



The Environmental Protection Group Ltd



Gas Risk Assessment

**Corner House, Churchgate,
Whaplode, Spalding**

March 2021

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1. INTRODUCTION

1.1 Background

Planning Permission (Ref. H23-1068-19) has been secured from South Holland District Council (SHDC) for the construction of a detached residential bungalow in the garden of an existing residential property referred to as 'Corner House', located off Churchgate in Whaplode, Spalding (Lincolnshire, PE12 6TA).

Condition 7 of the Outline Planning Approval for the scheme (Ref. H23-0095-19) relates to the requirement to investigate, assess and mitigate (where necessary) any potential contamination risks at the site. Consistent with the requirements of Planning Condition 7, the following works have been implemented:

- Humberside Materials Laboratory Limited (HML). Phase 1 (Desk Study) Report – Corner House, Church Gate, Whaplode. Reference 991/4873/P/P1, June 2019;
- South Lincs Consulting Limited (SLC). Soil Report – Raft Design - Corner House, Church Gate, Whaplode. Reference 20-0020, January 2020; and
- Humberside Materials Laboratory Limited (HML). Phase 2 (Site Investigation) Report – Corner House, Church Gate, Whaplode. Reference 0991/4873/P/P2, March 2020.

Consistent with the known history of the site and its environmental setting, the afore referenced reports concluded that contamination risks are Low. The only mitigation that was identified to be required was the incorporation of Characteristic Situation 2 (CS2) gas protection measures within the floor slab construction of the dwelling, to be constructed in accordance with British Standard (BS) BS8485:2015+A1:2019 (Code of Practice for the Design of Protective Measures for Methane & Carbon Dioxide Ground Gases for New Buildings (BSI, 2019)).

The decision to recommend CS2 gas protection measures was based on the following:

- Past precedence whereby, on a recent residential development site to the immediate north (constructed circa 2018), CS2 gas protection measures had been incorporated into the construction of the new property, negating the requirement for gas monitoring and satisfying a similar SHDC planning condition; and

- Application of the CLAIRE Research Bulletin 17 Approach (RB17) – A Pragmatic Approach to Ground Gas Risk Assessment, whereby Total Organic Carbon (TOC) test results can be used as an indicator of generic gas risk mitigation requirements, in low-risk situations negating the need for gas monitoring.

In a low-rise residential development, CS2 gas protection measures typically involve:

- Passive sub-floor venting (2.5 Gas Protection Points, Table 6 of BS); and
- Provision of a gas resistant membrane (2.0 Gas Protection Points, Table 7 of BS).

If constructed and verified correctly, the above measures meet the Minimum Gas Protection Point allocation required by the BS (3.5 Gas Protection Points, Table 4 of BS) for a Type A Building (i.e. private residential dwelling) on a CS2 site.

The above scenario assumes no mitigation is provided by the structural barrier (i.e. floor slab construction). This is because a precast suspended segmental floor (i.e. beam and block construction) is often adopted for residential use. Such floor slabs are typically very leaky and this is why they are not allocated any Gas Protection Points (0.0, Table 5 of BS).

On the Corner House development site the above situation does not reflect the construction of the new dwelling. The structural barrier comprises a monolithic reinforced ground bearing raft, constructed on top of a Damp Proof Membrane (DPM). On its own, this form of structural barrier provides a good level of gas resistance, achieving 1.5 Gas Protection Points (Table 5 of BS). However, no passive venting was provided beneath the raft and no gas resistant membrane was incorporated into the raft construction. On this basis, the gas mitigation incorporated into the constructed residential dwelling does not meet the Minimum Gas Protection Point requirement of 3.5 Gas Protection Points for a Type A Building on a CS2 site.

In this scenario there are two options:

1. Retrospectively install gas risk mitigation measures; and/or
2. Review the actual gas risk to determine if the original gas risk classification was reasonable.

In practice, whilst retrospective installation of gas risk mitigation measures is possible, it is very difficult to achieve effectively – certainly without causing significant damage to the dwelling finishes.

Reflecting the above, the Environmental Protection Group Limited (EPG) were asked to review the gas risk on site and assess if the CS2 classification is reasonable and if retrospective gas risk mitigation is required.

EPG's preliminary review of the site identified three key issues with the previously prepared documents:

1. They did not take into account the raft construction of the building – which inherently provides a level of gas resistance;
2. The RB17 Approach had been applied incorrectly, with TOC data from the natural geology (Tidal Flat Deposits) used to assess gas risk relative to stipulated CS Limiting Values (which should only be applied to TOC results from Made Ground); and
3. The reports prepared previously for the site had not used the obtained lines of evidence to support the development of a robust Conceptual Site Model (CSM) for the assessment of permanent gas risks.

The following Gas Risk Assessment sets out the lines of evidence available for the site, using them to support the development of a robust CSM. The CSM is then used to inform quantitative (diffusion) modelling, which takes into account the raft construction of the property, to assess gas risks and determine if mitigation is required. The use of quantitative modelling techniques is allowed by BS8485:2015+A1:2019, notably in situations where generic models (e.g. the RB17 Approach and/or Wilson and Card Modified Approach) may be resulting in an over-conservative site assessment.

This report has been prepared in general accordance with UK guidance and good practice documents, including (but not limited to):

- BS8485: 2015 + A1: 2019 - Code of Practice for the Design of Protective Measures for Methane & Carbon Dioxide Ground Gases for New Buildings (BSI, 2019);
- CIRIA Report C735 - Good Practice on the Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gases (CIRIA, 2014);
- Land Contamination: Risk Management (<https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm>) (Environment Agency, October 2020);
- BS EN ISO 21365 - Soil quality – Conceptual Site Models for Potentially Contaminated Sites (BSI, 2020). and
- CIRIA Report C795 – Retrofitting Hazardous Ground Gas Protection Measures in Existing or Refurbished Buildings (CIRIA, 2020).

With respect to gas risk, EPG's report supersedes all previous documents. A copy of this report should be submitted to SHDC for their review, comment and approval.

1.2 Competence

Land Contamination: Risk Management (LCRM) requires that for *'land contamination and planning you must use and meet the National Planning Policy Framework definition of a competent person'*. Further, British Standard BS8485: 2015 + A1: 2019 states that *"It has been assumed in the preparation of this report that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced"*.

This report has been prepared by Sarah Mortimer (Associate) and Steve Wilson (Technical Director) of EPG.

Sarah is a Chartered Geologist with 20 years' experience in Contaminated Land. She is a specialist in Permanent Gas Risk Assessment and Vapour Intrusion Risk Assessment, being Accredited by the Society of Brownfield Risk Assessment (ASoBRA) in these fields.

Steve is a Chartered Engineer and Registered Ground Engineering Advisor with over 30 years' experience in the investigation and assessment of ground gas. He is a SoBRA Accredited Risk Assessor for Permanent Gas and Vapour Intrusion. He has written numerous technical papers on the subject and contributed to much of the UK's guidance, including various British Standards.

The above demonstrates compliance with the competency requirement(s) of both the LCRM and the British Standard.

2. BACKGROUND INFORMATION

Site Summary:

Site	Former garden of Corner House Churchgate Whaplode Spalding PE12 6TA	Date	March 2021
Location	Lincolnshire	Assessment by	SM
Grid Reference	532500, 324230	Approved by	SAW
Current Surrounding Land Uses	North: Residential house, recently constructed ~2018. East: Residential houses. South: Residential houses. West: Church Gate with residential houses beyond.		

Information Provided:

Referenced Report	• Humberside Materials Laboratory Limited (HML). Phase 1 (Desk Study) Report – Corner House, Church Gate, Whaplode. Reference 991/4873/P/P1, June 2019; • South Lincs Consulting Limited (SLC). Soil Report – Raft Design - Corner House, Church Gate, Whaplode. Reference 20-0020, January 2020; and • Humberside Materials Laboratory Limited (HML). Phase 2 (Site Investigation) Report – Corner House, Church Gate, Whaplode. Reference 0991/4873/P/P2, March 2020. <i>Note: In addition to the above, factual data (an exploratory hole location plan and summary trial pit log sheets) have been provided for the recently constructed property to the north – as completed by Humberside Materials Laboratory Limited (HML), Reference 973/3041/P, May 2017.</i>
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Referenced Drawing(s)	- Cooper Architectural Design – Block & Location Plan, Drawing 0901-01-A. - Cooper Architectural Design – Three Bedroom Bungalow & Garage, Drawing 0901-02-A. - Cooper Architectural Design – Foundation Plan, Drawing 0901-04. The above drawings are referenced within EPG’s report and copies presented in Appendix A.
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Development:

Development	1 No. three bedroom bungalow with integral garage.	Sensitivity	High
Details	The property has been constructed on a 300mm thick raft, thickened around the edge to 375mm. The raft construction is as per the detail provided in Figure 1, incorporating top and bottom reinforcement. The raft is continuous beneath the building construction, including the integral garage. All utility services are cast into the raft construction. The dimensions of the raft and reinforcement are such that cracking will be minimal and will not provide a gas migration pathway. There is a DPM below the raft which although not completely gas tight will provide gas resistance if any cracks do form through the full depth of the concrete. It also acts as a slip membrane to the concrete slab, allowing it to shrink without restraint (although the slight down stands will provide some restraint). Detailed description of Figure 1: This is a technical cross-section drawing of a foundation raft. From top to bottom, the layers are: - Existing GL (Ground Level) - PAVING SLABS TO PERIMETER - 5 NO COURSES RED ENGINEERING BRICK BELOW D.P.C. - 100mm ECO THERM ECO-CAVITY INSULATION BOARD TO 450mm ABOVE D.P.C. - 100mm FACING BRICK - 12.5mm WALL BOARD & SKIM ON PLASTER DABS - 100mm TARMAC TOP/LITE GRI BLOCK - 75mm SAND / CEMENT SORBED - 150mm KINGSPAN KOOL THERM KISO INSULATION BOARD ON 1200µ POLYTHENE DPM LAPPED UP INTO D.P.C. - 900mm RC35 CONCRETE WITH ONE LAYER A399 MESH TOP AND BOTTOM - TYPE 1 DOT HARDCORE Dimensions shown include vertical heights of 450, 250, 125, 225, 75, 150, 300, and 200 mm, and horizontal widths of 250, 500, 550, and 600 mm. Reinforcement includes B10 12 BARS AT 600mm c.c.		

Figure 1. Raft Detail

Consistent with the above detail a series of photographs have been provided for the construction of the raft foundation, see Plates 1 to 6. In addition, an Architects Inspection Certificate for the raft has been provided, confirming that the raft was constructed as per the detail, see Appendix B.



Plate 1. Topsoil Removed, Utilities Installed and Compacted Hardcore Placed



Plate 2. DPM and Reinforcement Placed



Plate 3. DPM and Reinforcement Placed



Plate 4. DPM and Reinforcement Placed



Plate 5. Utility Service Cast Into Raft Construction



Plate 6. Utility Service Cast Into Raft Construction

Desk study:

Site History

The earliest Ordnance Survey (OS) map for the site is dated 1888 and indicates it to comprise a garden associated with a residential property, see Figure 2. To the immediate north-east of the site (slightly impinging onto the sites northern boundary) is an area referred to as 'The Broads'. In later maps this is indicated to comprise an area of marshy ground. To the north-west of the site is a Windmill (Corn).



Figure 2. OS Map - 1888

No changes are noted on site until 1931, when a new land boundary is indicated and a building constructed (use unknown, possibly a house, domestic garage or outbuilding). The area of marshy ground referred to as The Broads remains to the north-east of the site (slightly impinging onto the northern site boundary) – see Figure 3.



Figure 3. OS Map – 1931

In the OS map dated 1970 a further structure is identified on site, again possibly comprising a residential outbuilding or domestic garage. The Broads are no longer present, with this former area of marshy ground presumably infilled and a Drain constructed to the north. The former area of The Broads is now occupied by a Piggery, see Figure 4. The former Corn Mill to the north-west is now indicated to be a Store and a Nursery is now indicated to the south-west of the site. A Garage (petrol filling station) has been constructed ~55m north of the site.



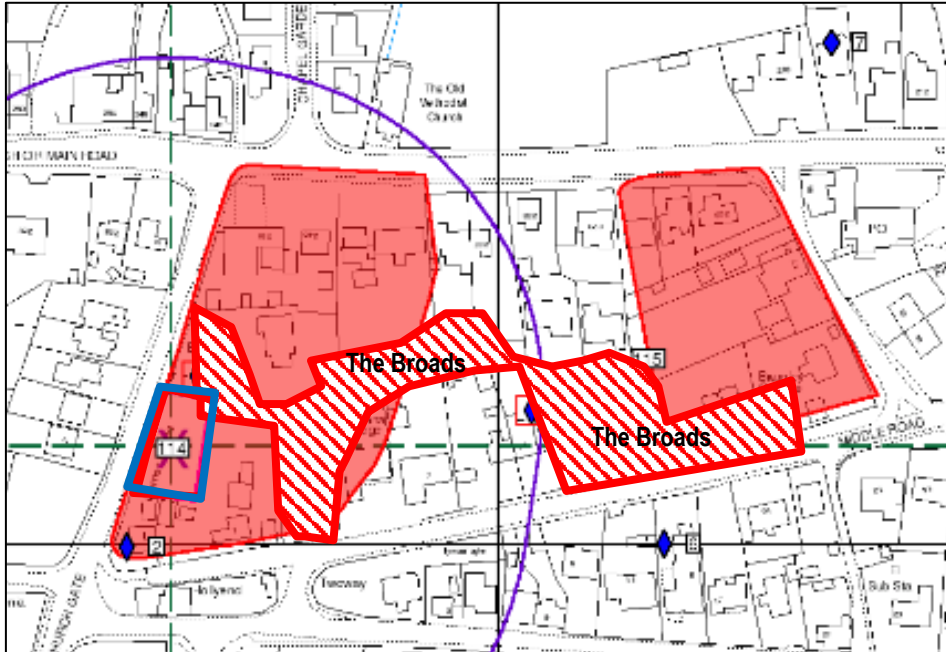
Figure 4. OS Map - 1970

The Piggery is indicated to have been demolished in circa 1981, following which time this area is incorporated into the rear gardens of newly constructed residential properties located off Middle Road. The former Store to the north-west is noted as being in use as a Garage (presumably vehicle maintenance), later being redeveloped with residential houses in circa 1991.



Figure 5. OS Map - 1991

In the 1991 OS map all structures have been cleared from the site. No significant changes are noted on site, or in the surrounding area after 1991.

	In summary, the site and surrounding area have a long history of residential land use. To the immediate north-east of the site was an area of marshy ground referred to as The Broads. This area appears to have been reclaimed (infilled) in circa 1970. Any fill placed in this area will be >50 years old and well past the point of any significant gas generation. Interspersed with the off-site residential land uses are some historical commercial properties including a Corn Mill, Nursery, Store and Garages (potentially operating for both vehicular maintenance and refuelling). Contamination risks associated with these off-site uses are considered likely to be Low, noting that the prevailing geology is predominantly cohesive (see Geology & Ground Conditions, the fine grained Tidal Flat Deposits will limit lateral / vertical contamination migration pathways) and these areas have subsequently been developed with residential dwellings.
Landfills	Two areas of landfilling are noted in the area – one impinging onto the northern boundary of the site (The Piggery) and one located ~100m east (Foundry House). It is considered likely that both these areas of ‘landfilling’ relate to the reclamation of the marshy ground identified in historical OS maps and referred to as ‘The Broads’ – see overlay presented as Figure 6. Any filling associated with the reclamation of these areas is likely to be shallow, not exceeding the depth to the water table (which has been encountered at <1m below ground level – see Geology and Ground Conditions).  Figure 6. Landfills with The Broads Overlay

The Envirocheck Report obtained for the site indicates deposited wastes to include 'household' material. No dates of deposition are provided, but it is known that all filling was complete by 1970 (i.e. the material placed is >50yrs old).

In 2017 HML completed two trial pits (TP1 and TP2) to the north of the site in connection with the construction of a new residential property (Report Reference 973/3041/P), see Figure 7.



Figure 7. Off-Site Intrusive Works, HML 2017

TP1 would appear to be outside the area of filling. However, TP2 is located in the area of filling. Ground conditions in both these exploratory holes comprised a mantle of Topsoil (0.3m thick) underlain by reworked Tidal Flat Deposits (brown silt with occasional brick, concrete and tarmac) to maximum 1.3m depth with natural (in-situ) Tidal Flat Deposit beneath, comprising light brown silt.

	These ground conditions are consistent with EPG's review, whereby: • Any fill placed is relative thin (maximum 1.3m thick, extending to the shallow water table which is prevalent in the area), associated with the reclamation of marshy ground referred to as The Broads; • Any fill which was placed was deposited by 1970 (when these areas were developed with a Piggery and residential housing). As such, any fill material will be >50yrs old and well past the point of any significant landfill gas generation. • Exploratory holes completed to the north (in conjunction with those completed on site – see Geology and Ground Conditions) do not indicate that significant thicknesses of 'waste' are present either on the site or in its immediate vicinity. Instead, the fill material comprises reworked natural over-burden, which will have a 'Very Low' gas generation potential as it does not contain large quantities of degradable organic material; and • Given the fine-grained nature of the natural geology (Tidal Flat Deposits) any minor gas which is present is unlikely to migrate laterally toward the Corner House development site, instead it will diffuse to atmosphere via the gardens positioned above. In view of the above, the off-site areas of landfilling referred to as The Piggery and Foundry House are not considered to pose a credible source of landfill gas which requires further consideration within this report.
Radon	The site is located in a low-risk radon area, where less than 1% of properties are affected by radon in excess of the specified Action Level. No radon protection measures are required for incorporation within new buildings.

Geology and Ground Conditions:

Geology	
Prevailing	The prevailing geology beneath the site comprises Tidal Flat Deposits underlain by the West Walton Formation (mudstone or siltstone).
Ground Conditions	An initial phase of intrusive work was completed on the site in January 2020, comprising a hand auger borehole (BHA), progressed to 2.1m depth. This was supplemented by 4 No. window samplers boreholes (WS1 to WS4), progressed to 2.0m depth in February 2020. An exploratory hole location plan for the completed exploratory hole works is presented as Figure 8.  Figure 8. Exploratory Hole Location Plan The intrusive works are considered to provide good coverage of the site, with WS1 located on the northern area of the site where historical maps inferred that backfilling of The Broads may have impinged onto the development site.

	Across all the exploratory holes, and consistent with the off-site ground conditions observed in TP1 and TP2, soils encountered comprised between 0.2m and 0.4m of topsoil, underlain by grey silt with variable clay and sand content. The silt represents the Tidal Flat Deposits, which were noted to contain rootlets and have local organic odour. In WS4 the Tidal Flat Deposits were reworked to 0.9m depth, with a clay pipe (possible land drain) encountered at 0.7m. Also in WS4 the Tidal Flat Deposits were noted to contain organic matter (fibrous peat) at between 1.7m and 1.9m depth. Despite the references to rootlets, organic odour and local presence of fibrous peat, testing of the Tidal Flat Deposit material indicates it to have a relatively low Total Organic Carbon (TOC) with 2.2% indicated in the clayey silt (WS3, 1.10m to 1.25mbgl) and 1.4% indicated in the peaty material (WS4, 1.70m to 1.90mbgl). Shallow water strikes were recorded in each of the exploratory holes, stabilising at between 0.45m and 0.53mbgl within 20 minutes of drilling. The above ground conditions are consistent with the known history of the site, the prevailing geology of the area and the known potential for marshy ground as a result of a shallow water table. Importantly, no evidence of any on-site waste material was observed – including via WS1 which specifically targeted the proximity of the former infilled referred to as The Broads. The gas generation potential of the Tidal Flat Deposits is considered to be ‘Very Low’, reflecting that they do not contain large quantities of degradable organic material (Table 3.1 of the Local Authority Guide to Ground Gas, Chartered Institute of Environmental Health, 2008). It is possible that more organic rich material is present at depth, with the shallowest peat recorded in WS4 at between 1.7m and 1.9m depth. Even though organic material may be present at depth it will not be generating gas at the present time (see Card G B, Lucas J and Wilson S (2019) Reliability and risk in gas protection design: 20 years on. Part 1, Ground Engineering, August 2019). Further, the peat and Tidal Flat Deposits are saturated and as such there is negligible free phase gas present, plus the gas permeability is very low. Thus, any gas in the peat or Tidal Flat Deposits is effectively immobile and either in dissolved phase in water or adsorbed onto the organic material. Importantly, it is not capable of causing hazardous emissions at the surface.
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Contamination	During the intrusive works no visual or olfactory evidence of contamination was observed, with only local incidences of clinker in the topsoil. Consistent with these observations, chemical testing of representative soil samples confirmed concentrations of potential contaminants to be present at concentrations lower than the adopted Generic Assessment Criteria. On this basis, there is no credible vapour phase risk on site.
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3. CONCEPTUAL SITE MODEL

3.1 Source

EPG's data review has identified that the main source of ground gas is organic rich inclusions within the Tidal Flat Deposits, i.e. the fibrous peat as encountered in WS4 at between 1.7m and 1.9m bgl. Consistent with Table 3.1 of The Local Authority Guide to Ground Gas (CIEH, 2008) the Tidal Flat Deposits are considered likely to have a 'Very Low' gas generation potential and pose a 'Low' level of risk to on-site development. This is because any gas which is present in the peat is historically generated and trapped or adsorbed in the soil such that the actual current gas generation rate is 'Very Low'.

Note: As discussed in previous sections of this report, the off-site areas of landfilling referred to as The Piggery and Foundry House are not considered to be credible sources of landfill gas which require further consideration within this Gas Risk Assessment.

3.2 Pathway

As noted above, the actual rates of gas generation from the organic rich inclusions within the Tidal Flat Deposits will be 'Very Low'. This source of gas will not be capable of sustaining any pressure driven (advective) flow. Instead, any gas migration which does occur will be via diffusion. Diffusion flow occurs very slowly, as gas migration follows a tortuous network of soil pores. On this site this will be especially slow given the fine-grained silt which dominates the matrix of the Tidal Flat Deposits and the shallow water table which means the soils are saturated.

3.3 Receptor

The primary receptor associated with the site is the future occupants of the bungalow. However, the raft foundation will provide a good level of resistance to gas ingress, noting that it comprises a minimum 300mm thickness of reinforced mass concrete and all utility services have been cast into the floor slab construction. The only routes for gas ingress will be via the service ducts themselves (which should be sealed – see Section 5) and via any micro-cracks which are present in the mass concrete of the raft. However, the potential for micro cracks will have been significantly reduced via the incorporation of extensive reinforcement within the raft construction.

3.4 Ground Model

EPG's data review has been used to develop a pictorial ground model for the site. This is presented as Figure 9.

Notes:
1. No radon protection required.
2. No vapour phase risks identified.

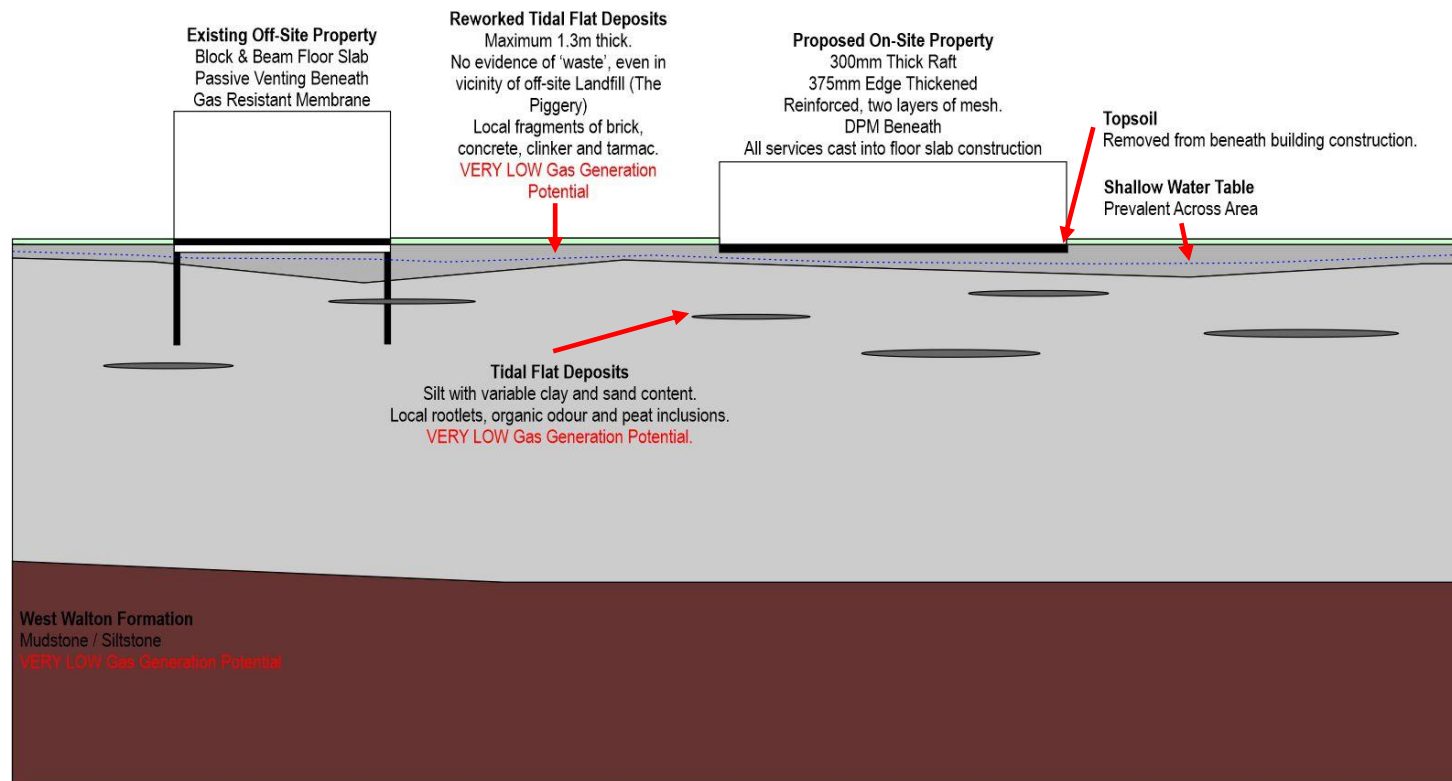


Figure 9. Ground Model – Ground Gas

4. RISK MODELLING

EPG's review has indicated that only Very Low gas generation potential sources are present beneath the site, i.e. organic inclusions (fibrous peat) within the Tidal Flat Deposits. Any migration of gas from this source will be via diffusion, which will be very slow due to the nature of the source, its depth (minimum 1.7mbgl), the fined grained matrix of the Tidal Flat Deposit and the high water table which is prevalent across the area.

If any diffusion of gas does occur it is unlikely that this would result in the accumulation of gas beneath the floor slab. Even if it does, given the construction of the building there are only two routes for gas ingress – via the internal annulus of the service ducts (which should be sealed, see Section 5) and/or via micro cracks within the raft construction.

The potential for micro cracks to occur within the raft foundation will be significantly limited by both the thickness of the mass concrete (minimum 300mm) and the incorporated reinforcement. It is certainly highly unlikely that any micro crack will be present which propagates through the full thickness of the floor slab.

In view of the above, associated gas risks are considered to be Negligible. Furthermore, there are no known cases where methane from Alluvium or geological peat deposits has migrated out of the ground and posed a risk to overlying developments (see Card G B, Lucas J and Wilson S (2019) Reliability and risk in gas protection design: 20 years on. Part 1, Ground Engineering, August 2019).

However, to robustly demonstrate this diffusion modelling has been completed – see the data output sheet presented in Appendix C. This model has used the most precautionary and conservative parameters that would sensibly apply to the Tidal Flat deposits and the raft construction (for example the assumption of 100% methane in the ground below the whole building footprint).

The diffusion modelling indicates that there is minimal risk of gas migrating through the slab. The worst case is pressure driven flow through the floor slab which results in an estimated methane concentration inside the building of 0.006% which is negligible and less than concentrations commonly found inside buildings associated with minor leaks in gas appliances. In reality, gas ingress would be limited by diffusion of gas from the underlying ground which would result in even lower estimated concentrations inside the building.

5. CONCLUSIONS AND RECOMMENDATION

EPG's review has indicated that only Very Low gas generation potential sources are present beneath the site, i.e. organic inclusions (fibrous peat) within the Tidal Flat Deposits. Any migration of gas from this source will be via diffusion, which will be very slow due to the nature of the source, its depth (minimum 1.7mbgl), the fined grained matrix of the Tidal Flat Deposit and the high water table which is prevalent across the area.

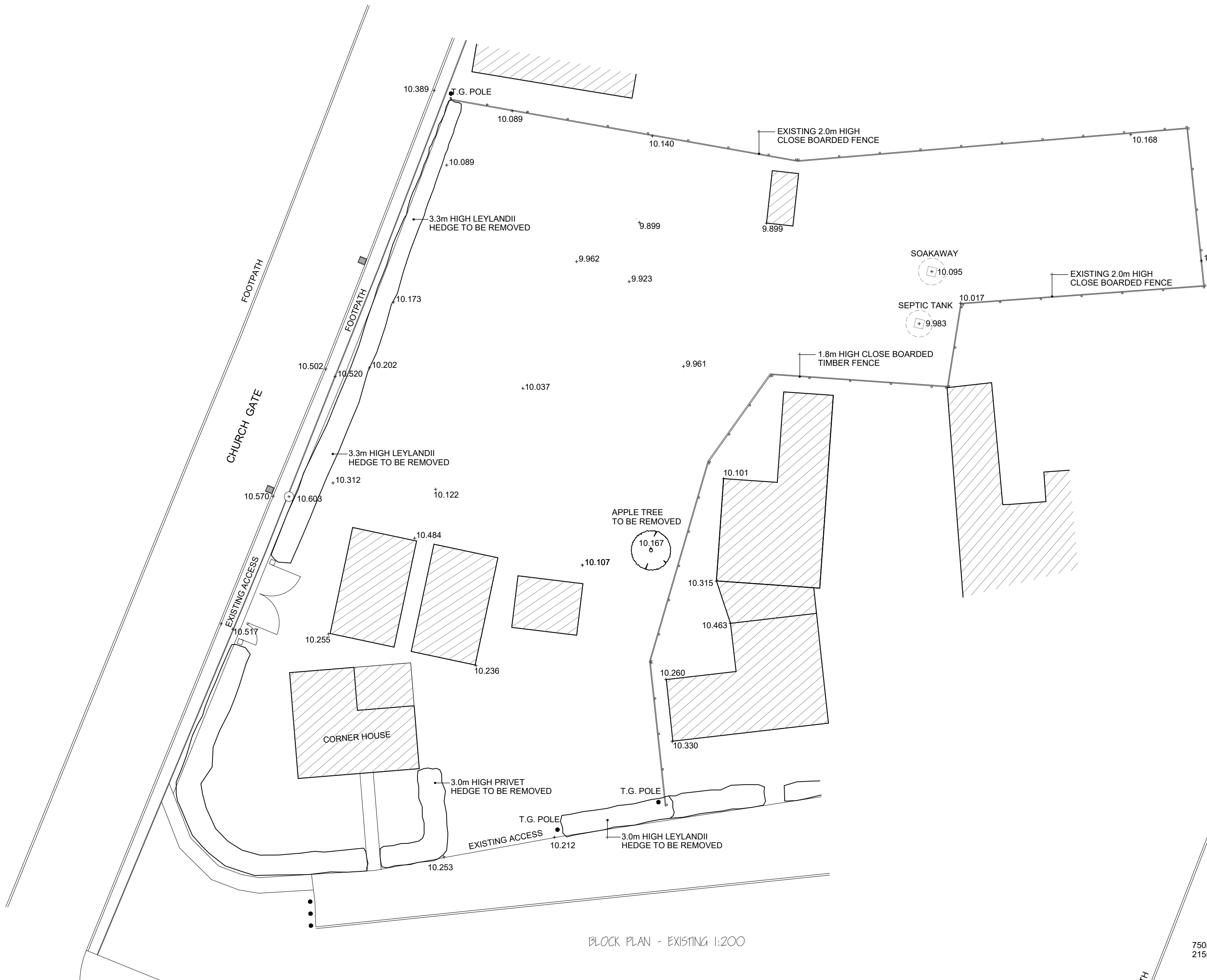
If any diffusion of gas does occur it is unlikely that this would result in the accumulation of gas beneath the floor slab. Even if it does, given the construction of the building there are only two routes for gas ingress – via the internal annulus of the service ducts and/or via micro cracks within the raft construction.

EPG's diffusion modelling has demonstrated that there is no credible risk of gas migration via micro cracks within the raft. On this basis, there is no requirement to retrospectively install gas mitigation measures (passive venting and/or a gas resistant membrane) within the floor slab construction of the constructed bungalow.

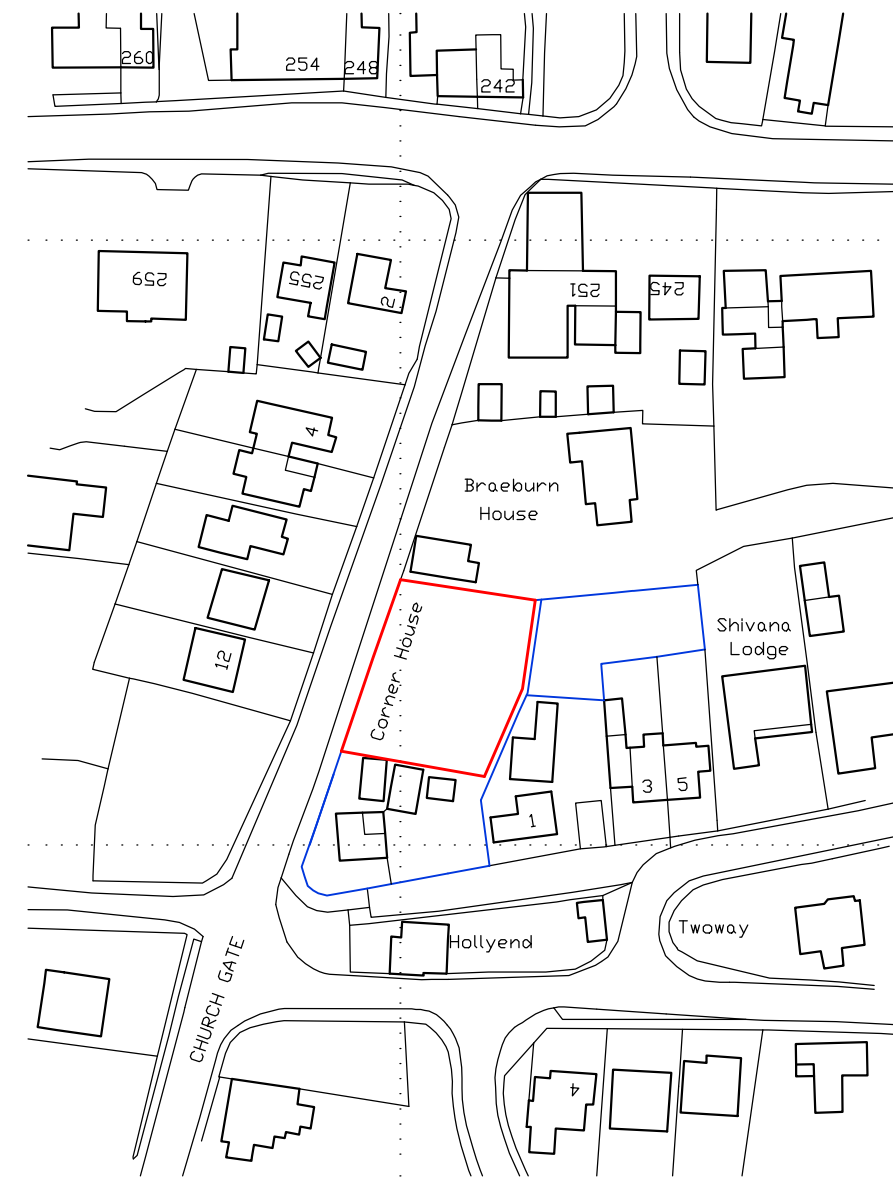
Notwithstanding the above, it is recommended that the internal annulus of each service duct is sealed, via the injection of minimum 200mm deep partially of fully closed cell expanding polyurethane foam, with liquid gas membrane (e.g. [LIQUID GAS BARRIER Membrane - Juta UK](#)) painted over the top. Photographs of these works should be provided to SHDC for their records and in order to facilitate discharge of the related Planning Condition.

Appendix A

Drawings



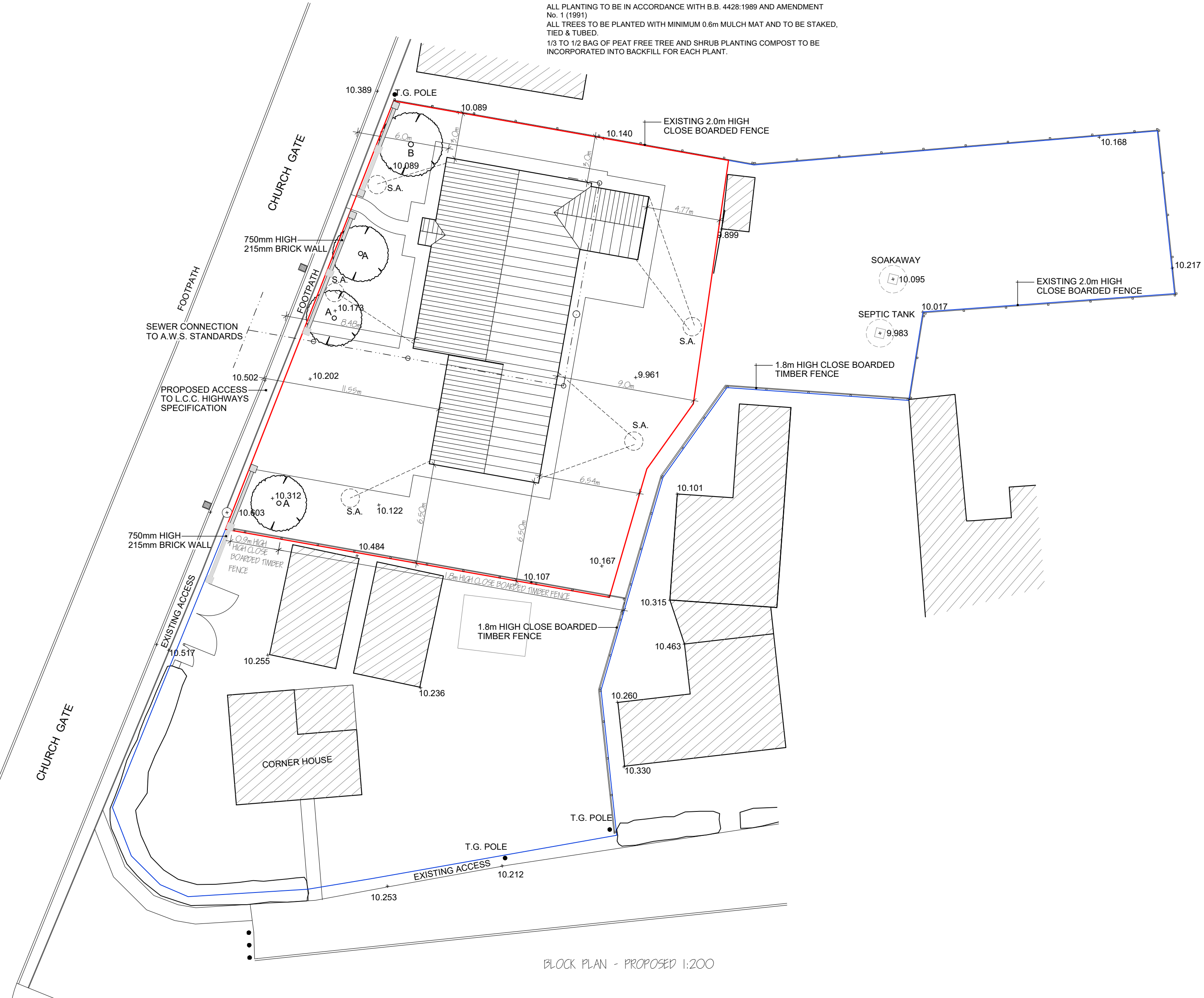
BLOCK PLAN - EXISTING 1:200



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LOCATION PLAN 1:1250

- TREE PLANTING**
- A WHITEBEAM (SORBUS ARIA) STANDARD
 - B LOCUST TREE (ROBINIA PSEUDOACACIA 'FRISIA') STANDARD
- ALL PLANTING TO BE IN ACCORDANCE WITH B.B. 4428:1989 AND AMENDMENT No. 1 (1991)
ALL TREES TO BE PLANTED WITH MINIMUM 0.6m MULCH MAT AND TO BE STAKED, TIED & TUBED.
10 TO 12 BAGS OF PEAT FREE TREE AND SHRUB PLANTING COMPOST TO BE INCORPORATED INTO BACKFILL FOR EACH PLANT.



BLOCK PLAN - PROPOSED 1:200

LIMITATIONS.
This drawing is limited in the amount of information contained and does not purport to contain a full specification of the works. It is solely for the purpose of obtaining Planning/Building Regulation approval.
The drawing must not be used for any other purpose than above. All dimensions shall be taken from site from actual work, under no circumstances shall measurements be scaled from this drawing for construction or ordering purposes.
All given dimensions shall be checked by the Builder/Contractor and will be his responsibility from commencement of site works.
The works will not be supervised or inspected on site by C.A.D. or any representative thereof. It is the client or their appointed agents responsibility to control workmanship, substitution of materials, adherence to specification, variations to contract etc.

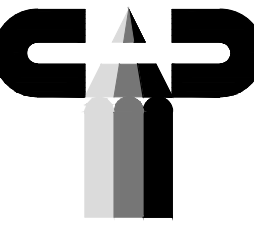
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STANDARDS.
All materials to be new unless otherwise stated and all components and materials etc. to be used fitted and installed etc. in which accordance with manufacturers instruction and relevant Code of Practice.
Materials shall conform to appropriate British Standard Specification or BBA Certificate or European Code equivalent.

HEALTH & SAFETY.
The Employer/Client shall ensure that the selected contractor is conversant with and adopts all measures necessary to achieve compliance with Health & Safety legislation for Building Sites and Work Places.
The Employer /Client is advised that should the works need to comply with the Construction Design and Management Regulations an independent Planning Supervisor will be required.

SCOPE OF THE WORKS.
The works shall comprise of all that is shown on the drawing and details. Work that may not be specifically shown but may be reasonably inferred as necessary to carry out the works shall be deemed to be included.

revision	date	init.	revision details.
A	JAN 20	J.C.	BUILDING REGULATIONS



COOPER ARCHITECTURAL DESIGN

90 WINSOR ROAD
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Client. MR & MRS J GRAVES

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WHARFLOPE
PE12 6TA

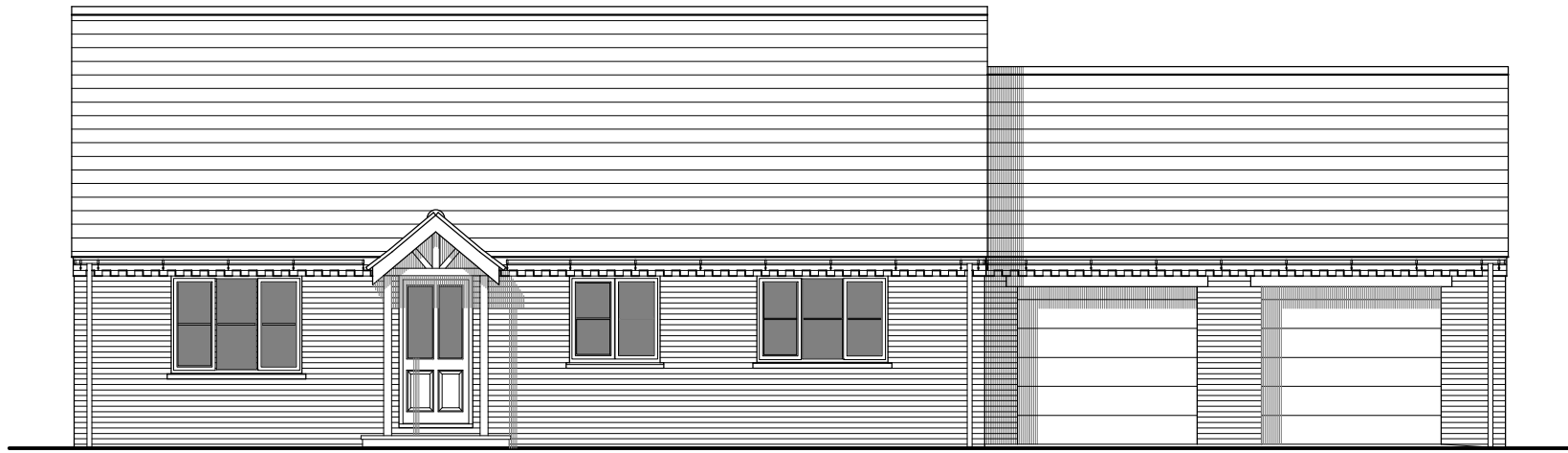
Drawing.

BLOCK & LOCATION PLANS

Scale 1:200 1:1250 @ A1	Drawing No. 1901-01-A
Date. MAY 19	Drawn. J.C.



WEST ELEVATION



EAST ELEVATION



NORTH ELEVATION



SOUTH ELEVATION

LINTEL / OPENING SCHEDULE				
POSN	W	H	LINTEL	LENGTH
1	1810	1950	1.G. L1 / 9100	2100
2	1020	2100	1.G. L1 / 9100	1560
3	1250	1200	1.G. L1 / 9100	1675
4	1810	1200	1.G. L1 / 9100	2100
5	2485	2175	1.G. L1 / 10100	3000
6	2485	2175	1.G. L1 / 10100	3000
7	1810	1050	1.G. L1 / 9100	2100
8	1810	1050	1.G. L1 / 9100	2100
9	1455	2100	1.G. L1 / 9100	1800
10	975	1050	1.G. L1 / 9100	900
11	1250	1200	1.G. L1 / 9100	1650
12	910	1050	1.G. L1 / 9100	1200
13	1020	2100	1.G. L1 / 9100	2100
14	+ 975	1050	1.G. L1 / 9100	2100
15	1810	2100	1.G. L1 / 9100	2100
16	1250	1950	1.G. L1 / 9100	1650
17	1250	1050	1.G. L1 / 9100	1650
18	975	1050	1.G. L1 / 9100	900

ELECTRICAL INSTALLATIONS.
All electrical work to meet the requirements of Approved Document Part P (Electrical Safety) and must be designed, installed, inspected and tested by a person competent to do so.
All electrical switches, socket outlets, telephone and T.V. points to habitable rooms to be positioned at appropriate heights between 450mm & 1200mm from F.F.I.
Electrical consumer units to be positioned so that switches are mounted between 1350mm & 1450mm above F.F.I.
Prior to completion of the works the Local Authority must be satisfied that either:
An electrical installation certificate issued under a competent persons scheme has been issued.
OR
An appropriate installation certificate has been issued for the work and that it has been signed by a person competent to do so.

LIGHTING.
To all habitable rooms provide energy efficient light fittings capable of taking lamps having a luminous efficacy greater than 45 lumens per circuit watt and a total output greater than 400 lamp lumens.
External lighting is to be fitted with Dawn-Dusk or movement sensors and capable of taking lamps having a luminous efficacy greater than 45 lumens per circuit.
All lighting to be in accordance with the Domestic Building Services Compliance Guide.

HIGH-SPEED ELECTRONIC COMMUNICATIONS.
Building work must be carried out so as to ensure that the building is equipped with a high-speed-ready in-building physical infrastructure, up to a network termination point for high-speed electronic communications networks.
Where the work concerns a building containing more than one dwelling, the work must be carried out so as to ensure that the building is equipped in addition with a common access point for high-speed electronic communications network.

CEILING / INSULATION.
Roof Level: Flat ceilings by 500mm total thickness of Knauf Earthfast Loft Bat 40 glass mineral wool insulation. 100mm between joists & 400mm (2 layers 200mm) over Joists 15mm Agrifo wallboard with skim finish.
1st value of 0.09 W/m²K.
Ensure 50mm air gap over all insulation.; All joints to be taped and filled. Provide access trap to roof space; opening to be lined with 25 x 25 planted stops. Access panel to be 12mm ply with layer of 12.7mm Fireline board fixed to face. 100mm J-labite to top surface. Provide slide bolt fastening & draught seal all round

LEVEL ENTRY THRESHOLD
Provide 'Jeldwon Ltd.' Mobility door frame & threshold (FN29M-NOB) Principal entrance to building. All External doors to be 850mm wide. And in all cases to provide minimum 775mm clear opening width.

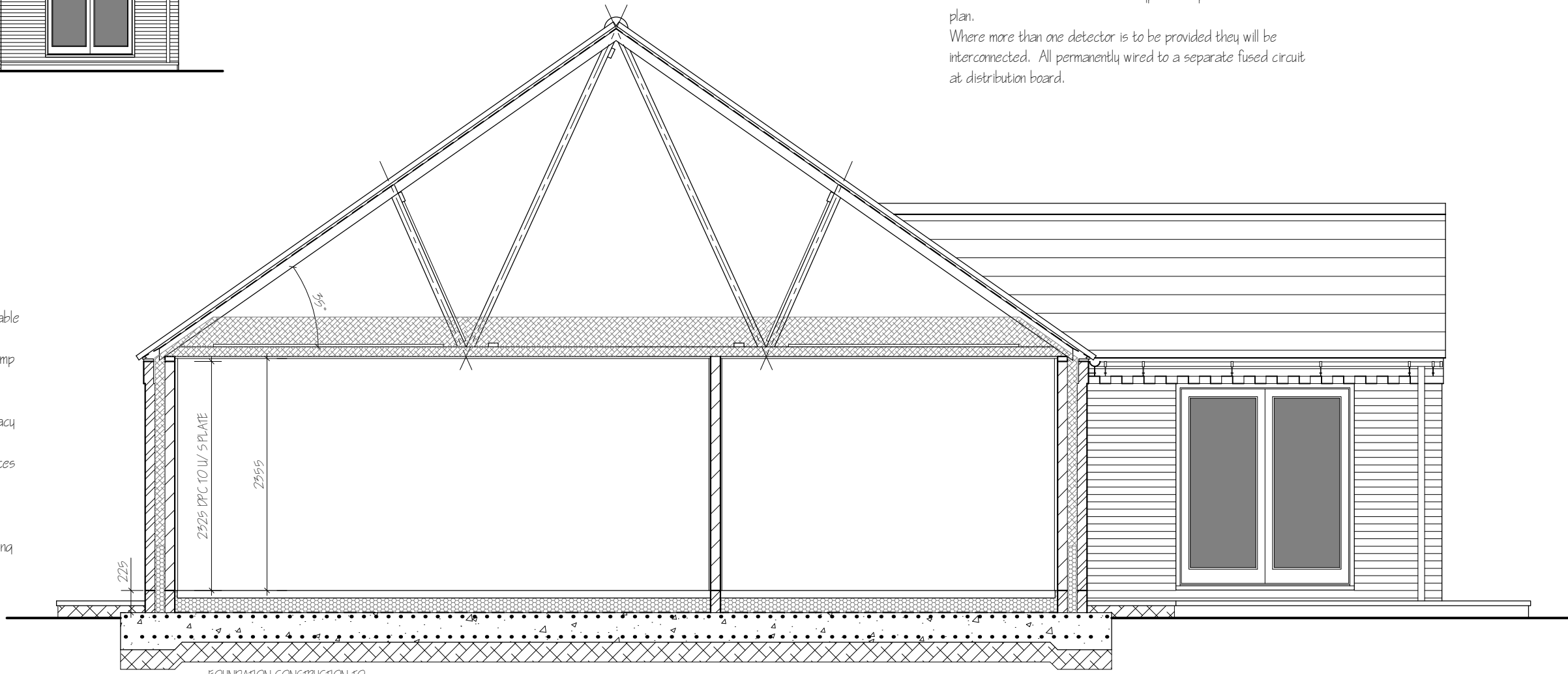
INTERNAL DOORS.
All internal doors to ground floor habitable rooms and toilet accommodation to be 850mm wide.

FOOTPATHS / DRIVES.
Provide min. 900mm wide paving slab footpath positioned at 150mm below D.P.C. level and min 150mm away from face of wall to perimeter of building. All footpaths to have slight fall away from building. Gap between wall & footpath to be filled with 150mm depth of 20mm washed gravel. Form 1.0m wide footpath from dwelling to road frontage, suitable for wheelchair access. At least 5.0m of drive adjacent to building x 3.0m wide to be hard standing i.e. Concrete, Tarmac or Block pavers. All to be sloped up to footpath level at min. 1:20

FOLL DRAINAGE
Fall drainage pipes to be 110mm dia. UPVC, to B.S. 4660:1985 flexibly jointed and laid to makers' instructions to a fall of 1:70 bed and surround with 100mm pea gravel. Where pipes pass under floors encase in 150mm pea gravel. Where pipes pass under drives surround in 150mm concrete with flexal joints to correspond with joints in pipe work. Provide 65 x 100 pre-stressed concrete lintel bridging where pipes pass through walls, provide compressible filler around pipe, opening masked both sides of wall with ridged sheet material. Soil and vent pipes to be 110mm dia. PVC to B.S. 4514: 1985 and to extend 900mm above window head terminating with PVC ballon. Waste pipes to be generally 40mm dia. 1st over 3.0m long run increase to 50mm dia. All PVC to B.S. 5945: 1979 complete with rodding eyes at every change of direction. Bath, basins and sink to have 75 deep seal traps. Shower to be raised on 150mm plinth with access plate to anti-siphon trap and 50mm waste. All redundant drains to be grubbed out or filled with lean-mix concrete. Condensation drainage from boiler flues to discharge via min. 22mm diameter pipes work through a 75mm condensation trap. Alternatively an additional trap should be provided externally to provide the required seal, an air gap should be provided between the boiler and the trap.

SURFACE WATER DRAINAGE.
112mm dia. half round rainwater gutters to 68mm dia. rainwater pipes. 110mm dia. underground pipes flexibly jointed to a fall of 1:70 pipes bedded and surrounded in pea gravel and discharge to 1.2m dia. soak away min. 5.0m to edge from dwelling. All footpaths and drives to slope away from building.

SMOKE / HEAT DETECTORS.
Provide ceiling mounted mains operated self-contained Smoke Alarms to BS 5399-1:2013 in positions shown on plan. Provide ceiling mounted mains operated self-contained Rate of Rise Alarms to BS 54-5 Type 'R' in positions shown on plan.
Where more than one detector is to be provided they will be interconnected. All permanently wired to a separate fused circuit at distribution board.



SECTION A - A

GLAZING.
Double glass property throughout with p.v.c.u windows BPRC rating in BAND C or better.
All windows and doors to have min. 1st value of 1.4 W/m²K or better, i.e. 'Saint-Gobain Glass UK Ltd PLANITHERM TOTAL + with 16mm air gap.
All excluding garage.
All glazing between F.F.I. and 800mm high and between F.F.I. and 1500mm high in doors and side lights to be safety glass to B.S. 6206. All windows/ doors to be draught sealed.

VENTILATION.
All windows to have opening lights that open to 30 degrees or more and to provide the equivalent of 1/20th the floor area of each room. Should opening lights be to less than 30 degrees provide the equivalent of 1/10th the floor area of each room. Background ventilation to windows to provide a minimum total of 60,000 mm. sq. permanent free air ventilation per dwelling. Based upon a minimum of 5,000 mm. sq per habitable room and 2,500 mm. sq per kitchen, utility room, bathroom, en-suite, wet room and cloak room.
The following rooms to have in addition to the above wall mounted mechanical extractor fan (Specific Fan Power (SFP) to be no worse than 0.5W/L/s) Recommended extract rates:
Kitchen min. 30 litres per second.
Utility rooms min. 30 litres per second, which may be operated intermittently and to have a 15 minute over-run.
W.C. min. 6 litres per second with 15 minute over-run.
Electrical Engineer to provide L / A Building Control with a suitable Commissioning Certificate upon completion.
Flow rate test results to be deposited with L / A Building Control no more than 5 days after final test.

WATER
Provision is to be made for wholesome water to be drawn off wherever drinking water is drawn off. Also to any wash basin, bidet, fixed bath or shower in any room containing a sanitary convenience. Water of suitable quality is to be provided to all sanitary fittings with flushing devices. Pressure, flow rate and reliability to be sufficient for operating all sanitary appliances.
Potable water is to be supplied by any statutory water undertaker or licensed water supplier.
Potential consumption of wholesome water is to be limited to be not more than 125 litres per person per day. Water efficiency calculations are to be submitted to L / A Building Control not later than 5 days after work is completed.
Recommendations:
Bath - 140 litre max capacity
Showers Flow Rate 10 litres/ minute
W.C. - Dual Flush - Full 6 litres Half 4 litre
Taps - Flow Rate - 5 litres/ minute
Hot water supply to any fixed bath to be regulated to ensure maximum temperature of delivered water will not exceed 48 deg.C by the use of an in-line blending valve or other appropriate device.

LIMITATIONS.
This drawing is limited in the amount of information contained and does not purport to contain a full specification of the works. It is solely for the purpose of obtaining Planning/Building Regulation approval.
The drawing must not be used for any other purpose than above. All dimensions shall be taken from site from actual work. Under no circumstances shall measurements be scaled from this drawing for construction or ordering purposes.
All given dimensions shall be checked by the Builder/Contractor and will be his responsibility from commencement of site works.
The works will not be supervised or inspected on site by C.A.D. or any representative thereof, it is the client or their appointed agents responsibility to control workmanship, substitution of materials, adherence to specification, variations to contract etc.

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STANDARDS.
All materials to be new unless otherwise stated and all components and materials etc. to be used fitted and installed in strict accordance with manufacturers instruction and relevant Code of Practice.
Materials shall conform to appropriate British Standard Specification or BBA Certificate or European Code equivalent.

HEALTH & SAFETY.
The Employer/Client shall ensure that the selected contractor is conversant with and adopts all measures necessary to achieve compliance with Health & Safety legislation for Building Sites and Work Places.
The Employer /Client is advised that should the works need to comply with the Construction Design and Management Regulations on independent Planning Supervisor will be required.

SCOPE OF THE WORKS.
The works shall comprise of all that is shown on the drawing and details. Work that may not be specifically shown but may be reasonably inferred as necessary to carry out the works shall be deemed to be included.

■	DENOTES EXTRACT FAN
●	DENOTES BOILER FLUE
ELECT	ELECTRICITY METER BOX
GAS	GAS METER BOX

MATERIALS	
FACE BRICK:	'VANDERSANDEN' WICKFORD ANTIQUE
ROOF:	'SANDTOP' CALDERDALE EDGE - DARK GREY
WINDOWS:	CREAM - UP.V.C.
DOORS:	COLOURED - COMPOSITE.
RAINWATER GOODS:	BLACK UP.V.C. IN RISE & FALL BRACKETS

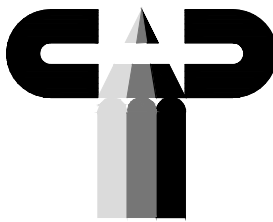
LABC CONSTRUCTION DETAILS
Available at -
www.labc.co.uk/register/schemes/constructiondetails

E1MCF4	-	Lintel
E3MCF4	-	Chim
E4MCF4	-	Jamb
E5MCF9	-	Beam & Block Floor
E5MCF22	-	Floor Slab Ins. Under
E6MCF4	-	Intermediate Floor
E10MCF4	-	Eave - Flat Ceiling
E11MCF4	-	Eave - Sloped Ceiling
E12MCF4	-	Gable - Pitched Roof
E16MCF4	-	Corner - Full Fill
E17MCF4	-	Inverted Corner - Full Fill
E18MCF7	-	Party Wall - Ext. Wall Junction
P1PCF2	-	Party Wall - Floor Junction
P4PMCF2	-	Party Wall - Roof Junction

DETAIL CHECK LIST SHEETS, DULY SIGNED, TOGETHER WITH NOTIFICATION OF ANY CHANGES TO SPECIFICATION ARE TO BE SUBMITTED TO AN APPROVED SAP ASSESSOR UPON COMPLETION.

RESULT OF AIR PRESSURE TEST TO BE 5.0 m ³ / hr / m ² @ 50 PASCALS OR BELOW.	
ROOM DIMENSIONS ARE INTERNAL OF WALL FINISHES	

revision	date	init.	revision details.
A	JAN. 20	J.C.	BUILDING REGULATIONS



COOPER ARCHITECTURAL DESIGN
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SPALDING, Lincs PE11 1HA
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Mobile: 07808 125 778
E-MAIL: c.a@btconnect.com

Client.
MR & MRS J GRAVES

Project.
**RESIDENTIAL DEVELOPMENT
Adj. CORNER HOUSE
CHURCH GATE
WHARFLOPE
PE12 6TA**

Drawing.

THREE BEDROOM BUNGALOW & GARAGE

Scale 1:50 1:100 @ A1	Drawing No. 1901-02-A
Date. AUG. 19	Drawn. J.C.

WALLING.

300 cavity walling to consist of Face brickwork to B.5. 592/1974 for clay bricks and B.5. 187/1978 for calcium silicate bricks. 100mm cavity. Build into cavity 100mm lower. H. Cav 52 (Thermal Conductivity 0.052W/ mK) or similar cavity wall batt insulation in accord. with makers instructions and agreement cert. No.80/ 2465. 100mm Tarmac Toplite G11. 2.9 N/ mm2 (Thermal Conductivity 0.11W/ mK) or similar solid insulation blocks or similar. U' value 0.25 W/ m2K .

In lower cavity to 450mm above F.F.L. build in 100mm Ecoterm Eco-Cavity insulation board (Thermal Conductivity 0.22W/ mK) U' value 0.18 W/ m2K

Cavity walls tied together using stainless steel vertical twist ties set 750 horizontally and 450 vertically all to B.5. EN 845 wall ties positioned at 300 vertical centres at all unbanded courses of cavity. Close cavities with "thermulate" preformed closer and provide bitumen felt D.P.C. to C.P. 121. All work to be carried out in accordance with B5 Code of Practice 121 Pt.1. 1975. Internal walls of 100mm Tarmac Toplite Standard solid insulation blocks.

Movement joints to be installed in blockwork in accordance with B.5. 562B pt. 3 1985.

External walls to receive 12.5mm Plasterboard on dabs with skim finish. Except Garage.

Internal walls to receive 15mm Render & Set with skim finish.

Stud walls to consist of 38 x 89 C.L.5. timber studs at 400mm c/ c, both sides to be clad with 12.5mm Giprox SoundBloc and skim. 29mm Isoacoustic partition roll infill between studs.

FOOTPATHS/ DRIVES.

Provide min. 900mm wide paving slab footpath positioned at 150mm below D.P.C. level and min 150mm away from face of wall to perimeter of building. All footpaths to have slight fall away from building. Gap between wall & footpath to be filled with 150mm depth of 20mm washed gravel. Form 1.0m wide footpath from dwelling to road frontage, suitable for wheelchair access. At least 5.0m of drive adjacent to building x 3.0m wide to be hard standing i.e. Concrete, Tarmac or Block pavers. All to be sloped up to footpath level at min. 1:20

GROUND FLOOR / RAFT CONSTRUCTION.

Strip all vegetable soil and lay floor/ raft as follows: 75mm sand/ cement screed, on 300mm concrete slab thickened to 375mm at perimeter. Concrete mix to be FC 35 in non-aggressive soils and FMP2 mix in sulphate bearing soils to B.5. 592B, pt1 1991 on 500kg polythene D.P.M. on 150mm Kingspan Kooltherm K10B insulation board on 1200kg polythene D.P.M.lapped continuous with D.P.C. by min. 100mm on 200 blinbed and consolidated type I 1st hardcore.

P/ A = 0.4 U' value 0.10 W/ m2K

FOUNDATIONS.

Under walls as shown provide Slab-Raft foundation. All in accordance with South Lincs Consulting recommendations see Detail sheet Ref No 20-0020

SUB STRUCTURE WALLING.

3 course 102mm Red Engineering Brickwork to external walling. D.P.C. to external wall positioned in accordance with CP 102 min. 150 above finished ground level.

LINTELS.

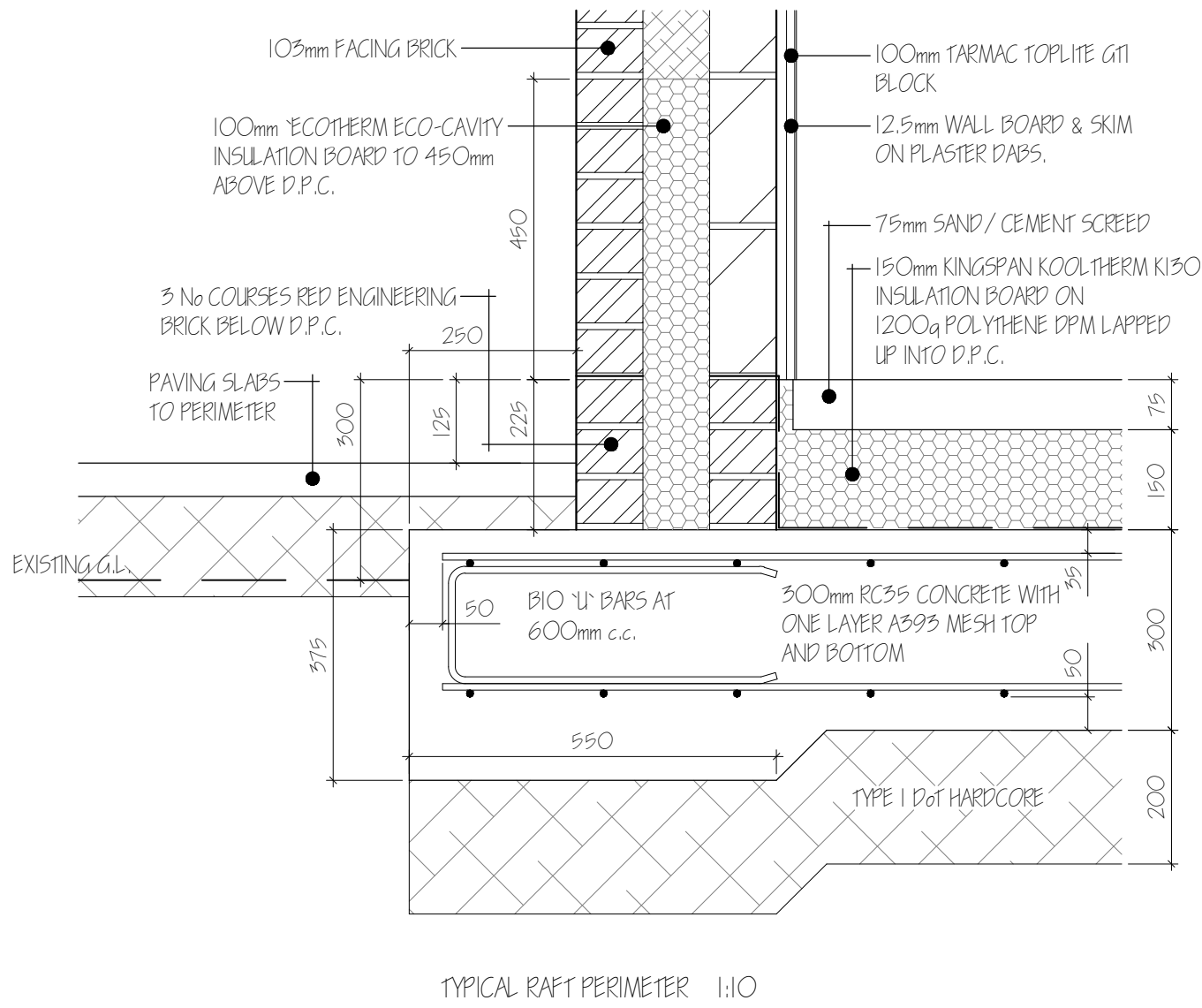
All lintels to be as manufactured by Messrs. L.G. Limited L.G. Hi-Therm or similar and to be installed in accordance with makers' instructions, all to have min. end bearing of 150mm and at external positions to have cavity tray D.P.C. to C.P. 121. Internal lintels to be L.G. 100 Box type. Lintels in garage to be underlined with 12.7 fire line board or receive 12mm render and skim. Provide Perpend weep holes and stop ends to cavity tray

FULL DRAINAGE

Fall drainage pipes to be 110mm dia. UPVC, to B.5. 4660:1985 flexibly jointed and laid to makers' instructions to a fall of 1:10 bed and surround with 100mm pea gravel. Where pipes pass under drives surround in 150mm concrete with flexi joints to correspond with joints in pipe work. Provide 65 x 100 pre-stressed concrete lintel bricklay where pipes pass through walls, provide compressible filler around pipe, opening masked both sides of wall with ridged sheet material. Soil and vent pipes to be 110mm dia. All PVC to B.5. 4514: 1985 and to extend 900mm above window head terminating with PVC balloon. Waste pipes to be generally 40mm dia. If over 3.0m long run increase to 50mm dia. All PVC to B.5. 5945: 1979 complete with rodding eyes at every change of direction. Bath, basin and sink to have 75 deep seal traps. Shower to be raised on 150mm plyth with access plate to anti-siphon trap and 50mm waste. All redundant drains to be grouted out or filled with lean-mix concrete. Condensation drainage from boiler flues to discharge via min. 22mm diameter pipe work through a 75mm condensation trap. Alternatively an additional trap should be provided externally to provide the required seal, an air gap should be provided between the boiler and the trap.

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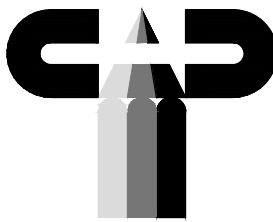
E1NCFF4	-	Lintel
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revision	date	init.	revision details.



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Client. MR & MRS J GRAVES

Project. RESIDENTIAL DEVELOPMENT
Adj. CORNER HOUSE
CHURCH GATE
WHARFLODE
PE12 6TA

Drawing.

FOUNDATION PLAN

Scale 1:50 @ A1	Drawing No. 1901-04
Date. JAN. 20	Drawn. J.C.

Appendix B
Architects Inspection Certificate

ARCHITECT'S INSPECTION CERTIFICATE



CLIENT: RK WILSON BUILDERS
PROJECT: STAGE INSPECTIONS OF NEW DWELLING
ADDRESS: CHURCH GATE, WHAPLODE
DATE: 24 SEPTEMBER 2020
STAGE OF WORKS: FOUNDATION & GROUND FLOOR CONSTRUCTION
NOTE: THIS REPORT CONSISTS OF A TOTAL OF ONE PAGE

An inspection of building works at foundation and ground floor construction stage was undertaken on site on 24 September 2020.

Observations were as follows:

1. It is understood that the ground was good, firm and level prior to the dpm and mesh being installed.
2. Virtually all of the mesh for the raft was in place and appeared to match the drawings.
3. The dpm was evident across the whole raft and appeared to be as specified
4. The vast majority of the shuttering was installed and backed filled with only a small amount left to do prior to the concrete delivery.

In summary, it appeared that the construction was satisfactory.

A handwritten signature in blue ink, appearing to read 'TAC' or similar, with a stylized flourish.

Signed:

Date: 25 September 2020

Appendix C

Diffusion Modelling

CORNTON VALE - GROUND SLAB MODEL

CHEMICAL PHYSICAL PROPERTIES

		Methane	Carbon dioxide				Comment
Assumed subsurface temperature	°C	16	16				Assumed temperature.
Diffusivity In Air	cm ² /sec	1.50E-01	1.39E-01				Chemical specific
Diffusivity in Water	cm ² /sec	1.50E-05	1.39E-05				Chemical specific
Molecular Weight	g/mol	16	44				Chemical specific
Henry's Law Constant (ref temp at 25°C)	unitless	29	1.1				Chemical specific
Unit Weight	kg/m ³	0.67	1.84				Chemical specific
Odour Threshold at STP	ppm	N/A	N/A				Chemical specific
	mg/m ³						Chemical specific
	Ref.						Full reference provided below.
Lower Explosive Limits (LEL) at STP	%v/v	5.00	N/A				Chemical specific
	mg/m ³	N/A	N/A				Chemical specific
	Ref.	Ground gas Handbook	Ground gas Handbook				Full reference provided below.

BUILDING PROPERTIES

Building Type		Leisure Centre					Site-specific
Building Rooms of Interest		Groundfloor					Groundfloor main area of concern for VI
No. of Levels		N/A	N/A				
Type (eg. slab on grade)		Suspended cast insitu					Site-specific
Slab Material		Cast institu concrete					Site-specific
Floor Slab Thickness	m	0.2	0.2				Site-specific
Building Length	m	1	1				Nominal small room - makes no difference to calculations
Building Width	m	1	1				
Building Height (floor to ceiling Only)	m	2.4	2.4				
Total Building Volume	m ³	2.4	2.4				Assumed height
Floor Area (A _B)	m ²	1	1				
Adopted Migration Area over Floor (A _B)	m ²	1	1				
Building Ventilation	hr ⁻¹	0.50	0.50				CLEA Briefing Note 3 for Residential
	m ³ /hr	1	1				
	m ³ /sec	0.00033	0.00033				

DETERMINATION OF SOURCE TERM - Gas SOURCE

Concentration at Source (Cs)	g/m ³	48.0000	45.0000				Based on review of site data
	mg/m ³	4.80E+04	4.50E+04				
	ug/m ³	48000000.0	45000000				
	ppm	7.11E+04	2.43E+04				
	%v/v	7.1	2.4				Max concentration at groundwater
Comparison of Cs against LEL		>LEL	N/A				

SOIL DIFFUSION

HORIZON A (Unsaturated Zone)							
Effective Diffusion Coefficient (D ^{eff}) Unsaturated Zone	m ² /day	2.17E-02	2.01E-02				Tidal Flats
Soil Air-filled Porosity	cm ² /cm ²	0.2	0.2				Upper 1.5m of Made Ground sandy loam - effective air filled porosity (ie interconnected pores that can allow gas diffusion). Effective porosity excludes isolated pores and pore volume occupied by water adsorbed on clay minerals or other grains
Soil Total Porosity	cm ² /cm ²	0.53	0.53				Total effective porosity
Soil Water Filled Porosity	cm ² /cm ²	0.33	0.33				
Horizon A Zone Thickness	m	1.5	1.5				
HORIZON B (Unsaturated Zone)							
Effective Diffusion Coefficient (D ^{eff}) Unsaturated Zone	m ² /day	4.07E-05	7.49E-05				Lower 0.5m of Made Ground - assumed saturated from capillary rise of groundwater
Soil Air-filled Porosity	cm ² /cm ²	0.03	0.03				High water content reduces effective porosity
Soil Total Porosity	cm ² /cm ²	0.53	0.53				
Soil Water Filled Porosity	cm ² /cm ²	0.5	0.5				
Horizon B Zone Thickness	m	0	0				
CAPILLARY ZONE (WET)							
Effective Diffusion Coefficient (D ^{eff} _{c2}) Capillary Zone	m ² /day	4.54E-05	7.61E-05				Horizon not applicable for this ground model
Soil Air-filled Porosity	cm ² /cm ²	0.03	0.03				
Soil Total Porosity	cm ² /cm ²	0.5	0.5				
Soil Water Filled Porosity	cm ² /cm ²	0.47	0.47				
Capillary Zone Thickness	m	0.5	0.5				
Pathway Length (L ₁)	m	2	2				Total depth to gas source (groundwater)
Overall Effective Diffusion Coefficient (D ^{eff} _T)	m ² /day	1.81E-04	3.01E-04				
	m ² /s	2.09E-09	3.48E-09				

GAS MIGRATION AND ESTIMATED INDOOR AIR CONCENTRATIONS (NO MEMBRANE)

INDOOR AIR CALCULATIONS - DIFFUSION

Diffusion of Gas into Building (assuming no floor slab)	mg/s	5.02E-05	7.84E-05				As per Wilson S. 2008
	µg/s	5.02E-02	7.84E-02				
Equilibrium Air Concentration in building (diffusion dominated)	mg/m ³	1.51E-01	2.35E-01				As per Wilson S. 2008
	ug/m ³	1.51E+02	2.35E+02				
	ppm	2.30E-01	1.31E-01				
	%v/v	0.0000230062	0.00001307				
Comparison of Internal Concentration against LEL		<LEL	<LEL				
Margin of Safety		217332.987	N/A				
Attenuation Factor (alpha)	-	3.14E-06	5.23E-06				
Equivalent Dilution Factor in Building		318827	191330				

INDOOR AIR CALCULATIONS - ADVECTION

Pressure Differential (delta P)	Pa	3.1	3.1				As per SR3 Table 4.2.1 for residential properties
Effective Slab Gas Permeability (Kv)	m ²	8.00E-09	8.00E-09				Permeability of rough crack 0.5mm wide
	cm ²	8.00E-05	8.00E-05				
Crack ratio	m ² /m ²	3.35E-05	3.35E-05				
Total Area of Crack (A _{crack})	m ²	3.35E-05	3.35E-05				Assume 0.5mm crack around a 150mm dia pipe in a toilet in a cell - crack area = 2.35 x 10 ⁻⁴ m ² Crack ratio = 0.000235/7 = 3.35 x 10 ⁻⁵
	Pa.sec or kg/m-sec or N.s/m ²	1.81E-05	1.81E-05				
Temperature Below Slab	Kelvin	289.15	289.15				
Unit Weight of Air	N/m ³	12.23	12.23				
Pressure gradient across migration zone (i)		1.27	1.27				
Viscosity of Air Gas (u)	g/cm-sec	1.81E-04	1.81E-04				
	kg/m-sec	1.81E-05	1.81E-05				Calculated viscosity at specific temperature
Total Emission Rate of Challenge Chemical via Advection Dominated Flow through Crack	mg/s	1.10E-02	1.03E-02				As per Wilson S. 2008
Equilibrium Indoor Air Concentration ground slab, advection)	mg/m ³	3.30E+01	3.10E+01				As per Wilson S. 2008

	%	5.05E-03	1.72E-03				Assumes gas cloud develops below slab from diffusion and it is drawn through the slab by advection due to stack effect
Attenuation Factor (alpha)	-	1.05E-10	3.83E-11				
ESTIMATED INDOOR AIR CONCENTRATIONS WITH GAS MEMBRANE							
Gas membrane gas transmission rate	ml/m ² /day/atm	3.00E+02	3.00E+02				DPM - LDPE typical gas tranmission rate
Flow of gas through membrane	ml/h	8.80E-11	5.00E-11				Assumes continuous DPM over entire building floor installed to achieve air tightness requirements.
	m ³ /h	8.80E-17	5.00E-17				
Equilibrium Indoor Air Concentration (diffusion dominated through membrane)	%v/v	7.33E-15	4.17E-15				As per Wilson S. 2008
Attenuation Factor (alpha)	-	1.03E-15	1.72E-15				
SUMMARY							
Equilibrium concentration in building - diffusion and no floor slab	% v/v	0.000023	0.000013				Minimal risk value for methane (100ppm) and carbon dioxide (1000ppm)
Equilibrium concentration in building (advection through cracks)	% v/v	0.00505	0.00172				
Equilibrium concentration in building (with membrane)	% v/v	7.33E-15	4.17E-15				
Allowable air concentration inside building	% v/v	0.01	0.1				