might not be stated and the current condition of the site could be very different to that shown online.

NOTE 2 Examples of some land uses that can give rise to contamination are listed in BS ISO 18400-202.

NOTE 3 Industry Profiles provide information on the processes, materials and wastes associated with individual industries. They also provide information on the contamination which might be associated with specific industries, factors that affect the likely presence of contamination, the effect of mobility of contaminants and guidance on potential contaminants. They are not definitive studies but introduce some of the technical considerations that need to be in mind at the start of an investigation for possible contamination. Industry profiles can be found on the CL:AIRE website: [DoE Industry Profiles \(claire.co.uk\)](#)

NOTE 4 An agricultural site or a wooded site might be a potentially contaminated site, not only because of activities associated with their current use, but because they were developed in the past for example on old refuse disposal sites (landfills) or mining waste.

NOTE 5 Old OS map editions do not represent a complete record of historical land use, but can assist understanding of historical land use. There might be several years between survey date and the publication of OS maps. In addition, because of the sometimes large time intervals between surveys, activities can occur in an area (e.g. formation and filling of a pit) without being recorded on an OS map.

NOTE 6 Other base maps that can be considered alongside OS maps available from commercial providers include Russian Maps, which have the benefit of focusing on military establishments.

Research should be conducted to determine whether any of the following common causes of contamination could have occurred:

- a) spills or leaks of potentially harmful substances from tanks, pipes and drains on the surface or underground;
- b) deposition or burial of industrial, agricultural or domestic waste or temporary stockpiling of leachable materials (for example, road salt);
- c) demolition of industrial structures and dispersal or burial of contaminated rubble and other materials; and
- d) importation of potentially contaminated fill material onto the land.

In addition, it should be determined whether UXO is likely to be present.

NOTE 7 PAS 128 provides guidance on the detection, verification and location of active, abandoned, redundant or unknown underground utilities and the location of their associated surface features (e.g. manhole covers and utility markers). It applies regardless of where these utilities are located (e.g. in urban or rural areas, in the street, or on private sites such as hospitals or airfields). It applies to utilities buried no deeper than three metres. Where ground investigation, borehole, trial pit works and other construction works are proposed, a current utility mapping survey conforming to PAS 128 can be used as an indicator of the presence or absence of underground utilities before conducting further ground investigation prior to breaking ground.

8.2.1.2.3 Geology, geochemistry, hydrology and hydrogeology

All available sources of information on the geological, geochemical, hydrological and hydrogeological conditions of the site should be collected and examined.

NOTE The following sources can be consulted, though this is not an exhaustive list of the available resources.

- *British Geological Survey (BGS) for geological, geochemical and hydrogeological maps for England and Wales, for certain radon information, for groundwater vulnerability maps for Scotland, and for borehole and well records. Geological maps, datasets and logs of borehole and wells can be purchased from BGS and be viewed and ordered online at www.bgs.ac.uk.*
- *Multi-Agency Geographic Information for the Countryside (MAGIC) for aquifer designation maps, Drinking Water Protected Areas (Surface Water) (England), Drinking Water Safeguard Zones (Surface Water) (England), Drinking Water Safeguard Zones (Groundwater) (England), Aquifer Designation Map (Bedrock) (England), Aquifer Designation Map (Superficial Drift) (England), Groundwater vulnerability (England),*
- *Aerial photographs - both historical and current aerial photography have to be considered, together with suitable metadata detailing the date when the imagery was taken. English Heritage hold the National Library of Aerial Photographs for England at the National Monuments Record in Swindon. Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) hold the National Collection of Aerial Photography for Scotland in Edinburgh. Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMS) hold the National collection for Wales in Aberystwyth. Aerial photographs for Northern Ireland are held by the Northern Ireland Environment Agency Built Environment.*
- *The results of any previous ground investigations carried out on, or in the vicinity of, the site, or information from national surveys covering the vicinity.*
- *BS 5930:2015+A1, Annex C gives a comprehensive list of geological and other information sources including available soil and hydrogeological maps.*
- *BGS, the Environment Agency and Natural Resources Wales - mapping and the locations of previous site investigation and well logs deposited with the BGS are sometimes included in reports collating publicly available information for preliminary investigations which can be purchased from private companies.*
- *In Scotland, groundwater vulnerability maps are available from the BGS and outline vulnerability information is also available on SEPA's website. There are no formal source protection zones in Scotland.*
- *Information on drinking water protected areas and groundwater resource potential can be obtained on SEPA's website.*

8.2.1.2.4 Ecology and archaeology

The preliminary investigation should determine whether the site (or its immediate environs) has been designated as an area of ecological or archaeological significance.

NOTE 1 If it has been so designated, it is likely that there will be constraints on the methods of ground investigation that can be used. It is also likely that ecological and/or archaeological surveys and desk studies will need to be undertaken before any contamination-related field investigations.

NOTE 2 Historic England has published guidance about the interactions between archaeology and land contamination including during investigation and assessment, and design and implementation of remedial measures [28].

The preliminary investigation should also determine whether there are species (e.g. bats, nesting birds and water voles) or habitats of importance

NOTE 3 Attention is drawn to the Wildlife and Countryside Act [29] and Habitat Regulations [30].

NOTE 4 The presence of these species or habitats could restrict the timing or method of investigation.

The presence of invasive plant species, such as Japanese Knotweed and Giant Hogweed, should also be determined. Subsequent ground investigations should be designed to avoid any spread of these species.

NOTE 5 The presence of Japanese Knotweed can add to waste disposal and other remediation costs.

NOTE 6 Examples of the organizations to be contacted to determine if there are any ecological or archaeological designations are listed in 8.2.1.4.3.

8.2.1.3 Consultations

Relevant parties should be consulted, normally in parallel with the documentary research. Client approval should be obtained before entering consultations with third parties and regulators, in case of confidentiality issues, though this could be required by a planning condition.

Interviews with persons possessing knowledge of activities on, or adjacent to, the site should be combined with the site reconnaissance visit (8.2.2) to obtain further information on, or enhance knowledge of, suspect locations or features, underground services, etc. Anecdotal evidence should be viewed with caution.

Consultations with the local authority's contaminated land officer (CLO) and, when applicable, the Environment Agency (England), Northern Ireland Environment Agency, Natural Resources Wales or SEPA (Scotland) as appropriate should cover methods of ground investigation.

NOTE 1 It is vital that potential risks to controlled waters, caused by the creation of migration routes during boring or trial pitting, are avoided.

If investigations are likely to be undertaken on (or accessed via) archaeologically sensitive sites, the archaeological adviser to the local authority should be consulted about the proposed programme and methods of work. In England and Wales it is usually the County Archaeological Adviser who should be contacted, although in London the Greater London Archaeological Advisory Service (GLAAS), part of Historic England advises the local authorities for all boroughs, except Southwark and the City of London:

- a) Natural England,
- b) Natural Resources Wales,
- c) Scottish Natural Heritage
- d) Council for Nature Conservation or the Countryside Office
- e) Joint Nature Conservation Committee

NOTE 2 The MAGIC website (<https://magic.defra.gov.uk>) provides geographic information about the natural environment from across government. The information covers rural, urban, coastal and marine environments across Great Britain. It is presented in an interactive map which can be explored using various mapping tools that are included. MAGIC provides links to other sources of data in order to make best use of a wide range of information available on other websites. Natural England manages the service under the direction of a Steering Group who represent the MAGIC partnership organizations. The MAGIC partners are:

- Department for Environment, Food and Rural Affairs

- *Historic England*
- *Natural England*
- *Environment Agency*
- *Forestry Commission*
- *Marine Management Organisation*

The local authority development plan should be consulted to determine whether the site is of national or international importance, as designated by Natural England, Natural Resources Wales, Council for Nature Conservation and the Countryside and Scottish Natural Heritage, respectively, or of county or local importance.

If investigations are likely to be undertaken on (or accessed via) archaeologically sensitive sites, the archaeological adviser to the local authority should be consulted about the proposed programme and methods of work. In England and Wales it is usually the County Archaeological Adviser who should be contacted, although in London English Heritage advises the local authorities for all boroughs, except Southwark and the City of London.

NOTE 3 More information can be obtained from:

- Natural England* <http://www.naturalengland.org.uk>
- NatureScot* <https://www.nature.scot/>
- Natural Resources Wales* <https://naturalresources.wales/evidence-and-data/maps?lang=en>
- Council for Nature Conservation and the Countryside (Northern Ireland)* <http://www.cnccni.gov.uk/>
- Joint Nature Conservation Committee* <http://www.jncc.gov.uk/>
- Association of Local Government Archaeological Officers UK (ALGOA)* <http://www.algoa.org.uk/>

NOTE 4 A full list of advisers for the United Kingdom is available from the Association of Local Government Archaeological Officers (ALGOA) <http://www.algoa.org.uk/>.

8.2.2 Site reconnaissance

8.2.2.1 General

A reconnaissance of the site, neighbouring land and the local area should be made, ideally after carrying out documentary research (see also **8.2.1.2**). Arrangements for the reconnaissance visit, including access, should be agreed with the client and the site owner and/or occupier, as appropriate, before being undertaken. The visit should be made by a suitably qualified, trained and experienced person.

The principal objectives of the visit should be to:

- verify information on the site collated during the desk study (**8.2.1**);
- collect additional information about the site, its environs and any potential contaminants, pathways and receptors;
- record observations of aspects of the site and its environs not revealed by the desk study, including the presence of invasive plant species; and
- collect information that will assist in the planning of any subsequent phases of field investigation (for example any constraints to access).

The topography of the site should be observed and compared to levels anticipated by the desk study.

NOTE Raised ground and artificial slopes could be indicative of made ground imported onto the site.

A strategy for the visit should be decided in advance and suitable plans, checklists and reference documentation prepared.

8.2.2.2 Safety during site reconnaissance

Measures should be taken to maintain the safety of the investigator when a preliminary site reconnaissance is carried out prior to commencing the full site investigation, particularly as all potential hazards might not have been identified at that time.

A full desk study as described above and in ISO 18400-202 should be carried out before the site reconnaissance visit, so that potential chemical, physical (e.g. below-ground cavities), biological and other hazards can be identified and any necessary protective measures determined.

NOTE 1 The desk study might not identify all potential hazards so appropriate caution is always required when conducting a preliminary investigation.

A health and safety risk assessment should also be carried out for the visit. This assessment should be based on the results of the desk study but can be refined once the preliminary investigation is completed. The assessment should be kept under review as the investigation proceeds, but where there is any doubt as to the presence or degree of contamination then protective equipment should be used. Personnel undertaking the visit should be briefed on any hazards that could be encountered and any precautions to be taken.

Precautions should be taken while on site in relation to the physical state of buildings. Dilapidated buildings should not be entered, and such buildings should also be treated with caution where there is a possibility of falling masonry or other debris (e.g. glass, sharp metal objects).

NOTE 2 Where loose asbestos is in evidence, the area should be avoided until appropriate precautions can be taken (either sealing or removal of the asbestos or wearing respiratory protection equipment to enable sampling to be carried out).

If buildings are present in which potentially contaminating processes could have taken place, the past and present usage should be reviewed and the buildings inspected for evidence of actual and potential contamination, subject to the condition of the building.

NOTE 3 It might be necessary for derelict and disused building to be inspected by a suitably qualified engineer or surveyor prior to entry.

Personnel entering old buildings should treat rooms entered as potential confined spaces.

WARNING. Closing doors can create a “confined space” where gases previously vented could build up creating a hazard to the personnel entering the space, as well as to other persons who might later enter the property.

On very contaminated sites, initial observations should be made from the perimeter using binoculars or a video camera.

A request should be made for personnel visiting the site to be accompanied by someone familiar with the site, such as a plant manager or safety officer in the case of an industrial site.

During the site visit photographs of salient features should be taken, where permissible.

If during the site reconnaissance anything is seen that is considered likely to pose an immediate threat to human health and safety or the environment, this should be reported immediately to whoever is in control of the site so that any essential urgent action can be taken (see Note 5).

NOTE 4 There might be a duty under the Health and Safety at Work Act [31] and/or professional Code of Conduct to do this.

NOTE 5 Sampling is not normally undertaken during a site reconnaissance. However, it might be appropriate to do so where materials are identified during the visit that could potentially present an immediate hazard to vulnerable receptors. This ought only to be undertaken if it can be done safely using appropriate containers and protective equipment. If not, an urgent exploratory investigation could be planned where the objective is to determine whether an immediate risk is present from the identified site materials. There might be instances, dependent on the known history of the site, where use of rapid on-site analytical methods could be usefully

employed to characterise “suspect” materials or emanations, e.g. portable XRF, hydrocarbon determinations, instruments and other devices for gas detection and identification (see 10.4).

NOTE 6 *Additional, detailed guidance on carrying out preliminary field inspections of land potentially affected by contamination is given in:*

- a) *CLR 2, published by Defra/Environment Agency [32];*
- b) *SP103, published by CIRIA [33].*

NOTE 7 *Detailed guidance on the field inspection of buildings prior to decommissioning or demolition is provided in BS 6187 and SP102, published by CIRIA [23].*

8.3 Data assessment and reporting

8.3.1 Formulating the initial CSM

The information from the desk study, site reconnaissance visit and consultations should be collated and evaluated to formulate an initial CSM of the site.

The initial CSM should identify, as far as reasonably possible:

- a) potential types, depths and extent of soil, groundwater and ground gas contamination present in different zones of the site;
- b) the likely vertical and horizontal stratification of natural and artificial layers beneath the site;
- c) strata variability (occurrence and thickness) in different areas of the site and their relative permeability, both vertically and horizontally;
- d) potential migration routes (including airborne dispersion);
- e) the presence of physical features such as service trenches, drainage runs, soakaways, underground storage tanks, power lines and former foundations that could influence the occurrence or migration of contamination or provide a constraint to investigation;
- f) the occurrence of biological, chemical or physical processes that could affect contaminant concentrations and migration (including natural attenuation);
- g) the characteristics of groundwater bodies beneath the site, including groundwater levels and flow directions;
- h) the presence of surface water bodies on, or adjacent to, the site;
- i) presence and planned (or potential) presence of human receptors;
- j) presence of other actual or potential receptors;
- k) presence of controlled waters; and
- l) any reasonably foreseeable event, for example rising groundwater, variable sea water levels or nearby construction, that might affect a) to k).

NOTE 1 *The initial CSM can also include hypotheses about the presence of made ground, underground obstructions, buried river channels, the expected directions of groundwater flow, number of aquifers and details of groundwater recharge, permeability of the ground, the physical and chemical properties of the expected contaminants, their possible degradation products, the location and form of the contaminant source, duration, etc.*

When further investigations are carried out the additional information should then be used to refine the CSM.

Where there are data gaps or uncertainty in the initial CSM, these should be highlighted in the report containing the CSM.

NOTE 2 *ISO 18400-203 suggests that formal contamination-related hypotheses about the nature and distribution of possible contamination are formulated that can then be tested in subsequent exploratory and detailed investigations. Other aspects of the CSM can also be presented as formal hypotheses that can be tested.*