



Geotechnical &  
Environmental  
Consultants

Harrington Drive

Crowland

## Ground Gas Verification Plan

For

Ashwood Homes



THE RADON  
COUNCIL



SSIP



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## Contents

|                                              | Page No |
|----------------------------------------------|---------|
| 1.0 INTRODUCTION                             | 1       |
| 2.0 SITE SPECIFIC GROUND GAS RISK ASSESSMENT | 3       |
| 3.0 GAS PROTECTION SYSTEM                    | 4       |
| 4.0 RISK BASED APPROACH TO VERIFICATION      | 7       |
| 5.0 VERIFICATION PROCESS                     | 8       |
| 6.0 VALIDATION REPORT PREPARATION            | 12      |

## Appendices

- I Ashwood Homes Standard Details Drawing
- II Membrane Technical Data & BBA Certificate
- III Membrane Verification Proforma
- IV Conditions & Limitations

| Project No: D41153 |                                                                                     | Date: 21 <sup>st</sup> November 2023                                                 |                                                                                       |
|--------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Issue/revision     | Prepared by                                                                         | Checked By                                                                           | Approved By                                                                           |
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|                    |  |  |  |
| Comments           |                                                                                     |                                                                                      |                                                                                       |

## 1.0 INTRODUCTION

### 1.1 Introduction

GeoDyne Ltd has been instructed by the Client, Ashwood Homes to prepare a Ground Gas Verification Plan relating to a development site at Harrington Drive, Crowland.

### 1.2 Project Understanding

It is understood that it is proposed to redevelop the site with a total of 52No. houses with associated access roads, driveways, gardens and garages.

The proposed site layout is shown on the standard detail drawing included in Appendix I (Ashwood Homes drawing '*Proposed Residential Development at Harrington Drive, Crowland – Gas Membrane Details*', dated November 2023, Drawing No. 132-GMD-01)

### 1.3 Previous Works

Previous exploratory investigation works have been undertaken at the site by others, these works are detailed in the following report:

- Ground Engineering Ltd. report entitled '*Site Investigation Report – Land off Harrington Drive, Crowland, Lincolnshire*', produced for Seagate Homes, Ref. C15350, dated June 2021.

It is assumed that the Client benefits from/will benefit from formal reliance on the above documents.

The above report identified the possibility for the generation of potentially hazardous ground gases from on-site sources associated with Made Ground or naturally deposited organic soils and noted that '*If additional boreholes are to be undertaken, it would provide the opportunity to install gas monitoring standpipes to check on the gas regime at the site*'.

Following our review of the above report, further works comprising a series of boreholes were undertaken by GeoDyne to assist with foundation design for the proposed dwellings. As part of these works, a programme of ground gas monitoring was undertaken to assess the ground gas regime at the site. The findings of the ground gas monitoring programme are detailed in the following document:

- GeoDyne letter report to Ashwood Homes '*Ground Gas Report – Harrington Drive, Crowland*', Ref: D41153/PK dated 17<sup>th</sup> December 2021.

We would recommend that the above documents are read in conjunction with this report.

### 1.4 Details of Verification Plan

This Ground Gas Verification Plan (GGVP) is intended to act as a standalone document which draws together the information relating to the ground gas risk assessment and ground gas protection system design proposals (prepared by others) for the development. This GGVP has been prepared based on the requirements of BS8485:2015 +A1:2019 '*Code of practice for the design of protection measures for methane and carbon dioxide ground gases for new buildings*' and CIRIA guidance C735 '*Good Practice on the testing and verification of protection systems for buildings against hazardous ground gases*' (2014). These documents are hereafter referred to as BS8485 and C735, respectively.

We would note that the responsibility for the design of the ground gas protection system rests with others. This GGVP prepared by GeoDyne Ltd serves to summarise the ground gas protection system designed by others and provides a methodology for the verification of installed ground gas protection measures.

## **1.5 Limitations**

Where comments in this report are made based on information obtained from third-parties, GeoDyne Ltd assumes that all third-party information is true and correct. No independent action has been undertaken to validate the findings of third-party information unless specifically stated.

This report has been prepared in accordance with our understanding of current good practice. However changes to good practice, guidance or legislation may necessitate revision of this report after the date of issue.

This report relates solely to the verification of the ground gas protection system and does not address issues with respect to remediation and validation of gardens/soft landscaped areas or any pre-construction remediation at the site. For a detailed review of the sites setting and recommendations relating to all other matters, reference should be made to the reports referenced in Section 1.3.

GeoDyne Ltd has prepared this report for the sole use and reliance of the Client, Ashwood Homes, in accordance with our Standard Conditions and Limitations (included in Appendix V). This report may not be used or relied upon by any unauthorised third-party without the explicit written agreement of GeoDyne Ltd.

## 2.0 SITE SPECIFIC GROUND GAS RISK ASSESSMENT

### 2.1 Summary of Ground Gas Monitoring

As part of the GeoDyne works, a total of 3No. ground gas monitoring points were installed across the site to facilitate a programme of ground gas monitoring comprising 6No. monitoring visits, which were carried out over a 6 to 7 week period.

The monitoring revealed a maximum carbon dioxide concentration of 6.6% by volume (v/v). Measurable concentrations of methane were not recorded during the monitoring programme. Detectable flow rates were not recorded during the monitoring programme.

Based on the results of the monitoring undertaken, a gas screening value of 0.0066 l/h was calculated for carbon dioxide (assuming a flow rate of 0.1 l/h, in accordance with current guidance).

### 2.2 Site Classification

With respect to the ground gas regime and site classification in accordance with BS8485, the GeoDyne letter report stated *'with a maximum GSV of 0.0066 l/h and a maximum carbon dioxide concentration of 6.6% v/v, together with no measurable methane and no steady gas flow rates, this initially classifies the site as characteristic situation CS1, in accordance with Table 2 of BS8485 and based on the visits undertaken.'*

*However, where carbon dioxide concentrations exceed 5% by volume the British Standard recommends that consideration should be given to increasing the ground gas regime from CS1 to CS2. A CS2 ground gas regime would therefore indicate that gas protection measures would be required in the proposed new buildings to be constructed at the site'.*

Radon precautions are not required at the site.

### 2.3 Ground Gas Protection Score

To establish the level of ground gas protection required at a site, a ground gas protection score may be established from Table 4 of BS8485. The score takes account of the Characteristic Situation of the site and Building Classification (in accordance with Table 3 BS8485).

The gas protection score for the site is summarised in Table 1.

| TABLE 1 – GROUND GAS PROTECTION SCORE                                                                                                                                                                                                                                                                                   |                                         |                                        |                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------------------------|-----------------------------------------------|
| Development Proposals                                                                                                                                                                                                                                                                                                   | Characteristic Situation <sup>(1)</sup> | Building Classification <sup>(2)</sup> | Gas Protection Points Required <sup>(3)</sup> |
| Residential Housing                                                                                                                                                                                                                                                                                                     | CS2                                     | A                                      | 3.5                                           |
| <b>Notes</b><br>(1) Characteristic Situation established from site specific ground gas monitoring data, in accordance with BS8485.<br>(2) Building Classification is considered to be the most applicable building type based on Table 3 BS8485.<br>(3) Ground Gas Protection Points in accordance with Table 4 BS8485. |                                         |                                        |                                               |

On this basis, ground gas protection measures achieving a minimum score of 3.5 points should be included within all proposed dwellings at the site.

### 3.0 GAS PROTECTION SYSTEM

#### 3.1 Introduction

In accordance with BS8485, the ground gas protection system should be designed to score an appropriate amount of points from two or more of the following elements:

- Structural barrier.
- Ventilation measures.
- Membrane.

The points assigned for each element vary on the design of that element, as detailed in Section 7.2 of BS8485.

#### 3.2 Gas Protection System Summary

We understand that the foundations and floor slabs for the proposed dwellings will comprise a piled reinforced raft.

The ground gas protection system is summarised in Table 2

| TABLE 2 – GROUND GAS PROTECTION SYSTEM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                 |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------|
| Element                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Proposed Design                                                                                                 | Score Minimum |
| Structural Barrier                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Cast in situ monolithic reinforced raft with minimal penetrations (Speedeck Foundation Solution) <sup>(1)</sup> | 1.5           |
| Ventilation Measures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | None                                                                                                            | 0             |
| Membrane                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Gas Resistant Membrane (Juta GP-1, or similar) <sup>(2)</sup>                                                   | 2             |
| Total Minimum Points score for gas protection system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                 | 3.5           |
| <b>Notes</b><br>(1) Ideally services should be brought into the plot above the raft. Any penetrations through the raft should be kept to a minimum and all penetrations should be fully sealed (See Section 5.8 with respect to ducting).<br>(2) For a membrane to achieve 2 points, the membrane must satisfy the performance criteria detailed within Table 7 BS8485, inclusive of third-party verification in accordance with C735. We would note that based on the BBA Certificate for the Juta GP-1 membrane, the properties of the membrane appear to be suitable based on the guidance within BS8485. Should an alternative membrane be selected, the datasheet/BBA Certificate should be provided to the Verification Engineer for approval prior to installation on site. |                                                                                                                 |               |

Table 2 reveals that the proposed ground gas protection system for the proposed dwellings will achieve a minimum score of 3.5 points, which is in compliance with the requirements of BS8485.

The following standard detail drawing relating to the ground gas protection measures is included in Appendix III:

- Ashwood Homes drawing '*Proposed Residential Development at Harrington Drive, Crowland - Gas Membrane Details*', dated November 2023, Drawing No. 132-GMD-01.

Each element of the ground gas protection system is detailed in the following sections.

### **3.3 Structural Barrier**

The proposed dwellings are to be constructed with piled foundations on top of which a raft will be formed. The raft is to be a specialist Speedeck system which will incorporate reinforcement at the top and bottom of the slab. The drawing within Appendix I includes a schematic showing a typical raft construction.

We understand that the membrane will be installed on top of the raft and that insulation will be placed on top of the membrane, prior to pouring the screed.

### **3.4 Ventilation Measures**

The dwellings will achieve the required point score in accordance with BS8485 from the reinforced slab (raft) and the proprietary membrane (providing the membrane is subject to third party validation). No sub-slab ventilation is proposed.

### **3.5 Gas Resistant Membrane**

It is understood at this stage that the membrane to be installed in all plots is likely to comprise the Juta GP-1 membrane.

The Juta GP-1 membrane comprises a multi-layer reinforced low density polyethylene (LDPE) membrane with an aluminium core. In accordance with the requirements of BS8485, the membrane is ISO15105-1 certificated and is indicated to have a methane transmission rate of  $\leq 0.09 \text{ ml/m}^2\text{/day/atm}$  which satisfies the performance criteria of BS8485. A technical datasheet and BBA Certificate relating to the membrane is included in Appendix III.

Should an alternative membrane be selected, the membrane should meet the performance criteria required by BS8485 and a technical datasheet/BBA certificate relating to the alternative membrane should be forwarded to GeoDyne for review and inclusion in our records prior to installation on site.

### **3.6 Installation Process**

#### **3.6.1 Membrane**

It is understood that the membrane within all plots will be installed adopting a total lineout approach (i.e. the membrane will be installed in a single stage).

The components of the Juta GP-1 system (or similar) should form a continuous gas resistant barrier throughout each plot, including across the cavities. The membrane should also be continuous across adjoining plots, where applicable.

It is understood that the membrane will be installed immediately above the raft and will be covered by insulation (which will act as protective covering) prior to pouring the screed, as shown on the drawing in Appendix I.

#### **3.6.2 Jointing and Sealing Methodology**

It is understood that the specialist contractor installing the membrane is yet to be confirmed. It is envisaged that the joints and seals in the membrane panels will be formed by welding (likely to be hot air fusion or wedge welding). It is further anticipated that bespoke corners and service penetration seals may be formed on site from compatible self-adhesive gas membrane (SAGRM). This method of joining and sealing membranes is widely acceptable to the industry (where applicable) and should be detailed within the membrane installers method statement.

The method statement of the appointed installer should be forwarded to GeoDyne for review and comment, prior to the commencement of the installation works.

### **3.6.3 Subgrade Preparation**

The subgrade (i.e. concrete raft) should be swept to remove all debris prior to installation of the membrane. The subgrade should be inspected and approved by the installer prior to commencement of the membrane installation. Where a smooth surface cannot be achieved it may be necessary to provide a sand blinding or geotextile layer across the concrete raft on top of which the membrane can be placed.

### **3.6.4 Screed**

We understand that insulation is to be placed on top of the membrane with the screed poured above the insulation.

The insulation should provide an inherent level of protection against any damage to the membrane when the screed is poured. However, should it be proposed that the screed will be poured directly onto the installed membrane (i.e. if the insulation were to be beneath the membrane), the ground gas membrane should at all times be suitably protected against the possibility of inadvertent puncture (such as reinforcement fibres within the screed). Where required a protective fleece/geotextile or similar should be employed to protect the membrane, as appropriate.

The screed should be poured as soon as possible following the installation and validation of the membrane and placement of the insulation to minimise the opportunity for damage to the membrane from both follow on trades and the elements.

Please note that we cannot validate a membrane that has been covered over by screed (or is otherwise not visible) prior to our attendance to site.

### **3.6.5 Membrane Installers & Qualifications**

We understand that at this stage, the membrane installers are yet to be confirmed although we understand that they will likely be specialist membrane installers. Ideally the lead installer should hold a NVQ Level 2 qualification in sub-structure work occupations (construction – installation of gas membranes) or hold alternative appropriate qualifications/experience in membrane installation.

Once available, the Method Statement for the membrane installation should be forwarded to GeoDyne for review/comment.

#### **4.0 RISK BASED APPROACH TO VERIFICATION**

The site specific GSV calculated for carbon dioxide based on the results of the monitoring programme revealed that the site would fall into characteristic situation CS1, however, the monitoring revealed concentrations of carbon dioxide above the thresholds for sites where consideration should be given to increasing the characteristic situation to CS2.

Taking account of the development proposals (i.e. low rise housing), the proposed foundation solutions, and the maximum concentrations of carbon dioxide encountered at the site, at this stage we would propose that verification should comprise a thorough visual inspection of the membrane installed in each and every plot at the site. The visual inspection will be supplemented with mechanical point stress tests (i.e. pick tests).

## **5.0 VERIFICATION PROCESS**

The following sections summarise our proposals to undertake a visual inspection of the ground gas protection measures installed at the site.

### **5.1 Inspecting Engineer(s)**

Inspection of the gas protection system would be undertaken by a suitably trained and experienced Engineer from GeoDyne. As a minimum, our inspecting Engineers have attended '*The A – Z of Ground Gas*' training course jointly hosted by PAG and GGS or have undergone similar approved training.

Wherever possible we would propose for the same Engineer to carry out all inspection visits at the site to maintain consistency throughout the inspection process. Where this is not possible, we would endeavour to use as few Engineers as possible.

### **5.2 Inspection of Sub-Floor Ventilation Measures**

Sub-floor ventilation is not required as the plots are to be constructed with a Speedeck foundation/floor slab solution.

### **5.3 Inspection of Structural Barrier**

To minimise the risk of damage/punctures to the underside of the membrane, it is imperative that the concrete rafts are swept prior to installation of the membrane. The Installer should be satisfied that this has been carried out and where a suitably clean/level surface cannot be achieved it may be necessary to provide a sand blinding or geotextile layer over the sub-grade (i.e. concrete raft) to minimise the risk of damage to the underside of the membrane.

### **5.4 Inspection of Membrane**

A suitably trained and experienced third-party inspecting Engineer (i.e. GeoDyne) should attend site during the membrane installation process, to carry out a visual inspection together with mechanical stress testing i.e. pick testing (where appropriate and as far as practicable) of the membrane installed within the dwellings. Wherever possible the inspections should be carried out whilst the membrane installers are on site. The inspection should ensure that the installation is in general accordance with the Standard Detail drawing (Appendix I) and the specification of the membrane manufacturers. Reference will also be made to the installers Method Statement (to be forwarded to GeoDyne in due course). The inspection should ensure that the membranes are suitably installed and free from damage and defects.

Third-party verification undertaken by GeoDyne Ltd represents a 'second check' of the membrane based on inspection of observable elements of the membrane on the day of our works. No responsibility will be taken for areas of membrane that cannot be inspected or for any damage which occurs to the membrane after our visit.

The inspections should be carried out in accordance with good practice and should include the following as a minimum.

- Review of the installer's relevant qualifications/training certificates (i.e. CSCS cards or NVQ certificates). Ideally the lead installer should hold an NVQ Level 2 qualification for membrane installation.

- Obtain photographic records of the membrane during the installation process. An '*Inspection of Gas Protection Measures*' pro forma (based on the requirements of CIRIA C735) should be completed for each plot, to maintain records of the installed membranes (refer to Appendix IV).
- Visual inspection of the seams in the membrane to assess the continuity of the membrane throughout the dwellings. Mechanical point stress (Pick) tests will be undertaken along the edge of the seams to identify any unbonded seams, as far as practicable.
- Visual inspection of the seals around the corners and service pipe penetrations, with point stress testing adopted, where appropriate.
- Records of all materials used for ground gas protection (inclusive of serial numbers, where possible/appropriate) should be obtained during the inspection. Ideally a 'Test Weld / Joint' should be carried out on a section of membrane by the installer during each inspection visit, to be retained by the inspecting Engineer for in-house records.
- Should it become necessary for the membrane installers to deviate from the standard detail drawings and the installers Method Statements) during the membrane installation, the inspecting Engineer should be notified by the Client. Confirmation and approval of such changes should be sought by the Client / Membrane Installers from the inspecting Engineer and potentially the Local Authority if the changes are deemed to be significant) prior to installation. Records and photographic evidence of any changes to the installation detail should be taken by the inspecting Engineer during the inspection visit.

## 5.5 Non-Compliances

Should any non-compliances (i.e. punctures/tears to the membrane, defective joints/seals etc.) be identified during the inspection, corrective action in accordance industry good practice should be undertaken by the installer.

Typically, damaged areas of membrane, less than 150mm in diameter, should be sealed with a SAGRM patch which should be cut at least 200mm larger than the damage (i.e. the patch should extend a minimum of 100mm beyond the area of the damage in all directions). The repair patches will be hot air welded over the damaged section of membrane. Larger areas of damage may be repaired using membrane welded into position over the damage.

Any unbonded joints/seals could be repaired by either rewelding or by the application of SAGRM patch, heat sealed over the unbonded joint/seal.

Following appropriate repair of defective areas, the repair works will be re-inspected by an Engineer from GeoDyne. A photographic record will be obtained of the defective/damaged areas of the membrane and subsequent repair works.

## 5.6 Completion of Inspection

Following satisfactory installation of the membrane and satisfactory repair to any defective/damaged areas of the membrane, the membrane will be considered to 'Pass' the verification process.

## **5.7 Post Inspection Membrane Protection**

The Client should note that following inspection by GeoDyne, the membranes should be appropriately protected during follow-on construction works to minimise damage. It should also be noted that where the membrane is left exposed to the elements for prolonged periods of time the membrane and SAGRM will be susceptible to damage and may start to degrade. Ideally the insulation should be placed on top of the membrane and the finished floor (i.e. screed) poured as soon as possible following inspection to provide permanent protection to the membrane.

Alternatively, temporary protection may be provided which may comprise the provision of loose laid boarding over the membrane or the implementation of an exclusion zone preventing other Contractor's access onto the membrane prior to placement of insulation/pouring of screed.

The insulation installers should be requested not to cut the insulation to size in-situ, to minimise the risk of damage to the membrane during installation of the insulation across the membranes.

Should any damage occur to the membrane following inspection, the Client should ensure that appropriate remedial action, in accordance with industry good practice and the protocols of membrane manufacturer/installer is undertaken prior to placement of the insulation and pouring the screed. Any damage incurred should be revalidated in accordance with the established methodology.

Where unavoidable, any person(s) requiring entry onto the membrane should be provided with a Toolbox talk to raise awareness of the importance of the gas resistant membrane and to identify the risks associated with their entry, and control measures to be adopted. GeoDyne can provide the Toolbox talk if required. The Toolbox talk is especially relevant to follow on trades working over the installed membranes which are highly susceptible to damage if not appropriately protected.

## **5.8 Service Pipe Penetrations**

It should be borne in mind that where the service penetrations (typically 150mm pipes) are to be used as ducting for smaller service pipes (e.g. water or electricity supply etc.) an appropriate method of sealing the smaller pipes within the ducting should be adopted, (such as closed cell expanding foam injected 200mm thick/painted over with liquid membrane or sealed around the top with self-adhesive) to minimise the risk of the ducting acting as a conduit for ground gases to enter the dwellings.

## **5.9 Role and Responsibilities**

The following roles and responsibilities apply with respect to ground gas protection measures:

- I Detailed design of ground gas protection system

The Client (or appointed consultant such as an Architect or Structural Engineer) is responsible for the detailed design of ground gas protection measures at the site, with protection measures being appropriate to the ground gas regime identified and compatible with the Clients construction methodology.

## II Installation and certification of ground gas membrane

The membrane installation company is responsible for the supply of a suitable ground gas resistant membrane and ancillary products such as pre-formed top hats, corner details, seal tape and lap tape etc (where applicable).

The membrane company is responsible for the suitable installation of the ground gas membrane etc. An installation certificate should be provided by the membrane company to the Client for each plot.

Primary responsibility for the installation and certification of the installed ground gas membrane rests between the (specialist) membrane installation company and the Client.

## III Third-party check on installed ground gas protection measures

The third-party verification undertaken by GeoDyne Ltd represents a 'second check' of the membrane based on inspection of observable elements of the membrane on the day of our works. No responsibility will be taken for areas of membrane that cannot be inspected (or are not accessible at the time of our visit) or for any damage which occurs to the membrane after our visit.

## IV Post inspection protection and sealing of service pipes in ducting

The Client is responsible for providing suitable protection to the installed and inspected membrane. Should any damage occur to the membrane, appropriate repairs should be implemented by the Client and subject to third-party verification, as necessary. The Client should also ensure that following the installation of any services within ducting the services are appropriately sealed within the ducting to form a gas-tight seal.

## **6.0 VALIDATION REPORT PREPARATION**

Validation reports will be prepared on a rolling basis to suit the requirements of the Client following completion of all elements of the gas protection measures installation. The validation report will be prepared in general accordance with BS8485 and confirm the details of the materials used and include relevant photographic evidence of the membrane installed, to demonstrate compliance with the standard drawings and any installers method statement. Any variation from the standard drawings for the membrane installation will also be reported, with appropriate justification for the variation.

The validation report should typically include installation certificates prepared for each plot by the membrane installation company.

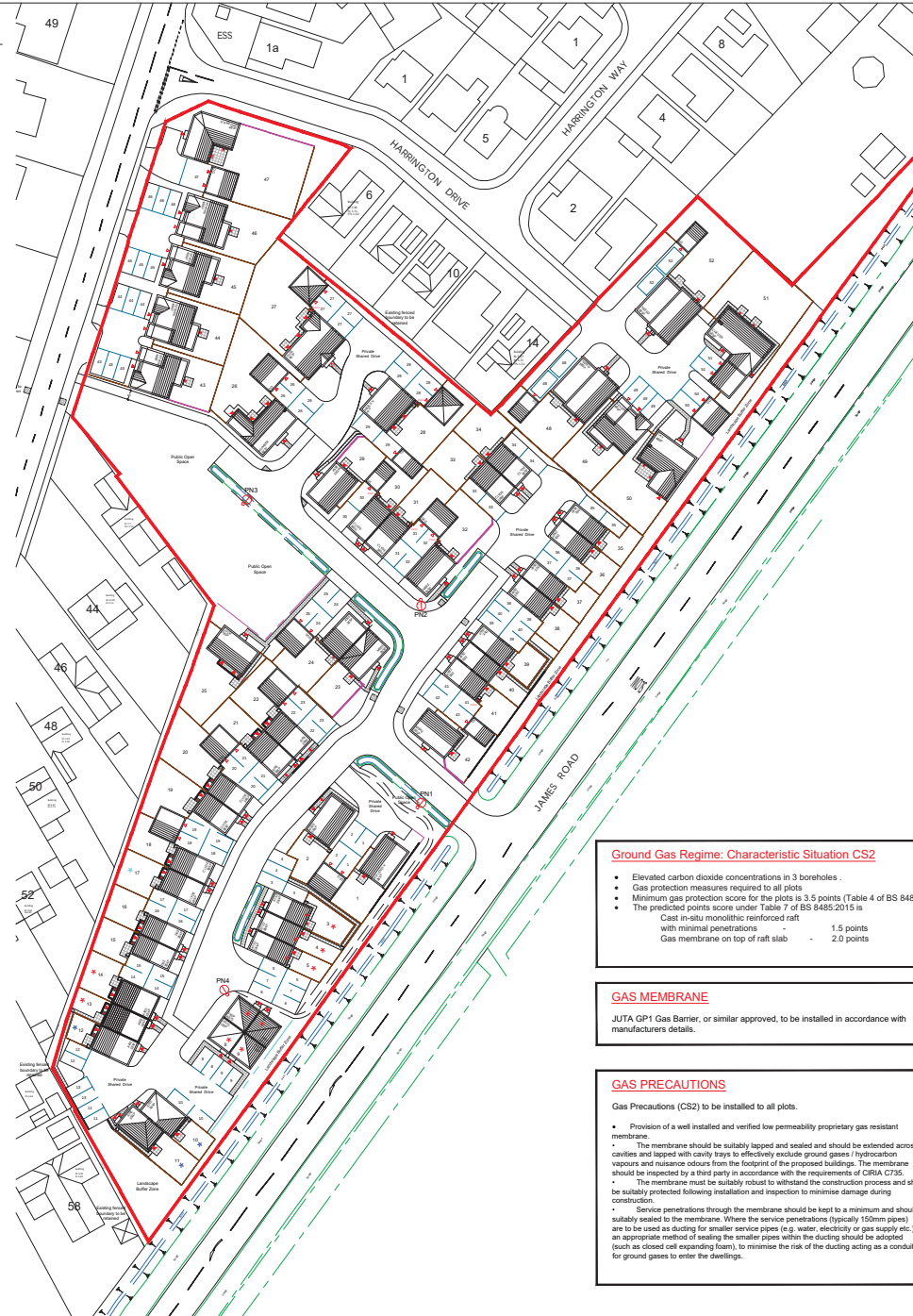
The Validation Report should be submitted by the Client, to the Local Authority for review and approval, as part of the planning process.

**APPENDIX I**

**Ashwood Homes Standard Details Drawing**

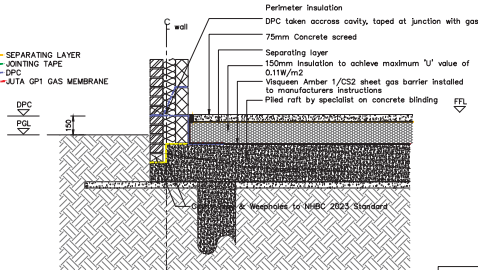
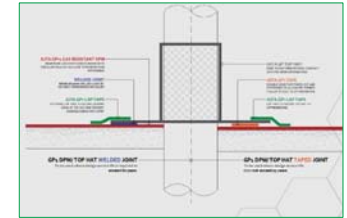
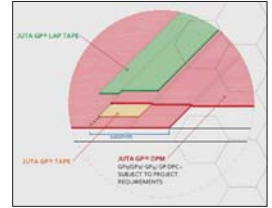
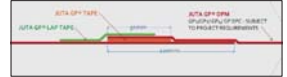
## Verification approach - Visual Inspections

- Ground gas precautions to be installed and verified in accordance with Geodyne RMS
- All dwellings to have a well installed and verified low permeability proprietary gas resistant membrane validated by a third party and conforming to the requirements of Table 7 of BS8485 details of which are to be agreed with the local authority.
- Membrane to be installed in accordance with an agreed method statement prepared by the installer.
- The membrane should be suitably lapped and sealed and should be extended across wall cavities and lapped with cavity trays to effectively exclude ground gases from the footprint of the proposed buildings.
- Gas protection measures are to be installed in accordance with the requirements of CIRIA C735 'Good practice on the testing and verification of protection systems for buildings against hazardous ground gas' (2014).
- Gas protection measures are to be installed by a suitably qualified & experienced specialist contractor in a quality controlled/quality assured manner.
- Membrane to be suitably robust to withstand construction process and should be suitably protected following installation and inspection to minimise damage.
- Installed gas protection measures should be visually checked and verified by the installer and an appropriate third party.
- The verifier should check adherence to the agreed specification and visually inspect key areas, such as membrane integrity, seals at pipe penetrations and corner details.
- Defects must be corrected and works rechecked before final 'sign-off' reporting.
- All reports should include the materials used, visual inspection of the joints, visual inspection of the seals around penetrations, records of any deviation from the construction drawings, records of any non-compliance and corrective action taken, the verifier's signature and photographs as supporting evidence.



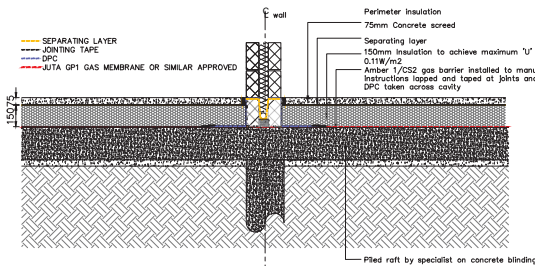
ALL WORKS IS TO BE IN STRICT ACCORDANCE WITH SPECIALIST MANUFACTURERS RECOMMENDATIONS AND INSTRUCTIONS.

IN ALL CIRCUMSTANCES, THE MEMBRANE SHOULD BE PROTECTED AS SOON AS POSSIBLE AFTER VERIFICATION TO PREVENT FUTURE DAMAGE



Typical Section A-A  
scale 1:20

Refer to AH-SDPD-01 and AH-SDPD-02 for standard SpeedDeck floor - wall details



Typical Section B-B  
scale 1:20

### Ground Gas Regime: Characteristic Situation CS2

- Elevated carbon dioxide concentrations in 3 boreholes.
  - Gas protection measures required to all plots
  - Minimum gas protection score for the plots is 3.5 points (Table 4 of BS 8485:2015)
  - The predicted points score under Table 7 of BS 8485:2015 is
- |                                                                   |            |
|-------------------------------------------------------------------|------------|
| Cast in-situ monolithic reinforced raft with minimal penetrations | 1.5 points |
| Gas membrane on top of raft slab                                  | 2.0 points |

### GAS MEMBRANE

JUTA GP1 Gas Barrier, or similar approved, to be installed in accordance with manufacturers details.

### GAS PRECAUTIONS

Gas Precautions (CS2) to be installed to all plots.

- Provision of a well installed and verified low permeability proprietary gas resistant membrane.
- The membrane should be suitably lapped and sealed and should be extended across wall cavities and lapped with cavity trays to effectively exclude ground gases/hydrocarbon vapours and nuisance odours from the footprint of the proposed buildings. The membrane should be inspected by a third party in accordance with the requirements of CIRIA C735.
- The membrane must be suitably robust to withstand the construction process and should be suitably protected following installation and inspection to minimise damage during construction.
- Service penetrations through the membrane should be kept to a minimum and should be suitably sealed to the membrane. Where the service penetrations (typically 150mm pipes) are to be used as ducting for smaller service pipes (e.g. water, electricity or gas supply etc.) an appropriate method of sealing the smaller pipes within the ducting should be adopted (such as closed cell expanding foam), to minimise the risk of the ducting acting as a conduit for ground gases to enter the dwellings.

| No. | Date | Description |
|-----|------|-------------|
|     |      |             |
|     |      |             |
|     |      |             |



1 Goodison Road, Lincs Gateway Business Park,  
Spalding, Lincs, PE12 6FY T: 01456 490990

PROJECT:  
Proposed Residential  
Development at  
Harrington Drive, Crowland

DRAWING:  
Gas Membrane Details

SCALE: 1:500@A1 DRAWN: GB  
DATE: NOVEMBER.2023 REVISION: /  
DRAWING NO: 132-GMD-01

## **APPENDIX II**

### **Membrane Technical Data & BBA Certificate**

**Juta GP® 1 - Gas Barrier is a multi-layer, low density polyethylene membrane, reinforced with a polypropylene reinforcing grid with an integral aluminium foil. GP® 1 is specifically designed and manufactured to perform as a Methane, Carbon Dioxide, Radon, Ground Gas, VOC /Hydrocarbon vapors, air & moisture protection system.**

| JUTA GP® 1                                      |                           |               |             |
|-------------------------------------------------|---------------------------|---------------|-------------|
| Characteristics                                 | Test Method               | Unit          | JUTA GP® 1  |
| Physical Properties                             |                           |               |             |
| Thickness                                       | EN 1849-2                 | mm            | 0.6         |
| Thickness - Between Scrim                       | BS EN ISO 9863-1:2016     | Mm            | 0.4         |
| Width                                           | EN 1849-2                 | m             | Various     |
| Length                                          | EN 1849-2                 | m             | Various     |
| Weight                                          | EN 1849-2                 | G/M2          | 370         |
| Hydraulic Properties                            |                           |               |             |
| Thickness                                       | EN 20811                  | -             | >300        |
| Resistance to Water Penetration                 | EN 13967, EN 1928         | -             | Pass        |
| Water Tightness                                 | EN 1296, EN 1367, EN 1928 | -             | Pass        |
| Hydraulic Properties                            |                           |               |             |
| Resistance to Static Load                       | EN 12730-B                | Kg            | 20          |
| Tensile Strength (MD)                           | EN 12311-1                | N/50mm        | 600         |
| Tensile Strength (CMD)                          | EN 12311-1                | N/50mm        | 480         |
| Tensile Elongation (MD)                         | EN 12310-1                | %             | 20          |
| Tensile Elongation (CMD)                        | EN 12310-1                | %             | 20          |
| Puncture Resistance                             | EN 12236                  | kN            | 1.25        |
| Resistance to Tearing (Nail Shank) MD           | EN 12310-1                | N             | 330         |
| Resistance to Tearing (Nail Shank) CMD          | EN 12310-1                | N             | 400         |
| Durability and Chemical Resistance              |                           |               |             |
| Transmission Rate of Volatile Liquids - Diesel  | ISO 6179:2010 (B)         | g/m2/h        | 0.246       |
| Transmission Rate of Volatile Liquids - Xylene  | ISO 6179:2010 (B)         | g/m2/h        | 0.571       |
| Transmission Rate of Volatile Liquids - Toluene | ISO 6179:2010 (B)         | g/m2/h        | 0.583       |
| Transmission Rate of Volatile Liquids - Petrol  | ISO 6179:2010 (B)         | g/m2/h        | 0.135       |
| Gas Permeability                                |                           |               |             |
| Methane Permeability                            | BS EN ISO 15105-1         | ml/m2/day/atm | <0.09       |
| Carbon Dioxide Permeability                     | BS EN ISO 15105-1         | ml/m2/day/atm | <0.09       |
| Radon Permeability                              | K124/02/95                | m2/s          | 8.0 x 10-15 |
| Compliance and Certification                    |                           |               |             |
| CE Mark - EN13967:2012                          |                           |               |             |
| NHBC Standards Compliant                        |                           |               |             |
| BS 8485:2015 + A1 2019 Accordant                |                           |               |             |
| BBA Certified - Certificate No. 12/4912         |                           |               |             |

**Contact us to find out more information.**  
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**Melton Grove Works, Church Road, Lytham, FY8 5PL**

**JUTA**



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# Additional Information

## HANDLING

Roll weights can be in excess of 20kg and hence appropriate care and equipment is required for unloading and handling.

## STORAGE

Rolls of JUTA GP® 1 should be stored on stable/level ground and stacked not more than five rolls high, with no other material stacked on top. The rolls can be stored outdoors when packaged, but should be protected from exposure to UV.

## INSTALLATION

JUTA GP® 1 should be installed in accordance with the product installation guidelines, and in accordance with BS 8485:2015.

## JOINTING AND SEALING

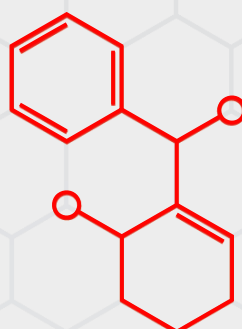
It is recommended JUTA GP® 1 be heat welded where possible, with welding carried out by competent personnel with suitable qualifications in accordance with best practice, and guidance contained within BS 8485:2015. JUTA GP® 1 should be overlapped by at least 100mm. If taping joints, only suitable tape must be used, ensuring application with a silicone roller to remove trapped air. JUTA pre-formed details, or Self Adhesive Gas Membrane are available for sealing around protuberances.

## ACCESSORY PRODUCTS

-  JUTA GP® 1 Starter Band
-  JUTA GP® Tape
-  JUTA GP® Self Adhesive Membrane
-  JUTA GP® Primer
-  JUTA GP® Top Hats and Preformed Corners
-  JUTA GP® Protection Fleece
-  JUTA GP® Void Vent (25/40mm)

**PLEASE CONTACT JUTA UK DIRECTLY FOR MORE INFORMATION ON JUTA GP® 1**

Contact us to find out more information.  
[info@juta.co.uk](mailto:info@juta.co.uk) | 01772 754177 | [JUTA.CO.UK](http://JUTA.CO.UK)  
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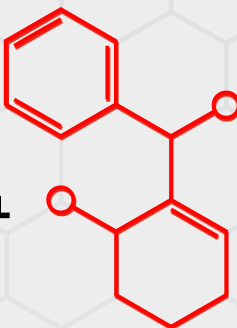


**JUTA GP<sup>®</sup> SAM – Gas Protection – Self Adhesive Membrane**, is a bituminous gas proof and water proof sheet, composed of self-adhesive SBS polymer modified bitumen incorporating an aluminium foil with an upper surface finish of white cross laminated HDPE, and a lower surface finish of siliconized paper release film. JUTA GP<sup>®</sup> SAM is used for the gas/waterproofing of underground structures where harmful ground gasses are anticipated.



| JUTA GP <sup>®</sup> SAM                              |                     |                            |                         |
|-------------------------------------------------------|---------------------|----------------------------|-------------------------|
| Characteristic                                        | Test Method         | Unit                       | GP <sup>®</sup> SAM     |
| Physical Properties                                   |                     |                            |                         |
| Thickness                                             | EN 1849-2           | mm                         | 1.00                    |
| Width                                                 | EN 1849-2           | M                          | 0.3 or 1                |
| Length                                                | EN 1849-2           | M                          | 20                      |
| Weight                                                | EN 1849-2           | g/m <sup>2</sup>           | 1100                    |
| Hydraulic Properties                                  |                     |                            |                         |
| Watertightness                                        | EN 1928             | -                          | PA55                    |
| Water Vapour Transmission                             | EN 1931             | g/m <sup>2</sup> /day      | 0.013                   |
| Mechanical Properties                                 |                     |                            |                         |
| Tensile Strength (MD/CMD)                             | EN12311-2           | N/mm <sup>2</sup>          | 3                       |
| Elongation (MD/CMD)                                   | EN 12311-2          | %                          | >120                    |
| Resistance to Static Load                             | EN 12370            | kg                         | 20kg                    |
| Joint Strength                                        | EN 12317-2          | N                          | >30                     |
| Durability and Water tightness (ageing and chemicals) | EN 1847             | -                          | PA55                    |
| Resistance to Nail Tear (MD/CMD)                      | EN 12310-1          | N                          | >100                    |
| Reaction to Fire                                      | EN 13501            | Euro Class                 | F                       |
| Gas Permeability                                      |                     |                            |                         |
| Methane Permeability                                  | BS EN ISO 15105 - 1 | ml/m <sup>2</sup> /day/atm | < 0.53                  |
| Carbon Dioxide Permeability                           | BS EN ISO 15105 - 1 | ml/m <sup>2</sup> /day/atm | < 0.53                  |
| Radon Permeability                                    | K124/02/95          | m <sup>2</sup> /s          | 5.0 x 10 <sup>-14</sup> |

**JUTA GP<sup>®</sup> SAM complies with the latest codes of practice as published by BRE, CIRIA and BSI (BS 8485:2015).**



# Additional Information

## **HANDLING**

Roll weights can be in excess of 20kg (approx. 33kg/roll) and hence appropriate care and equipment is required for unloading and handling. This product is non-toxic nor flammable.

## **STORAGE**

Rolls of JUTA GP® SAM should be stored horizontally, and pallets should not be stacked on top of one another.

JUTA GP® SAM should be stored in a cool, dry place, and be protected from exposure to rain, sun, heat and cold temperatures prior to installation. Exposure to sunlight for extended period of time could cause difficulty with removal of the release film.

## **INSTALLATION**

JUTA GP® SAM should be installed in accordance with the product installation guidelines, and in accordance with BS 8485:2015.

It is recommended that JUTA GP® SAM is not applied in temperatures below 10 °C, in colder weather the material can be warmed slightly to aid adhesion.

## **ACCESSORY PRODUCTS**



JUTA GP® Primer



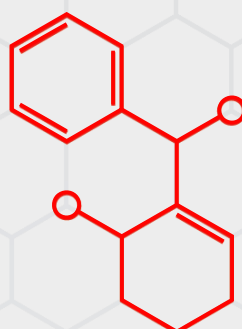
JUTA GP® Protection Board



JUTA GP® Protection Fleece

**PLEASE CONTACT JUTA UK DIRECTLY FOR MORE INFORMATION ON JUTA GP® SAM**

Contact us to find out more information.  
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## Juta a.s.

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## Agrément Certificate

12/4912

Product Sheet 1

### JUTA GAS-RESISTANT MEMBRANE

#### GP1 GAS BARRIER

This Agrément Certificate Product Sheet<sup>(1)</sup> relates to GP1 Gas Barrier, for use as a low-density polyethylene gas barrier and damp-proof membrane in concrete ground floors, above and below the slab not subject to hydrostatic pressure, to protect the building against moisture, radon, methane and carbon dioxide from the ground.

(1) Hereinafter referred to as 'Certificate'.

#### CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.



#### KEY FACTORS ASSESSED

**Resistance to water and water vapour** — the membrane provides an effective barrier to the passage of liquid water and water vapour from the ground (see section 6).

**Resistance to underground gases** — the membrane is capable of restricting the ingress of radon, methane and carbon dioxide into the building (see section 7).

**Resistance to puncture** — the membrane has a high resistance to puncture and on a smooth or blinded surface will not be damaged by foot or site traffic (see section 8).

**Durability** — under normal service conditions, the membrane will remain effective against the ingress of water and water vapour, and will restrict the ingress of radon, methane and carbon dioxide during the lifetime of the flooring construction in which it is installed (see section 12).



The BBA has awarded this Certificate to the company named above for the product described herein. This product has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of Third issue: 29 October 2018

John Albon — Head of Approvals  
Construction Products

Originally certificated on 10 July 2012

Claire Curtis-Thomas  
Chief Executive

The BBA is a UKAS accredited certification body — Number 113.

The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at [www.bbacerts.co.uk](http://www.bbacerts.co.uk)  
Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

#### British Board of Agrément

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Page 1 of 9

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## Regulations

In the opinion of the BBA, GP1 Gas Barrier, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements of the following Building Regulations (the presence of a UK map indicates that the subject is related to the Building Regulations in the region or regions of the UK depicted):



### The Building Regulations 2010 (England and Wales) (as amended)

|                     |              |                                                                                                                                                                                                                                           |
|---------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Requirement:</b> | <b>C1(2)</b> | <b>Site preparation and resistance to contaminants</b>                                                                                                                                                                                    |
| <b>Comment:</b>     |              | When properly installed in a correctly designed structure, the membrane forms an effective barrier to radon, methane and carbon dioxide, enabling compliance with this Requirement. See section 7.1 of this Certificate.                  |
| <b>Requirement:</b> | <b>C2(a)</b> | <b>Resistance to moisture</b>                                                                                                                                                                                                             |
| <b>Comment:</b>     |              | When properly installed in a correctly designed structure, the membrane forms an effective barrier to the movement of water within the ground floor slab, enabling compliance with this Requirement. See section 6.1 of this Certificate. |
| <b>Regulation:</b>  | <b>7</b>     | <b>Materials and workmanship</b>                                                                                                                                                                                                          |
| <b>Comment:</b>     |              | The membrane is an acceptable material. See section 12.1 and the <i>Installation</i> part of this Certificate.                                                                                                                            |



### The Building (Scotland) Regulations 2004 (as amended)

|                    |               |                                                                                                                                                                                                                                                                                                                                                  |
|--------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Regulation:</b> | <b>8(1)</b>   | <b>Durability, workmanship and fitness of materials</b>                                                                                                                                                                                                                                                                                          |
| <b>Comment:</b>    |               | The membrane can contribute to a construction satisfying this Regulation. See section 12.1 and the <i>Installation</i> part of this Certificate.                                                                                                                                                                                                 |
| <b>Regulation:</b> | <b>9</b>      | <b>Building standards applicable to construction</b>                                                                                                                                                                                                                                                                                             |
| <b>Standard:</b>   | <b>3.1</b>    | Site preparation – harmful and dangerous substances                                                                                                                                                                                                                                                                                              |
| <b>Standard:</b>   | <b>3.2</b>    | Site preparation – protection from radon gas                                                                                                                                                                                                                                                                                                     |
| <b>Comment:</b>    |               | The membrane will enable a floor to satisfy the requirements of these Standards, with reference to clauses 3.1.2 <sup>(1)(2)</sup> , 3.1.6 <sup>(1)(2)</sup> , 3.1.7 <sup>(1)(2)</sup> , 3.1.8 <sup>(1)(2)</sup> , 3.2.1 <sup>(2)</sup> and 3.2.2 <sup>(1)(2)</sup> . See section 7.1 of this Certificate.                                       |
| <b>Standard:</b>   | <b>3.4</b>    | Moisture from the ground                                                                                                                                                                                                                                                                                                                         |
| <b>Comment:</b>    |               | When properly installed in a correctly designed structure, the membrane forms an effective barrier to the movement of water within the ground floor slab, enabling compliance with this Standard, with reference to clauses 3.4.2 <sup>(1)(2)</sup> , 3.4.4 <sup>(1)(2)</sup> and 3.4.6 <sup>(1)(2)</sup> . See section 6.1 of this Certificate. |
| <b>Standard:</b>   | <b>7.1(a)</b> | Statement of sustainability                                                                                                                                                                                                                                                                                                                      |
| <b>Comment:</b>    |               | The membrane can contribute to meeting the relevant requirements of Regulation 9, Standards 1 to 6 and therefore will contribute to a construction meeting a bronze level of sustainability as defined in this Standard.                                                                                                                         |
| <b>Regulation:</b> | <b>12</b>     | <b>Building standards applicable to conversions</b>                                                                                                                                                                                                                                                                                              |
| <b>Comment:</b>    |               | Comments in relation to the product under Regulation 9, Standards 1 to 6 also apply to this Regulation, with reference to clause 0.12.1 <sup>(1)(2)</sup> and Schedule 6 <sup>(1)(2)</sup> .                                                                                                                                                     |

(1) Technical Handbook (Domestic).

(2) Technical Handbook (Non-Domestic).



## The Building Regulations (Northern Ireland) 2012 (as amended)

|                    |                    |                                                                                                                                                                                                                                          |
|--------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Regulation:</b> | <b>23(a)(i)</b>    | <b>Fitness of materials and workmanship</b>                                                                                                                                                                                              |
| <b>Comment:</b>    | <b>(iii)(b)(i)</b> | The membrane is acceptable. See section 12.1 and the <i>Installation</i> part of this Certificate.                                                                                                                                       |
| <b>Regulation:</b> | <b>26</b>          | <b>Site preparation and resistance to contaminants</b>                                                                                                                                                                                   |
| <b>Comment:</b>    |                    | When properly installed in a correctly designed structure, the membrane forms an effective barrier to radon, methane and carbon dioxide enabling compliance with this Regulation. See section 7.1 of this Certificate.                   |
| <b>Regulation:</b> | <b>28</b>          | <b>Resistance to moisture and weather</b>                                                                                                                                                                                                |
| <b>Comment:</b>    |                    | When properly installed in a correctly designed structure, the membrane forms an effective barrier to the movement of water within the ground floor slab, enabling compliance with this Regulation. See section 6.1 of this Certificate. |

### Construction (Design and Management) Regulations 2015

### Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See section: 1 *Description* (1.2) of this Certificate.

## Additional Information

### NHBC Standards 2018

In the opinion of the BBA, GP1 Gas Barrier, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements in relation to *NHBC Standards*, Chapters 4.1 *Land quality – managing ground conditions* and 5.1 *Substructure and ground bearing floors*.

### CE marking

The Certificate holder has taken the responsibility of CE marking the product, in accordance with harmonised European Standard BS EN 13967 : 2012. An asterisk (\*) appearing in this Certificate indicates that data shown are given in the manufacturer's Declaration of Performance.

## Technical Specification

### 1 Description

1.1 GP1 Gas Barrier is a multilayer, low-density polyethylene membrane, reinforced with a polypropylene reinforcing grid with an integral aluminium foil.

1.2 The membrane has the following nominal characteristics:

|                                                         |         |
|---------------------------------------------------------|---------|
| Thickness (mm)                                          | 0.6     |
| Roll length (m)                                         | various |
| Roll width (m)                                          | various |
| Mass per unit area ( $\text{g}\cdot\text{m}^{-2}$ )     | 370     |
| Tensile strength* ( $\text{N}\cdot 50\text{ mm}^{-1}$ ) |         |
| Machine direction                                       | 600     |
| Cross direction                                         | 480     |
| Elongation (%)                                          |         |
| Machine direction                                       | 20      |
| Cross direction                                         | 20      |

|                           |          |
|---------------------------|----------|
| Nail tear resistance* (N) |          |
| Machine direction         | 330      |
| Cross direction           | 400      |
| Watertightness*           | pass     |
| Colour                    |          |
| upper surface             | various  |
| lower surface             | various. |

1.3 Ancillary products for use with the membrane include:

- butyl or bitumen tape — for use for joints and laps
- jointing tape — for securing laps and joints.

1.4 Ancillary products for use with the membrane, but outside the scope of this Certificate, include:

- GP Top Hats — to seal around entry points to the membrane
- GP Internal Corner Cloaks — prefabricated corner details
- GP External Corner Cloaks — prefabricated corner details
- GP Primer — used to provide adhesion for application of bitumen enhanced geomembranes
- GP Void Vent 25 — cusped high-density polyethylene (HDPE) drainage core with a non-woven polypropylene geotextile separator/filter bonded to one side
- GP Void Vent 40 — cusped HDPE drainage core with a non-woven polypropylene geotextile separator/filter bonded to one side
- GP Protection Fleece — to form a protective layer to prevent damage to the membrane
- GR-SAM — gas-resistant self-adhesive membrane
- GP DPC — a gas resistant damp-proof course (dpc).

## 2 Manufacture

2.1 The membrane is manufactured by an extrusion/coating process.

2.2 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.3 The management system of Juta a.s. has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 and BS EN ISO 14001 : 2015 by Bureau Veritas (Certificates CZ002814-1 and CZ002815-1 respectively).

## 3 Delivery and site handling

3.1 Rolls are wrapped in polythene film. Each roll has a leaflet enclosed describing the membrane and installation details. The BBA logo and the number of this Certificate are printed on the leaflet and pallet label.

3.2 The rolls must be stacked on a flat surface, kept under cover and protected from sunlight and mechanical damage.

## Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on GP1 Gas Barrier.

### 4 Use

4.1 GP1 Gas Barrier is satisfactory for use as a gas-resistant barrier to restrict the ingress of radon, methane and carbon dioxide into buildings from landfill and naturally occurring sources.

4.2 Buildings in areas of risk should be constructed in accordance with the recommendations of BRE Report BR 211 : 2015 and following the guidance set out in BS 8485 : 2015.

4.3 The membrane is also satisfactory for use as a damp-proof membrane in accordance with CP 102 : 1973 Section 3, BS 8000-0 : 2014 and BS 8000-4 : 1989.

### 5 Practicability of installation

The membrane is designed to be installed by a competent general builder, or a contractor, experienced with this type of product.

### 6 Resistance to water and water vapour



6.1 The membrane, including joints, when completely sealed and consolidated, will adequately resist the passage of moisture into the building and enable a roof to comply with the requirements of the national Building Regulations.

6.2 The membrane is impervious to water and provides a waterproof layer capable of accepting minor structural movements without damage.

### 7 Resistance to underground gases



7.1 The membrane will restrict the ingress of radon, methane and carbon dioxide into buildings from landfill and naturally occurring sources and satisfy the performance criteria for a gas-resistant membrane as defined in BS 8485 : 2015.

7.2 Measured gas permeability/diffusion values on unjointed membrane are given in Table 1.

Table 1 Gas permeability of GP1

| Gas            | Method         | Result                                                                          |
|----------------|----------------|---------------------------------------------------------------------------------|
| Methane        | BS ISO 15105-1 | $<0.09 \text{ ml} \cdot \text{m}^2 \cdot \text{day}^{-1} \cdot \text{atm}^{-1}$ |
| Carbon dioxide | BS ISO 15105-1 | $<0.09 \text{ ml} \cdot \text{m}^2 \cdot \text{day}^{-1} \cdot \text{atm}^{-1}$ |
| Radon          | K124/02/95     | $8.0 \times 10^{-15} \text{ m}^2 \cdot \text{s}^{-1}$                           |

7.3 BRE Report BR 211 : 2015 recommends a 300  $\mu\text{m}$  thick polyethylene sheet as the minimum required thickness for a radon gas-resistant membrane. It is generally accepted that other materials with comparable or higher gas resistance are suitable, provided they can withstand the construction process. In the opinion of the BBA, the membrane satisfies these criteria.

### 8 Resistance to puncture

8.1 The membrane can be punctured by sharp objects and care should be taken when handling building materials over the exposed surface.

8.2 Provided there are no sharp objects present on the membrane's surface prior to and during installation of the protective layer, the membrane will not be damaged by normal foot traffic.

## 9 Compatibility with other materials

The membrane contains an aluminium foil interlayer which may be subject to corrosion by alkaline conditions if damage to the membrane and exposure occurs. However, under normal circumstances, the polyethylene faces of the membrane are compatible with other materials and products typically used in the same areas, with the exception of those containing pitch.

## 10 Underfloor heating

There will be no adverse effect on the membrane from the underfloor heating under normal service conditions. In other circumstances, the Certificate holder's advice should be sought.

## 11 Maintenance

As the membrane is confined under concrete and has suitable durability (see section 12), maintenance is not required. However, any damage occurring before enclosure must be repaired (see section 15).

## 12 Durability



12.1 The membrane will, in normal circumstances, remain effective against the ingress of water and water vapour, and will restrict the ingress of radon, methane and carbon dioxide during the lifetime of the building.

12.2 Long periods of exposure to ultraviolet light will reduce the effectiveness of the membrane.

## Installation

## 13 General

13.1 GP1 Gas Barrier must be installed and fixed in accordance with this Certificate, the Certificate holder's instructions, the relevant clauses of BRE Report BR 211 : 2015 and the guidance given in BS 8485 : 2015.

13.2 The membrane can be installed in all normal site conditions, provided that the air temperature is not below 5°C to prevent the risk of surface condensation.

## 14 Procedure

14.1 The membrane must only be applied to surfaces that have a smooth finish, ie they should be free from voids, projections and mortar deposits. Surfaces should be dry and free from dust and frost.

14.2 Concrete surfaces should be dense. Vertical surfaces of brickwork and blockwork must be dry and rendered to provide an even surface. Brickwork or blockwork not rendered must be flush pointed to give a smooth surface without sudden changes in level.

14.3 The membrane is rolled out with the printed side uppermost, ensuring that it is properly aligned. All end and side overlaps should be a minimum of 100 mm and prepared in accordance with the Certificate holder's instructions.

14.4 When the membrane is laid below the concrete slab, it should be loose-laid to accommodate any small movements.

14.5 All surfaces must be dried thoroughly prior to joining. Roll edges can be welded or taped. A strip of the tape is unrolled over the membrane with its nearest edge 50 mm from the membrane edge. The protective paper is removed from the butyl tape prior to rolling an adjacent run of the membrane, which must be carefully unrolled over the jointing tape, ensuring a 100 mm overlap.

14.6 All service penetrations and direction changes should be properly detailed in accordance with the Certificate holder's instructions. Service ducts should be vented to prevent the possibility of gas accumulating in confined spaces.

14.7 The continuity of the gas protection must extend over the footprint of the building, and the membrane must be sealed to a gas-resistant dpc where required.

14.8 The membrane should be covered by a screed or other protective layer, such as GP Protection Fleece, as soon as possible after installation. If blockwork protection is used, care must be taken to avoid damage to the membrane during construction.

14.9 The membrane installation should be subject to third-party independent validation, in accordance with BS 8485 : 2015.

## 15 Repair

Any damage to the membrane must be repaired using a patch of the membrane, and laps welded or sealed with double sided tape and secured with the butyl tape. All patched areas must extend a minimum of 100 mm from the damaged area. If required by the local authority, repair work should be confirmed by an independent validation report, as all gas membrane installations should be subject to third-party validation in accordance with BS 8485 : 2015.

## Technical Investigations

## 16 Tests

16.1 An assessment was made of data to BS EN 13967 : 2012 in relation to:

- tensile strength and elongation
- nail tear resistance
- watertightness
- resistance to static loading.

16.2 Tests were carried out to determine:

- thickness, width, density and mass per unit area
- dimensional stability, low temperature flexibility and water vapour permeability
- tensile strength and elongation on controls and after 12 weeks heat ageing at 70°C, and after 100 hours UVB exposure
- watertightness on controls and after 12 weeks heat ageing at 70°C
- nail tear strength on controls and after 12 weeks heat ageing at 70°C
- resistance of joints to air pressure
- tensile strength of joints on controls and after 12 weeks heat ageing at 70°C

to assess:

- membrane characteristics
- durability of the membrane and joints.

## 17 Investigations

17.1 An evaluation was made of the results of the test data regarding permeability of radon, methane and carbon dioxide.

17.2 A site visit was conducted to assess practicability of installation.

17.3 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

## Bibliography

BRE Report BR 211 : 2015 *Radon : Guidance on protective measures for new buildings*

BS 8000-0 : 2014 *Workmanship on construction sites – Introduction and general principles*

BS 8000-4 : 1989 *Workmanship on building sites — Code of practice for waterproofing*

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

BS EN 13967 : 2012 + A1 : 2017 *Flexible sheets for waterproofing — Plastic and rubber damp proof sheets including plastic and rubber basement tanking sheet — Definitions and characteristics*

BS EN ISO 9001 : 2008 *Quality management systems — Requirements*

BS EN ISO 14001 : 2015 *Environmental management systems – Requirements with guidance for use*

BS ISO 15105-1 : 2007 *Plastics. Film and sheeting. Determination of gas-transmission rate. Differential-pressure methods*

CP 102 : 1973 *Code of practice for protection of buildings against water from the ground*

K124/02-95 *Radon diffusion coefficient by Czech Technical University to test number 124-11 – Measurement of radon coefficient*

### 18 Conditions

#### 18.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

18.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

18.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

18.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

18.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

18.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

### **APPENDIX III**

#### **Membrane Verification Proforma**

## INSPECTION OF GAS PROTECTION MEASURES

|                |                            |          |               |
|----------------|----------------------------|----------|---------------|
| Site name      | Harrington Drive, Crowland | Client   | Ashwood Homes |
| Project number | D41153                     | Date     |               |
| Plot number    |                            | Visit by |               |

In general accordance with Appendix A5 of CIRIA C735 'Good practice on the testing and verification of protection systems for buildings against hazardous ground gas' (2014)

| No.                                                  | Item                                                 | Comments (see notes)                               | No.                              | Item                                                               | Comments (see notes)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                              |                           |        |
|------------------------------------------------------|------------------------------------------------------|----------------------------------------------------|----------------------------------|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------|--------|
| 1                                                    | Gas Membrane                                         |                                                    | 2                                | Passive Venting                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
| 1.1                                                  | Condition of sub-grade and underside of gas membrane |                                                    | 2.1                              | Sub-floor void                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
| 1.2                                                  | Gas membrane type                                    |                                                    | 2.2                              | External wall airbricks                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
| 1.3                                                  | Gas membrane condition                               |                                                    | 2.3                              | Internal sleeper walls                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
| 1.4                                                  | Joining tape product                                 |                                                    | 2.4                              | External vent trenches/ducts                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
| 1.5                                                  | Lapping design                                       |                                                    | 3                                | Active Venting                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
| 1.6                                                  | Laps, welds, joints and seals                        |                                                    | 3.1                              | System details                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
| 1.7                                                  | Service entries seals                                |                                                    | Areas Unavailable for Inspection |                                                                    | Material Batch Numbers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |                           |        |
| Installers Name & Company:                           |                                                      | NVQ Level 2 Qualified?                             |                                  | Photographic Evidence Requested from Site Manager/Installer YES/NO |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
|                                                      |                                                      | Yes                                                | No                               |                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Ongoing                      |                           |        |
|                                                      |                                                      | Yes                                                | No                               |                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Ongoing                      |                           |        |
|                                                      |                                                      | Yes                                                | No                               | Ongoing                                                            | <div style="display: flex;"> <div style="width: 30%; background-color: #d3d3d3;">The gas protection measures inspected:</div> <div style="width: 70%;"> <div style="background-color: #d3d3d3;">A – Are acceptable and comply with the specification</div> <div style="background-color: #d3d3d3;">B – Are acceptable but attention is drawn to issues related to item No.</div> <div style="background-color: #d3d3d3;">C – Are not acceptable due to the issues related to item No.</div> </div> </div> |                              |                           |        |
| Non-Conformance/Corrective Measures Sheet Completed? |                                                      | Yes                                                | No                               |                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
|                                                      |                                                      |                                                    |                                  |                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                           |        |
| Additional Notes -                                   |                                                      | Photographs, As A Minimum & Where Applicable ( ✓ ) |                                  |                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Test Weld & Material Samples |                           |        |
|                                                      |                                                      | Overall Plot / Area                                |                                  | Membrane Joint / Welds                                             | Corner Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Defects ALL                  | Test Weld Obtained        | YES/NO |
|                                                      |                                                      | Stanchions                                         |                                  | Air Bricks / Venting                                               | Service Pipe Seals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Repairs ALL                  | Material Samples Obtained | YES/NO |
| Name                                                 |                                                      | Signature                                          |                                  |                                                                    | Date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                              |                           |        |

NON-CONFORMANCE/CORRECTIVE MEASURES SHEET



|           |                            |             |        |        |               |
|-----------|----------------------------|-------------|--------|--------|---------------|
| Site Name | Harrington Drive, Crowland | Project No. | D41153 | Client | Ashwood Homes |
|-----------|----------------------------|-------------|--------|--------|---------------|

| Ground Floor Layout (Identify location of Non-Compliance on Layout) | Plot No |  | Ref. No. | Description: Weld failure (WF)<br>Puncture (P) Corner seal failure (CSF)<br>Service penetration failure (SPF)<br>Tear (T) Cut (C) Patch failure (PF)<br>Other (O) – please detail | Repair:<br>Patch (P)<br>Reweld (R)<br>Other (O) | Photo Ref. |        |
|---------------------------------------------------------------------|---------|--|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|------------|--------|
|                                                                     |         |  |          |                                                                                                                                                                                   |                                                 | Defect     | Repair |
|                                                                     |         |  | 1        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 2        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 3        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 4        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 5        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 6        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 7        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 8        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 9        |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 10       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 11       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 12       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 13       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 14       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 15       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 16       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 17       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 18       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 19       |                                                                                                                                                                                   |                                                 |            |        |
|                                                                     |         |  | 20       |                                                                                                                                                                                   |                                                 |            |        |

|                            |  |                             |  |                       |  |                        |  |
|----------------------------|--|-----------------------------|--|-----------------------|--|------------------------|--|
| Date of Initial inspection |  | Initial Inspection Visit by |  | Date of Re-Inspection |  | Re-Inspection Visit By |  |
|----------------------------|--|-----------------------------|--|-----------------------|--|------------------------|--|

**APPENDIX IV**  
**Conditions & Limitations**

## Conditions & Limitations

### Phase I Desk Studies

1. Works undertaken to provide the basis of the Phase I Desk Study report comprise a review of information available from a number of sources/parties (potentially also including the Client) together with a walk over of the site (where applicable and included within the quotation). The opinions given in the Phase I Desk Study are based on the information available from third parties/sources that has been obtained within the available timeframe. GeoDyne Limited assumes all third party information to be true and correct and therefore cannot accept liability for the accuracy of such information supplied.
2. Should additional information become available that may affect the comments and opinions made within the Phase I Desk Study, GeoDyne Limited reserves the right to review such information and make modifications to comments/opinions as appropriate.
3. It should be borne in mind that a Phase I Desk Study collates available information to generate a conceptual model of the site. The actual geotechnical and environmental considerations can only be fully quantified by intrusive investigation works to confirm the accuracy of the conceptual site model.

### Phase II Intrusive Investigations

1. Our quotation assumes that access to the site will be arranged by others at no cost to ourselves.
2. We have assumed that free access is available throughout to the entire site and that works can be undertaken during a single mobilisation. Where restricted access is encountered, or where additional unscheduled mobilisations are required, additional costs may be incurred to the client.
3. We have assumed that all available information relating to buried services will be supplied by the Client at no cost to ourselves. No responsibility will be accepted for damage to underground services that have not been brought to our prior attention by the Client.
4. All excavations/boreholes will be backfilled with compacted arisings upon completion, with any excess arisings left proud of ground levels. Excess arisings will not be removed from the site unless specifically requested by the Client. Where we are requested to remove excess arisings, all associated costs will be passed to the Client.
5. We will attempt to leave the site in a clean and tidy state, however, it must be understood that some disturbance of the site is unavoidable during intrusive works.
6. Exploratory holes are positioned approximately on site by GeoDyne Limited. Should the client require precise locations of all exploratory points, additional fees will be incurred. It must be borne in mind that backfilled trial pits can create 'soft spots', therefore, should the Client wish to designate 'no dig' zones, for example under the footprint of proposed structures, these must be brought to our attention prior to commencement of works.
7. Groundwater observations relate to conditions encountered at the time of investigation. It must be understood that groundwater levels may vary as a result of recent climatic conditions or seasonal variation.
8. Trial pits and boreholes examine only a small proportion of the total site area. No liability can be accepted for conditions not revealed in exploratory holes, particularly between positions. All extrapolations of available data are given in good faith.

### Payment

1. Payment terms are strictly 28 days from the invoice date.
2. Prior to commencement of works, we require receipt of formal written instruction from the party accepting full financial responsibility for the work. In the absence of such an instruction, we would expect the instructing Consulting Engineers/Architects to accept full financial responsibility for the works.
3. Receipt of instruction to commence work shall be taken as acceptance and compliance of the foregoing conditions.

### Liability

1. GeoDyne Limited offer £5,000,000.00 Professional Indemnity Insurance (in aggregate over the year). This shall be the limit of our liability for works undertaken. No individual liability shall be implied to, or accepted by, any employee for works undertaken for and on the behalf of GeoDyne Limited.