

Remediation Method Statement

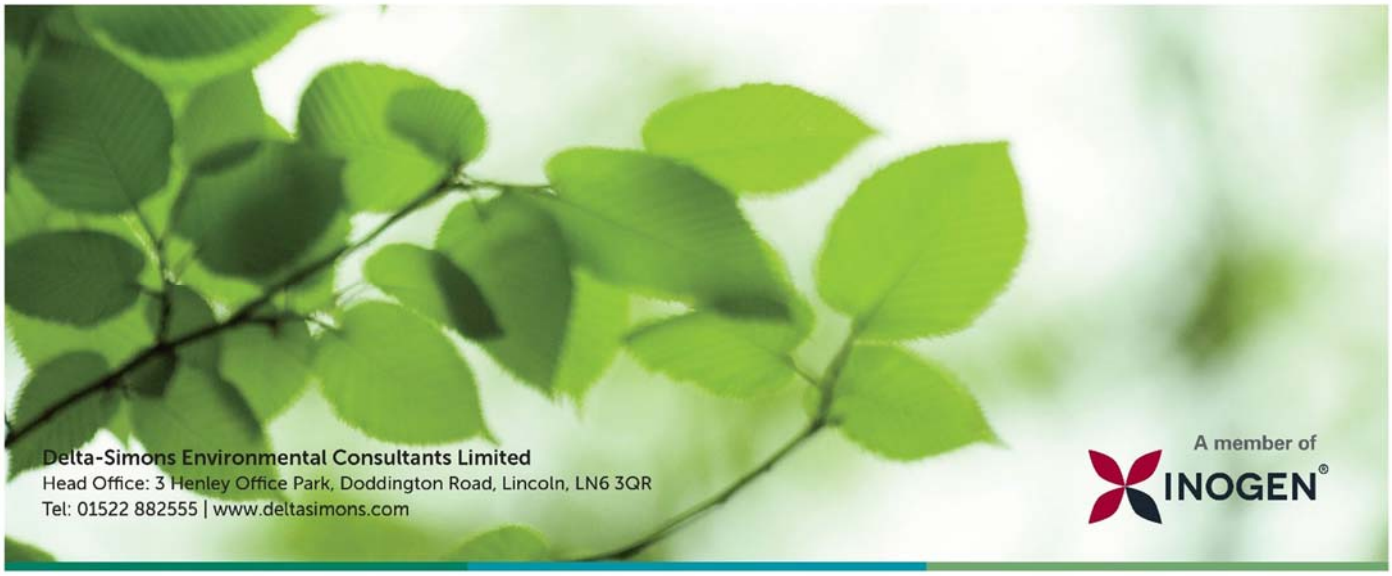
Pear Tree Farm, St James Road, Long Sutton

Presented to **Mr G Franklin**

Issued: September 2018

Delta-Simons Project No. 17-0252.03

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Report Details

Client	Mr G Franklin
Report Title	Remediation Method Statement
Site Address	Pear Tree Farm, St James Road, Long Sutton, Spalding, PE12 9BA
Project No.	17-0252.03
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Quality Assurance

Issue No.	Status	Issue Date	Comments	Author	Technical Review	Authorised
1	Final	7th September 2018				
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About us

Delta-Simons is a trusted, multidisciplinary environmental consultancy, focused on delivering the best possible project outcomes for customers.

Specialising in Environment, Health & Safety and Sustainability, Delta-Simons provide support and advice within the property development, asset management, corporate and industrial markets. Operating from nine locations - Lincoln, Birmingham, Dublin, Durham, Leeds, London, Manchester, Norwich and Nottingham - we employ over 70 environmental professionals, bringing experience from across the private consultancy and public sector markets.

Delta-Simons is proud to be a founder member of the Inogen® Environmental Alliance, a global corporation providing multinational organisations with consistent, high quality and cost effective environmental, health, safety, energy and sustainability solutions. Inogen assists multinational clients by resolving liabilities from the past, addressing today's requirements and delivering solutions for the future. With more than 200 offices located on every continent, more than 6,430 staff worldwide, and projects completed in more than 120 countries, Inogen provides a single point of contact for diverse markets as Automotive, Chemical, Consumer Products & Retail, Financial, Food & Beverage, Healthcare, Insurance, Manufacturing, Non Profit Organizations, Oil & Gas, Real Estate, Services Firms, Technology and Transportation, among others.

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1.0 Introduction, Context and Purpose

Delta-Simons Environmental Consultants Limited (Delta-Simons) has been instructed by Robert Dougherty Consultancy Ltd on behalf of Mr G Franklin (the 'Client') to prepare a Remediation Method Statement (RMS) prior to the redevelopment as a new residential dwelling at the Pear Tree Farm, St James Road, Long Sutton (hereafter referred to as the 'Site').

The purpose of this document is to provide a formal statement for the proposed construction phase mitigation requirements to facilitate the development following the completion of an initial contaminated land assessment by Delta-Simons and subject to Planning Condition 9 of application H11-0245, dated 27th June 2018, which states:

Condition 9 *The development hereby permitted shall not be commenced until a scheme to deal with any contamination of land or pollution of controlled waters has been submitted to and approved in writing by the Local Planning Authority (LPA) and until the measures approved in that scheme have been implemented. The scheme shall include all of the following measures:*	
Part i	*A desk-top study carried out to identify and evaluate all potential sources of contamination and the impacts on land and/or controlled waters, relevant to the site. The desk-top study shall establish a 'conceptual site model' and identify all plausible pollutant linkages. Furthermore, the assessment shall set objectives for intrusive site investigation works/Quantitative Risk Assessment (or state if none required). Two full copies of the desk-top study and a nontechnical summary shall be submitted to the LPA without delay upon completion.*
Part ii	*If identified as being required following the completion of the desk-top study, a site investigation shall be carried out to fully and effectively characterise the nature and extent of any land contamination and/or pollution of controlled waters. It shall specifically include a risk assessment that adopts the Source-Pathway-Receptor principle, in order that any potential risks are adequately assessed taking into account the sites existing status and proposed new use.*
Part iii	*Thereafter, a written method statement detailing the remediation requirements for land contamination and/or pollution of controlled waters affecting the site shall be submitted to and approved in writing by the LPA, and all requirements shall be implemented and completed to the satisfaction of the LPA. No deviation shall be made from this scheme. If during redevelopment contamination not previously considered is identified, then the LPA shall be notified immediately and no further work shall be carried out until a method statement detailing a scheme for dealing with the suspect contamination has been submitted to and agreed in writing by the LPA.*
Part iv	*Two full copies of a full closure report shall be submitted to and approved in writing by the LPA. The report shall provide verification that the required works regarding contamination have been carried out in accordance with the approved Method Statement(s). Post-remediation sampling and monitoring results shall be included in the closure report to demonstrate that the required remediation has been fully met*

For information on the Site setting, and full details of intrusive investigations completed at the Site, this RMS should be read in conjunction with the previous reports by Delta Simons:

- Preliminary Environmental Risk Assessment, Pear Tree Farm, St James Road, Long Sutton, Delta Simons. Project No. 17-0252.02 dated March 2018; and

- Geo-Environmental Report – Geotechnical Category 1, Pear Tree Farm, St James Road, Long Sutton, Delta Simons. Project No. 17-0252.03 dated August 2018.

It is considered that the above reports are suitable to support the discharge of Planning Condition 9 Parts i and ii. This RMS is required to support Part iii. A subsequent Closure Report will be required near completion of the development to support Part iv.

2.0 Previous Report Review

Preliminary Environmental Risk Assessment

Delta-Simons undertook a Preliminary Risk Assessment, in March 2018 to provide a review of the environmental setting of the Site, including the current and historical use of the Site and surrounding area and a review of the geology, hydrogeology and hydrology. Considering the potential use of the Site for a residential dwelling with associated access, vehicle parking and landscaped areas. Four ASTs, potential ACMs, stockpiles of Made Ground materials and stored farm machinery were noted as potential sources of contamination during the walkover, which posed a low to moderate risk to future users and groundworkers. As such, an environmental ground investigation was recommended to ascertain the presence of Made Ground, contamination and ground gas.

Geo-Environmental Report, Delta Simons

Delta-Simons subsequently undertook a Geo-Environmental Report (CAT1), in July 2018 to provide information regarding geo-environmental ground conditions and obtain data on chemical and geotechnical parameters at the Site for use by the Client considering potential development planning, design and engineering for the construction of a single dwelling. The assessment included the drilling of six dynamic sampler boreholes (DS101 to DS106) to between 3.0 m bgl and 5.0 m bgl. Two boreholes were installed with a monitoring well for ground gas and groundwater monitoring.

Concentrations of naphthalene and TPH were detected above residential with plant uptake guidance criteria within soil samples from DS103 at 1.6 m bgl. The elevated concentrations are considered likely to be associated with the AST in close proximity to borehole DS103. In addition, asbestos was not identified within soils within the scheduled samples.

An elevated concentration of carbon dioxide was detected on one occasion over the three rounds of ground gas monitoring, with a maximum concentration of 5.4 % v.v. As such, the Site was classified as Amber 1 in accordance with NHBC guidance. As such, ground gas protection measures were deemed necessary, including a volatile vapour membrane given the identified sources of volatile vapours. The foundation recommendations incorporate a degree of inherent gas protection in accordance with BS 8485:2015.

3.0 Remediation Requirements and Methodology

Following Delta-Simons contamination assessments, the following construction phase remediation mitigation measures were considered appropriate:

- The existing ASTs will require appropriate decommissioning and removing safely from the Site. In addition, further testing of the soils around and beneath the existing tank will be required following their removal, testing for speciated poly aromatic hydrocarbons (sPAH) and speciated total petroleum hydrocarbons (sTPH);
- Additional, unidentified localised areas of contamination may exist at the Site and an appropriate ‘hotspot’ protocol should be in place for groundworkers to act upon should such contamination be identified during the construction process;
- Importation of clean certified topsoil to a depth of 600mm within areas of proposed garden areas, with subsequent validation of depth and imported material;
- Ground gas monitoring identified the presence of elevated carbon dioxide across the Site. As such, the Site was classified as an Amber 1 in line with NHBC guidance. Basic ground gas protection measures will be required in new dwellings under this scenario. Additionally, a volatile vapour membrane within plots in the vicinity of DS103 will be required;

- Groundworkers who are required to perform sub-surface work at the Site should be made aware of the known contaminants in soil and groundwater and the possibility of encountering additional localised levels of contamination. Therefore, good standards of personal hygiene should be observed and appropriate levels of personal protective equipment (PPE) and respiratory protective equipment (RPE) utilised where necessary; and
- Due to the identified contamination at the Site, upgraded water pipes are likely to be required following liaison with the local Water Authority.

4.0 Removal of Existing ASTs and Additional Soil Sampling

To date soil testing has not been undertaken from beneath the existing tank. As such, further testing is required of the shallow soils following the removal of the existing ASTs to confirm no significant risk to Human Health and groundwater exists.

Following appropriate tank decommissioning by the main contractor and removal off-Site, a Delta-Simons representative will attend the Site to collect samples from immediately beneath the concrete base.

All soil samples will be collected on a $5m^2$ grid from beneath the footprint of the tanks and submitted to a UKAS and MCCERTs accredited laboratory for speciated Poly Aromatic Hydrocarbons (sPAH) and speciated Total Petroleum Hydrocarbons (sTPH).

Any potential hydrocarbon contaminated material will be loaded directly in to wagons or temporarily stockpiled pending off-Site disposal on suitable impermeable plastic sheeting and covered with plastic sheeting to prevent run off or leaching of contamination, and to minimise the potential of dust generation. The excavation of contaminated soils shall not extend beyond the standing groundwater table. Validation sampling will be undertaken to demonstrate that contaminated materials have been removed successfully.

5.0 Protocol for Addressing Previously Unidentified 'Hotspots' of Contamination

As with any brownfield development, there is a possibility that unknown area(s) of soil or groundwater contamination, including asbestos, may be encountered during demolition and excavation works. Should an area of contamination beyond that anticipated from the investigations be identified by visual or olfactory means the following procedure shall be followed:

- Immediately stop all works in the area where contamination is suspected;
- Immediately inform the Site Project Manager who should then contact Delta-Simons;
- Delta-Simons will judge each occurrence on merit and should it be deemed necessary Delta-Simons shall attend Site to oversee the excavation of the 'hotspot' and the collection of validation samples;
- Any excavated material shall be isolated from all other material at the Site and, if deemed appropriate, be disposed of to a suitably licensed facility. Delta-Simons should be supplied with consignment notes for all off-Site disposal;
- The excavation should remain open until the validation has been completed; and
- Any identified hotspot would need to be appropriately classified prior to disposal to landfill (or transferred to a treatment centre). If material is identified as hazardous then the Site needs to be registered with the Environment Agency as a producer of hazardous waste. This can be done online and requires the company's registration code and a code that relates to the industry type.

Delta-Simons are to be in attendance during the floor slab removal works to undertake a watching brief and provide a record of any potential additional sources of contamination. *Please note; should contamination be encountered at variance to the characteristics in the investigation reports it should be reported to the planning authority as soon as possible for further consideration. Action taken would be recorded as part of the validation.*

6.0 Clean Cover/Suitable Soil

Where permanent hardstanding (buildings and pavements) are not present, cover systems will be required to be installed to break the pathway between future site users and existing Made Ground. It is understood that landscaped areas will be used as private gardens for the residential development.

The clean cover should comply with the details set out in the Verification Requirements for Cover Systems, a technical guidance for developers, landowners and consultants, published by Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG), a copy of this document is included in Appendix B. Although YALPAG doesn't cover the area of Spalding, it is considered to be good practice.

The chemical composition of the imported material should not exceed the Generic Assessment Criteria for a residential with plant uptake end-use.

It is, therefore, proposed that the following cover system should be adopted:

- A layer of clean soil, a minimum of 600 mm in residential gardens. Subject to the final development levels a reduced level dig may be required to facilitate the clean cover layer. Any material requiring off-Site disposal will need to be appropriately classified to determine its final treatment/ disposal destination;
- The material will be sourced by the Contractor and documentation submitted on its origin that is acceptable to South Holland District Council, the Main Contractor and to Delta-Simons. The documentation should as a minimum comprise information on the origin of the materials and chemical testing of suitable suite of contaminants. Additionally, delivery notes and photographic evidence of the proposed cover system (measured against a levelling staff) shall be obtained for incorporation within the Verification Report; and
- The material shall not exceed the criteria presented in Appendix C.

7.0 Ground Gas and Volatile Vapour Mitigation Measures

Following three rounds of ground gas monitoring at the Site, carbon dioxide has been recorded above the CIRIA C665 threshold value of 5% on one occasion in DS103. As such the Site has been classified as Amber 1 in accordance with NHBC guidance. Ground gas protection measures will be required under this scenario. However, given that sources of volatile vapours have been identified, any ground gas protection measures installed will also need to consider the inclusion of a specialist vapour resistant membrane, in order to mitigate the risk to human health.

The buildings, considered to be classified as Type A buildings (residential) in a Site with a Amber 1 ground gas regime characterisation, as such in accordance with NHBC guidance a suspended beam and block floor with 2,000 gauge lapped and tapped membrane would a be sufficient form of ground gas protection. However, given the identified volatile vapours within the vicinity of DS103, it is recommended that the ground gas protection measures are upgraded reflective of a CS2 Site. A Type A building in an Amber 1 Site requires a 3.5 minimum gas protection score (points) as per BS8485:2015 guidance. A cast in-situ suspended floor slab provides a score of 1.0, and a gas resistant membrane, satisfying all the criteria in Table 7 on BS8485:2015 - including being verified in accordance with CIRIA C735, provides an additional score of 2.0. An additional passive pressure relief pathway, beneath the suspended slab would provide a score of 0.5.

As such, these three coinciding gas protection measure designs provide the necessary minimum protection score required to mitigate the risks associated with the Amber 1 ground gas regime characterisation and satisfy BS8485:2015 guidance.

The above protection measures are for information purposes only and the final ground gas protection measures will need to be designed by a suitably experienced contractor and the Client. The details of the ground gas protection measures, including membrane type, jointing details and design drawings should be passed to Delta-Simons for agreement and approval with South Holland District Council.

It is recommended that the selected ground gas membrane is confirmed as suitable by the local scientific officer prior to installation. Photographic evidence of the vapour gas membrane's installation should be provided for submission in the verification report. A verification report should be provided by an appropriately accredited gas verification contractor.

8.0 Mitigation of Risks to Groundworkers during Development

Contamination has been identified at the Site and as with any Brownfield development there is the potential for further previously unidentified hotspots of contamination to be present at the Site.

As such, it is recommended that the Contractor provides appropriate inductions to all groundworkers who are required to perform sub-surface work at the Site in order to ensure they are made aware of the possibility of encountering contamination at the Site. In addition, good standards of personal hygiene should be observed and appropriate levels of PPE and RPE, where applicable, provided and utilised in order to mitigate the potential for direct contact.

9.0 Upgrading of Potable Water Supply Pipes

Given the presence of hydrocarbons and volatile compounds within underlying soils, potable water pipes may require upgrading with 'Protectaline' water pipe, or similar. Confirmation should be sought from the Water Authority, and evidence of any upgraded pipework collected by the Contractor for inclusion within the verification report.

10.0 Validation Reporting

The validation report should comprise the following items of verification that the Remediation Method Statement has been complied with:

1. Results of the additional testing beneath and around the area below the existing ASTs following their removal;
2. Details and verification of any Hotspots encountered (Main Contractor and Delta-Simons);
3. Photographic evidence of the installation and thickness of the topsoil used in landscaped areas (To be supplied by Main Contractor);
4. Chemical test data and frequency for imported topsoil/subsoil (To be supplied by Main Contractor) in accordance with the YALPAG guidance document;
5. Details of waste disposal from the Site including waste transfer documentation and details of the receiving treatment/landfill facility;
6. Verification of installation of appropriate gas protection measures (Ground Gas Verification Contractor);
7. Upgraded water supply pipe delivery tickets, if required. (Client's Contractor); and
8. Brief report containing the above. (Delta-Simons).

Appendix A - Limitations

Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

This Report was prepared by Delta-Simons for the sole and exclusive use of the Client and for the specific purpose for which Delta-Simons was instructed. Nothing contained in this Report shall be construed to give any rights or benefits to anyone other than the Client and Delta-Simons, and all duties and responsibilities undertaken are for the sole and exclusive benefit of the Client and not for the benefit of any other party. In particular, Delta-Simons does not intend, without its written consent, for this Report to be disseminated to anyone other than the Client or to be used or relied upon by anyone other than the Client. Use of the Report by any other person is unauthorised and such use is at the sole risk of the user. Anyone using or relying upon this Report, other than the Client, agrees by virtue of its use to indemnify and hold harmless Delta-Simons from and against all claims, losses and damages (of whatsoever nature and howsoever or whensoever arising), arising out of or resulting from the performance of the work by the Consultant.

Appendix B - YALPAG Verification Requirements for Cover Systems











VERIFICATION REQUIREMENTS FOR COVER SYSTEMS

Technical Guidance for Developers, Landowners and Consultants

Yorkshire and Lincolnshire Pollution Advisory Group

Version 3.4 – November 2017

The purpose of this guidance is to promote consistency and good practice for development on land affected by contamination. The local authorities in Yorkshire, Lincolnshire and the North East of England who have adopted this guidance are shown below:













































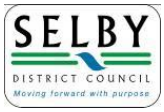




































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Disclaimer

This guidance is intended to serve as an informative and helpful source of advice. It is intended to review this guidance annually, but readers must note that legislation, guidance and practical methods are inevitably subject to change and therefore should be aware of current UK policy and best practice. This note should be read in conjunction with prevailing legislation and guidance, as amended, whether mentioned here or not. Where legislation and documents are summarised this is for general advice and convenience, and must not be relied upon as a comprehensive or authoritative interpretation. Ultimately it is the responsibility of the person/company involved in the verification of land contamination to apply up-to-date working practices and requirements.

Acknowledgments

The author, Wakefield Council [David Jackson], would like to acknowledge the assistance provided by the following organisations: City of York Council, City of Lincoln Council, Leeds City Council and City of Sheffield Council. The author would also like to acknowledge Liverpool City Council's Contaminated Land Team, Coopers Consulting Engineers for allowing us to use their guidance document and photographs and WSP Environmental Ltd for also donating photographs.

Consultation

39 Local Authorities and 6 Environmental Consultants were consulted over a four week period in 2010 during the production of the initial guidance. At that time, consultation comments were considered by the review panel and a number of revisions were made to the guidance to reflect these comments. Given that no major changes have subsequently taken place, only Local Authorities were consulted during the production of this version [3.1] of the guidance.

Introduction

This guidance has been produced to help developers ensure that they can demonstrate that material brought onto a development site for gardens or areas of soft landscaping are suitable for use and do not present harm to people, the environment and/or property. It is intended to improve the quality of reports submitted to Local Authorities on this matter and to give contractors/consultants a point of reference to obtain approval for such work from their client. This guidance does not cover the geotechnical suitability of soils or material or chemical suitability that does not affect human health e.g. sulphates.

The verification of cover systems should be an integral part of the remediation project and agreed between developers and regulators at an early stage in the project.

There are some UK guidelines regarding verification, for example CLR 11[1] and the document on verification of remediation[2]. This guidance note should be considered as supplementary advice in conjunction with these documents.

This guidance relates to the remediation of land contamination by using cover systems; however, the verification of the quality of imported material is equally important in other situations, such as raising levels for flood prevention or general landscaping works. This guidance could also be used in such instances.

The Process of Verification

Implementation plans for remedial works should always be site specific. Where a cover system and potentially, excavation, is the main remedial method or a component of an overall site remediation, specific goals will need to be set that are linked directly to the risk management strategy for the site in question.

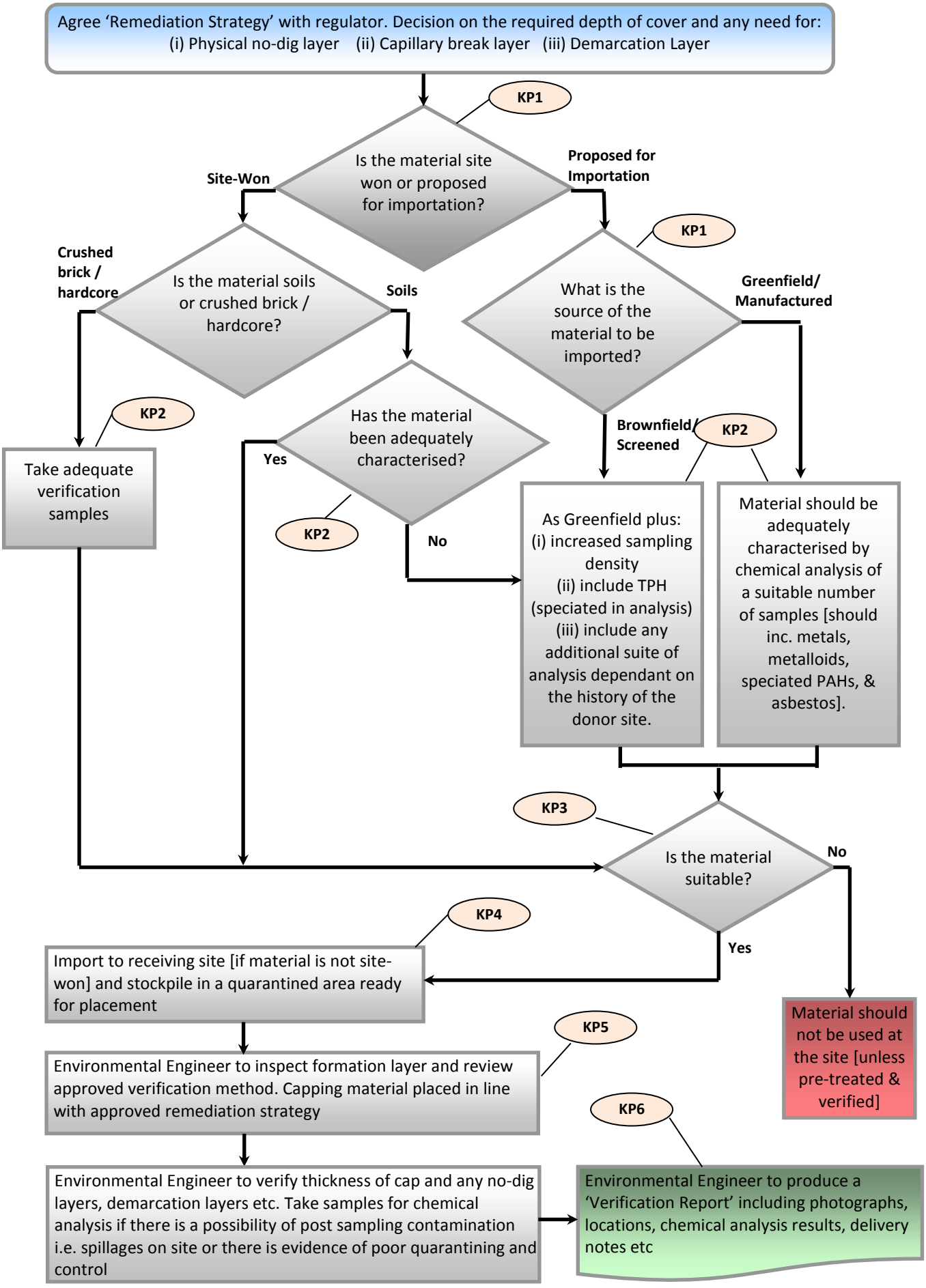
For cover and containment systems, verification will normally depend upon the provision of defensible measurements, observations and records. Critical factors to be considered are:

- What should be measured?
- When should they be measured?
- Where measurements need to be taken, what is the appropriate monitoring regime i.e. number and frequency of samples?
- Statistical constraints on sampling.

1 "Contaminated Land Report 11 - Model Procedures for the Management of Contaminated Land". Environment Agency, September 2004.

2 "Verification of Remediation of Contaminated Land. Environment Agency, 2010 [draft report].

Overview Flowchart



Key Points

KP1 **Source of Material**	Material can be sourced from site won material i.e. crushed brick /hardcore or site-won soils from existing open or landscaped areas. In the interest of sustainability, Local Authorities promote the use of such site-won material providing that they are suitable for the intended end use of the site. Alternatively, material can be sourced from other developments and commercial companies. Dependent on the source of the material it can be classified as either from a 'Greenfield/Manufactured' or 'Brownfield/Screened' source. Broadly speaking material can be classified as follows: **Greenfield** - if it can be demonstrated that it has not been developed and that no past contaminative uses have occurred at the site. **Manufactured** – from a commercial company who manufacture material by mixing or blending mineral soils (subsoil or sand) with an organic amendment (compost). **Brownfield** – material from a donor site that has previously been developed **Screened** – material from a company who deal with skip/demolition waste which is screened for unsuitable material i.e. bricks, wood, plastic etc.
KP2 **Characterisation of Material**	It is essential that material is inert and suitable for its intended use. Evidence of the source of the material should be provided to the Local Authority. What is required is a defensible method to ensure the verification proposals are site specific and that the level of sampling reflects the need to ensure that imported material are suitable for their intended use. **When Should this be Done?** Sampling of material should be undertaken as early as possible i.e. prior to placement [for site won material] and prior to importation [for imported material]. This is to avoid the costly exercise of re-excavating unsuitable material and the possibility of cross contamination. Where the assessor has confidence that the material is of sufficient quality (i.e. tested by supplier, used previously) it is acceptable to test the material on site but prior to placement. Although, if it is deemed unsuitable it would have to be either removed off site or pre-treated at the cost and time of the developer. **What about Certificates from Commercial Suppliers?** Where the material is provided by a commercial company, certificates or other industry Quality Protocol compliance i.e. WRAP, will normally be accepted. This is on the proviso that it (i) relates to

	the actual material being imported to the site and the type and amount of analysis is in line with what is prescribed in Appendix 1a and (ii) the certificates are less than two months old. Extreme caution should be given to importing material that has been recycled from demolition or skip waste as they could be easily be contaminated e.g. asbestos containing materials. [Please refer to questions you should be asking your supplier in Appendix 1b and include the responses in your report] **British Standard** Imported topsoils should be as specified in BS 3882:2007 as 'suitable for their intended purpose'. BS3882:2007 relates to nutrient content of topsoil and phytotoxic contamination and does not consider contaminants that pose a risk specifically to human health. Soils should be tested for contaminants that are considered to pose a risk to human health in addition to BS3882:2007 to ensure that they are suitable for their intended use. **Initial Screening** A visual / olfactory inspection of the material should be carried out by an Environmental Engineer to ensure that: • it is a suitable growing medium • it is free from obvious contamination i.e. staining / free product etc • it has not come from areas where Japanese Knotweed or other invasive or injurious plants, as specified by the Environment Agency, are suspected to have been growing. • it is not odorous (could be considered a statutory nuisance) • it is free from unsuitable material i.e. bricks, brick ties, timber and glass etc) • there are no visible signs of asbestos containing material (ACM's) **Testing Schedule & Number of Samples** Chemical testing will normally be required on any materials that are to be used as cover material, even where this includes first generation quarried material. This should be carried out by a suitably qualified Environmental Engineer. Please refer to the Characterisation of Material Matrix in Appendix 1a which details the number of samples to be taken; the testing schedule to be utilised dependant on the nature and source of the material and the acceptance criteria to be used.
KP3 **Suitability of Material**	Based on the characterisation of material above, the material should be either deemed suitable or unsuitable. Obviously unsuitable material should not be used [unless it is treated to reduce levels of contaminants below agreed target levels i.e. bioremediation – this would have to be agreed and included within the Remediation Strategy] and an alternative source of material should be sought by the developer. If the material is considered suitable it can be

	imported [if not site won] and stockpiled in a suitably quarantined area [refer to KP4].
KP4 **Stockpiling & Quarantining of Material**	It is essential that the 'suitable' material is either placed in its intended area straight away i.e. soft / landscaped areas or stockpiled in a suitable quarantine area to prevent on-site contamination. In the event that an assessor finds material has been stored in an unsuitable area, samples should be taken to confirm that no cross contamination has occurred [including a visual/olfactory check of the material]. The material should then be suitably quarantined or placed at its intended location immediately.
KP5 **Verification of Required Depth**	In line with the agreed 'Remediation Strategy', it is important to establish that the required depth has been achieved and is consistent across the site. There are two main ways to achieve this: Depth testing in situ – small trial pit excavated to allow measurement of its depth by tape measure or measuring staff. Topographical surveys – accurate survey of the base and final formation layer height to establish the depth of cover. **Specific Local Authority Policy** Please check with the local Contaminated Land Officer to establish: • which type of method for testing depth is accepted; and • the number of verification areas per property, plot, landscaped area or garden area [some Local Authorities recommend at least 2 per plot] **Important Note:** Where demarcation, physical no-dig and capillary break layers exist they should be verified for their thickness and presence during the time of their installation. Details of the demarcation layer should be agreed with the Contaminated Land Officer prior to placement. This will include the design, type and strength of the geotextile separator or visual warning membrane. The verification of depth and confirmation of such layers should be carried out by a suitably qualified environmental engineer.
KP6 **Reporting**	The purpose of verification documentation is to provide transparent reasoning why the remediation was required, a methodology about how it was to be undertaken and proof that the specified works have been undertaken and to provide confirmation that the site is 'suitable for its intended use'. The document is utilised not only to satisfy conditions of planning permissions but also is to be kept on record by the Local Authority should queries be raised during the lifetime of the development and to confirm to future purchasers that the site is suitable for use. Therefore, the presence of good quality photographs is essential to

prove beyond doubt that the remediation has been done as specified both by method and position.

It is also essential that other supporting documentation is included within a report e.g. laboratory analysis results, delivery tickets for material, certificates for imported material, trial pit logs etc. A checklist has been included in Appendix 2 to give an idea on what information should be recorded.

The reporting should be carried out by a suitably qualified Environmental Engineer.

To include details of any measures required to maintain the cover system integrity in the future e.g. successive construction phases (management plans) and longer term (restrictive covenants on title deeds).

Photographic Evidence for Validating the Depth of Cover

The Local Authority ideally would recommend the following programme of photographs to be taken of the placement of inert cover:

- Photographs of any stockpiles and quarantine areas
- Proof that the depth of inert cover has been installed
- Proof of the quality of the material to be used as inert cover
- Proof there is a geotextile separator and visual warning membranes if used between the made ground and suitable for use soils.
- Proof of the method of placement and different layers if appropriate
- Proof of the completed project
- Inclusion of geographic background features which will aid locating the photograph
- Inclusion of site identification boards within the photos which show the date, position taken i.e. corner of plot 3 and the site name.
- Inclusion of photographs of site stockpiles and quarantine areas.

The photographs have to prove beyond doubt that the images have been taken from the specific area stated.

Refer to Appendix 3 for examples of good photographic evidence.

Appendix 1a – Sampling & Testing Matrix

Type	Number of Samples	Testing Schedule	Assessment Criteria
Virgin Quarried Material	1 or 2 depending on the type of stone utilised, to confirm the inert nature of the material.	Standard metals/metalloids (should include as a minimum As, Cd, Cr, CrVI, Cu, Hg, Ni, Pb, Se, Zn)	This needs to be agreed with the Local Authority. The Assessment criteria needs to be UK based, e.g. LQM S4UL's, Defra C4SL's or other similarly derived GAC's.
Crushed Hardcore, Stone, Brick	Minimum 1 per 1000m^3	Standard metals/metalloids (As above) PAH (16 USEPA speciation) Asbestos	
Greenfield/ Manufactured Soils	Minimum 3 or 1 per 250m^3 (whichever is greater)	Standard metals/metalloids (As above) PAH (16 USEPA speciation) Asbestos	
Brownfield/ Screened Soils	Minimum 6 or 1 per 100m^3 (whichever is greater)	Standard metals/ metalloids (As above) PAH (16 USEPA speciation) TPH (CWG banded) Asbestos Any additional analysis dependant on the history of the donor site.	

Appendix 1b – Questions to Ask Your Soil Supplier Relating to Soil Quality

- What is the source of the material (refer to KP1)?
- Will all of the material be coming from the same source?
- Are you satisfied that the material is a suitable growing medium for the proposed end use?
- Has the supplier used an appropriate sampling protocol to ensure a representative sample is analysed? What volume of soil is represented by the analysis and does it comply with Appendix 1a?
- Does the testing include analysis of contaminants identified in Appendix 1a?
- Does the laboratory conducting the analysis have UKAS and MCERTS accreditation for the tests they are carrying out?
- Can I have a copy of the whole analysts report and does it include an interpretive section?
- Will the provided certificate be dated within the last 2 months?

Appendix 2 – Checklist for Verification Reports

Example only. Not to be considered as typical minimum requirements. Additional information should be included for non cover systems aspects of the remediation i.e. gas protection measures etc.

Site Details	
Site Name / location	
Developer name	
Development use	
Plot No / description of landscaped area (inc plan of inspection areas)	
National Grid Reference	
Inspection visit date	
Supporting Evidence	
Description of remediation (as per agreed Remediation Method Statement including depths / thickness checks, topographical readings)	
Material tracking information (including way tickets etc)	
Name of groundwork's remediation contractor	
Name of supervising environmental consultant	
Site Specific chemical analysis results	
Verification Photographs (inc. remarks)	
Recommendations	
Pass / fail	
If material fail, how will this be managed i.e. removed, treated	
Detail any further remedial works and / or inspection	
Signed off	

Failure to provide any of the above information may prevent planning conditions from being discharged.

Appendix 3 – Examples of Good Quality Photographs



Photograph 1: Depth check of inert cover within area of public open space. Physical break layer and topsoil visible.



Photograph 2: Depth check of inert cover with Site & Location Information Board.







Photographs 3 & 4: Depth check of inert cover within areas of front gardens.



Photographs 5 and 6: Depth check of inert cover within rear gardens. Taut string line spans across excavation.



Photograph 7 shows the spatial location of the verification pit.



Photograph 8: Excavation within public open space and verification pit showing the presence of a remediation break layer at the base, a crushed sandstone inert fill overlain by topsoil.





Photographs 9 and 10: Inert crushed sandstone being delivered with remediation break layer visible in Photograph 10. The spatial area of the remediation can be observed from these photographs (old terrace housing in Photograph 9 and traffic lights in photograph 10).





Photographs 11 and 12 show the remediation of the rear garden, with a significant depth (1.0m) of inert cover. Remediation break layer visible at the base of the excavation. Photograph 11 has been stitched to form a panoramic photograph and

Appendix C - Generic Assessment Criteria for Imported Materials

The following Generic Assessment Criteria shall apply as absolute limits for all soils imported for re-use as clean cover **regardless of the end use of the Site**.

The criteria selected are based on Residential with Plant Uptake land use scenario on the basis that imported clean cover soils should be 'clean' and not result in an increase in contaminant loading. It may be possible, in some circumstances, to agree alternative, higher criteria with the appropriate regulatory body, however, this is outside of the scope of this assessment.

Soils shall be tested for a suite of contaminants appropriate to the source land use but as a minimum for the contaminants stated below unless otherwise stated within this strategy. The below criteria assume a minimum of 1% Soil Organic Matter.

In addition to meeting the criteria below, imported materials shall be free from deleterious inclusions and shall be free from invasive weeds (Japanese Knotweed).

Any testing for asbestos must be from a UKAS accredited laboratory and the only acceptable criteria is 'Not Detected'. Any detected asbestos, even is reports as <0.001% is not acceptable. Asbestos containing soils must not be used for clean cover materials.

Criteria for Imported Materials			
Compound	**GAC**	**Source**	**Comment**
Arsenic	37	C4SL	
Cadmium	11	LQM	
Chromium (III)	910	LQM	
Chromium (VI)	6	LQM	
Copper	2400	LQM	
Lead	200	C4SL	
Mercury (inorganic)	40	LQM	
Nickel	130	LQM	
Selenium	250	LQM	
Zinc	3700	LQM	
Acenaphthene	210	LQM	
Acenaphthylene	170	LQM	
Anthracene	2400	LQM	
Benzo[a]anthracene	7.2	LQM	
Benzo[a]pyrene	2.2	LQM	
Benzo[b]fluoranthene	2.6	LQM	
Benzo[ghi]perylene	320	LQM	
Benzo[k]fluoranthene	77	LQM	
Chrysene	15	LQM	
Dibenz[ah]anthracene	0.24	LQM	

Criteria for Imported Materials			
Compound	**GAC**	**Source**	**Comment**
Fluoranthene	280	LQM	
Fluorene	170	LQM	
Indeno[123-cd]pyrene	27	LQM	
Naphthalene	2.3	LQM	
Phenanthrene	95	LQM	
Pyrene	620	LQM	
Benzene	0.2	C4SL	
Toluene	130	LQM	
Ethylbenzene	47	LQM	
Xylene – m/p	56	LQM	
Xylene - o	60	LQM	
Total Petroleum Hydrocarbons (TPH)	500		Professional judgement.
Aliphatic EC5-EC6	42	LQM	
Aliphatic >EC6-EC8	100	LQM	
Aliphatic >EC8-EC10	27	LQM	
Aliphatic >EC10-EC12	130	LQM	
Aliphatic >EC12-EC16	500	LQM	Capped at 500 - professional judgement
Aromatic >EC5-EC7	70	LQM	
Aromatic >EC7-EC8	130	LQM	
Aromatic >EC8-EC10	34	LQM	
Aromatic >EC10-EC12	74	LQM	
Aromatic >EC12-EC16	140	LQM	
Aromatic >EC16-EC21	260	LQM	
Aromatic >EC21-EC35	500	LQM	Capped at 500 - professional judgement
Asbestos	Not Detected		

The respective sources are:

- Soil Guidance Values (**SGV**) published by the EA;
- Category 4 Screening Levels (**C4SL**s) published by DEFRA;
- The 2014 Land Quality Management (**LQM**) / Chartered Institute of Environmental Health (CIEH) Suitable for Use Levels for Human Health Risk Assessment (S4ULs);
- The guidance values produced by the Environmental Industries Commission (**EIC**), the Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Application in Real Environments (CL:AIRE) in December 2009; and
- In house Generic Screening Values (**DS-GAC**s) derived by Delta-Simons.

Appendix D - BS8485:2015 Extracts

The following sections have been extracted from BS8485:2015 (© British Standards Institute), they are provided for information only and reference should be made to the full document in the preparation of designs for gas protection measures.

Table 3 Building types

	Type A	Type B	Type C	Type D
Ownership	Private	Private or commercial/ public, possible multiple	Commercial/ public	Commercial/ industrial
Control (change of use, structural alterations, ventilation)	None	Some but not all	Full	Full
Room sizes	Small	Small / medium	Small to Large	Large industrial / retail park style

Type A building: private ownership with no building management controls on alterations to the internal structure, the use of rooms, the ventilation of rooms or the structural fabric of the building. Some small rooms present. Probably conventional building construction (rather than civil engineering). Examples include private housing and some retail premises.

Type B building: private or commercial property with central building management control of any alterations to the building or its uses but limited or no central building management control of the maintenance of the building, including the gas protection measures. Multiple occupancy. Small to medium size rooms with passive ventilation of rooms and other internal spaces throughout ground floor and basement areas. May be conventional building or civil engineering construction. Examples include managed apartments, multiple occupancy offices, some retail premises and parts of some public buildings (such as schools, hospitals, leisure centres) and parts of hotels.

Type C building: commercial building with central building management control of any alterations to the building or its uses and central building management control of the maintenance of the building, including the gas protection measures. Single occupancy of ground floor and basement areas. Small to large size rooms with active ventilation or good passive ventilation of all rooms and other internal spaces throughout ground floor and basement areas. Probably civil engineering construction. Examples include offices, some retail premises, and parts of some public buildings (such as schools, hospitals, leisure centres and parts of hotels).

Type D building: industrial style building having large volume internal space(s) that are well ventilated. Corporate ownership with building management controls on alterations to the ground floor and basement areas of the building and on maintenance of ground gas protective measures. Probably civil engineering construction. Examples are retail park sales buildings, factory shop floor areas, warehouses. (Small rooms within these style buildings should be separately categorized as Type B or Type C).

NOTE 2 Type A buildings are those where the risk of failure of the gas protection measures is likely to be most significant to the safety of the occupants and Type D buildings are those where this same risk is likely to be least significant.

From the design CS and the type of building (A, B, C or D) the minimum level of gas protection (score) in the range 0 to 7.5 should be determined in accordance with Table 4.

Table 4 Gas protection score by CS and type of building

Characteristic Situation	Minimum gas protection score (points)			
	High Risk		Medium Risk	Low Risk
	Type A building	Type B building	Type C building	Type D building
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 (A)	5.5 (A)	4.5	3.5
5	-- (B)	6.5 (A)	5.5	4.5
6	-- (B)	-- (B)	7.5	6.5

(A) Residential buildings should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

(B) The gas hazard is too high for this empirical method to be used to define the gas protection measures.

NOTE 3 The NHBC has published guidance [8] for use on residential developments, which utilizes an alternative classification ("traffic light") system. This guidance typically applies to Type A buildings utilizing beam and block floor constructions with clear void ventilation. The design choice variables are limited to decisions relating to the membrane specification and verification recommendations (see Table 7). Designers utilizing this system would therefore need to refer to the NHBC [8] to assess compliance for specific recommendations.

When the minimum gas protection score has been determined for the building as a whole, or for each part of the building, then a combination of two or more of the following three types of protection measures should be used to achieve that score:

- the structural barrier of the floor slab, or of the basement slab and walls if a basement is present;
- ventilation measures; and
- gas resistant membrane.

NOTE 4 The method of selecting the combination of these types of protection measures for a particular building is given in 7.2.

Once the types of protection measures have been decided, the detailed design and specification of the measures should be undertaken (see 7.3).

NOTE 5 In some cases, the designer might be of the opinion at this stage that the extent of the protection measures is potentially more than is needed, because of limitations in the scope of the site investigation [these limitations having led to a more conservative GSV and CS than is likely from the conceptual site model (see 6.3.7.2 and 6.3.7.3)]. In this case, further site investigation could be carried out to check the GSV. Only if there is sufficient time to carry out additional site investigation and gas monitoring would this step be useful.

The detailed design and specification of the protection measures should be recorded in a design report (see 8.3).

7.2 Selection of appropriate protection measures

7.2.1 General

Having determined the minimum gas protection score for the building, or each different part of the building, from Table 4, an element or combination of elements should be chosen from Table 5, Table 6, and Table 7 with a combined score achieving the minimum recommended gas protection. No more than one element of each type (i.e. from each table) should be combined to achieve the recommended gas protection score.

The gas protection system should consist of at least two different elements; for example, a barrier element with either a membrane or a ventilation or dilution element (or both). The elements work independently and collaboratively, and a single element should not be used because there would be no redundancy to allow for defects in the component.

NOTE For low sensitivity buildings on low risk sites it might sometimes be possible to rely solely on a membrane or slab; for example, where internal ventilation provides secondary protection.

The selection process should be transparent in that all interested parties can see the approach taken, understand the various steps and decisions made, and

be confident that a robust risk-assessed solution has been designed and installed commensurate with the construction and site constraints.

Where the CS is CS4 or higher, the site should have a comprehensive assessment done to support the adequacy of the proposed protection measures. Reliance should not be placed solely on Table 5, Table 6 and Table 7.

7.2.2 Structural barrier

The first step in the methodology should be the assessment of the gas protection score of the structural barrier, since the construction of the floor slab has usually already been decided at the time the gas protection measures are being designed.

NOTE The floor slab design, and any basement design, are usually determined by geotechnical and constructability factors.

The common types of floor slab and substructure design and their relative performance as a structural barrier to ground gas ingress are described in Annex A. The structural barrier score should be assigned in accordance with Table 5; further guidance is given in Annex A.

Table 5 Gas protection scores for the structural barrier

Floor and Substructure (see Annex A)	Score [A]
Precast suspended segmental subfloor (i.e. beam and block)	0
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5
Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations	1 or 1.5 [B]
Basement floor and walls conforming to BS 8102:2009, Grade 2 waterproofing [C]	2
Basement floor and walls conforming to BS 8102:2009, Grade 3 waterproofing [C]	2.5

[A] The scores are conditional on breaches of floor slabs, etc., being effectively sealed.

[B] To achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations cast in (see A.2.2.2).

[C] The score is conditional on the waterproofing not being based on the use of a geosynthetic clay liner waterproofing product (see C.3, Note 4).

Table 6 Gas protection scores for ventilation protection measures

Protection Element/System	Score	Comments
(a) Pressure relief pathway (usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building)	0.5	Whenever possible a pressure relief pathway (as a minimum) should be installed in all gas protection measures systems. If the layer has a low permeability and/or is not terminated in a venting trench (or similar), then the score is zero.
(b) Passive sub floor dispersal layer: Very good performance: Good performance: Media used to provide the dispersal layer are: ▲ Clear void ▲ Polystyrene void former blanket ▲ Geocomposite void former blanket ▲ No-fines gravel layer with gas drains ▲ No-fines gravel layer	 2.5 1.5	Performance criteria for methane and carbon dioxide are shown in Figure B.6 and Figure B.7, respectively. The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and the thickness of the layer. The selected score should be assigned taking into account the recommendations in Annex B. Passive ventilation should be designed to meet at least "good performance", see Annex B.
(c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. There should be robust management systems in place to ensure the continued maintenance of the system, including pumps and vents. Active ventilation should always be designed to meet at least "good performance", as described in Annex B.
(d) Active positive pressurization by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. The score assigned should be based on the efficient "coverage" of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least "good performance".
(e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park)	4	Assumes that the car park is vented to deal with car exhaust fumes, designed to Buildings Regulations 2000, Approved Document F [9].

7.2.4 Membranes

Gas resistant membranes should be:

a) sufficiently impervious to methane and carbon dioxide;

b) capable after installation of providing a complete barrier to the entry of the relevant gas.

c) sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;

d) sufficiently strong to withstand in service stresses (e.g. due to ground settlement if placed below a floor slab);

e) sufficiently strong to withstand the installation process and following construction activities until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, and dropping tools); and

f) chemically resistant to degradation by other contaminants that might be present.

NOTE 1 A methane gas transmission rate of <40.0 ml/day/m2/atm (average) for sheet and joints (tested in accordance with the manometric method in BS ISO 15105-1) is usually considered sufficient.

NOTE 2 Guidance on the relevant properties relating to a), c) and e) is provided in CIRIA C748 [10].

There are many gas resistant membrane types available and membrane choice should be made according to the resistance of the material to the passage of the challenge gas and the resistance to site damage during and after installation in the designed position. The designer specifying the membrane should consider the combination of a particular membrane's properties to assess whether it is suitable in any given situation. The specified membrane and the reasons for its selection should be described in the design stage report (see 8.1).

NOTE 3 Advice on membrane selection is given in Annex C.

NOTE 4 The installation and subsequent protection of the membrane are key factors in its performance. A poorly installed membrane cannot perform, however well detailed and irrespective of the performance of the material. Historically, reference has been made to verification and integrity testing without having any referenced documents against which to judge. The verification process is now described in CIRIA C735 [N1] and as such, confidence in the installed solution can be measured. The process removes the uncertainty of unqualified or inexperienced installation operatives by requiring a verification plan to be drawn up prior to the installation, with frequency and type of verification being dependent upon the qualifications of the installation operatives, site risk and design criteria.

A verification plan for the installation of the membrane should be part of the detailed design (see 8.3.2).

NOTE 5 Current guidance on verification recommendations takes into account the risk of the overall design and confidence in its installation, and sets a frequency and level of verification appropriate.

A gas protection score (see Table 4) should only be assigned to a membrane which is formed of a material with suitably low gas permeability and which has been installed so it completely seals the foundation (including effective seals around all penetrations) and does not sustain damage from in-service stresses. The criteria which should be met to assign a gas protection score of two points is set out in Table 7.

Table 7 Gas protection score for the gas resistant membrane

Protection element/system	Score	Comments
Gas resistant membrane meeting all of the following criteria: ▲ sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method); ▲ sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; ▲ sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab); ▲ sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc); ▲ capable, after installation, of providing a complete barrier to the entry of the relevant gas; and ▲ verified in accordance with CIRIA C735 [N1]	2	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. For example, a minimum 0.4 mm thickness (equivalent to 370 g/m2 for polyethelene) reinforced membrane (virgin polymer) meets the performance criteria in Table 7 (see C.3). If a membrane is installed that does not meet all the criteria in column 1 then the score is zero.