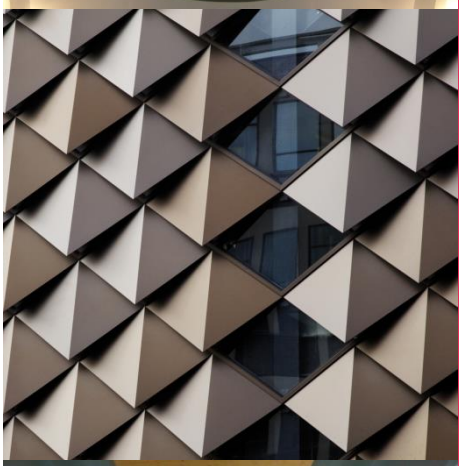

70 Gascony Avenue, N6 4NE

Ground Movement Assessment

Curtins Ref: 081114-CUR-XX-ZZ-RP-GE-001

Revision: 03

Issue Date: 08 February 2023

Client Name: Site Analytical Services Limited

Client Address: River Road Business Park, River Road, Barking, IG11 0EA

Site Address: 70 Gascony Avenue, London, N6 4NE

Curtins Consulting Limited
40 Compton Street
London
EC1V 0BD
Tel: 020 7324 2240
Email: london@curtins.com
www.curtins.com

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V02	Minor Amendments to Appendix A Plans	AS	DH	25/06/2022
V03	Amendments to text following external review	LP	AS	08/02/2023
V04	Further amendments following external review	LP	AS	20/03/2023

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Author	Signature	Date
Andrew Smith BSC (Hons) FGS CGeol MCIWEM RoGEP Principal Geotechnical Engineer		08/02/2023

Table of Contents

1.0 Introduction

1.1 Brief

Curtins have been commissioned by Site Analytical Services Limited (SASL) to complete a Ground Movement Assessment (GMA) in connection with a proposed residential basement development at 70 Gascony Avenue, London, N6 4NE. The location of the site is detailed on **Figure 1.1**. The purpose of this assessment is to determine what effects the permanent construction may have on permanent structures which surround the property.

A site-specific Ground Investigation was carried out at the site by SASL between February and March 2022. The ground investigation was designed by SASL, and results have been used in the derivation of parameters utilised in this assessment. Curtins cannot be held responsible for any inaccuracy in the factual data provided.

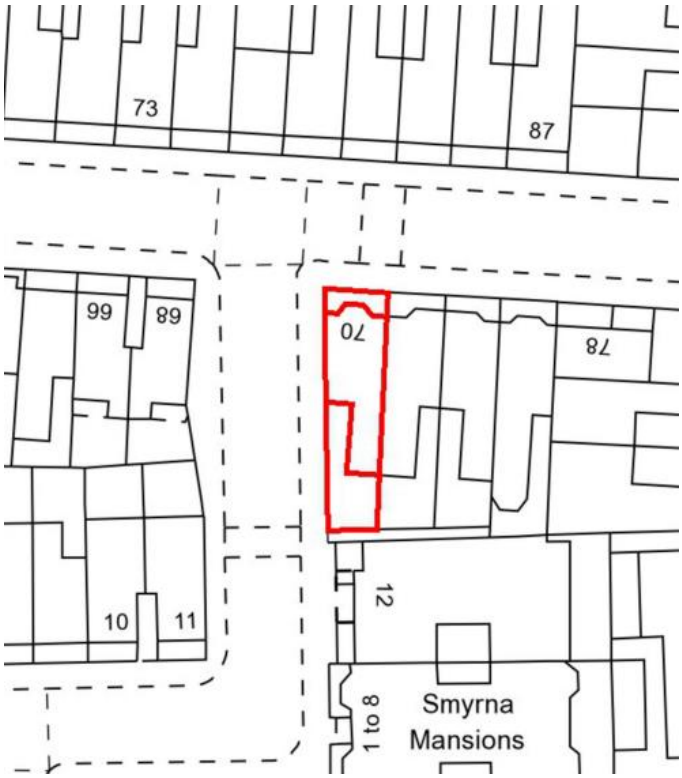

Figure 1.1: *Site Location (Outlined in red)*

1.2 Development Proposals

Based on the proposed development drawings contained in **Appendix A** the proposed development includes the construction of single storey extension to rear of existing house (to be addressed in a separate planning application) along with extension of the existing basement below the property to a maximum depth of approximately 3.2m below existing ground level, as shown in **Figure 1.2**.

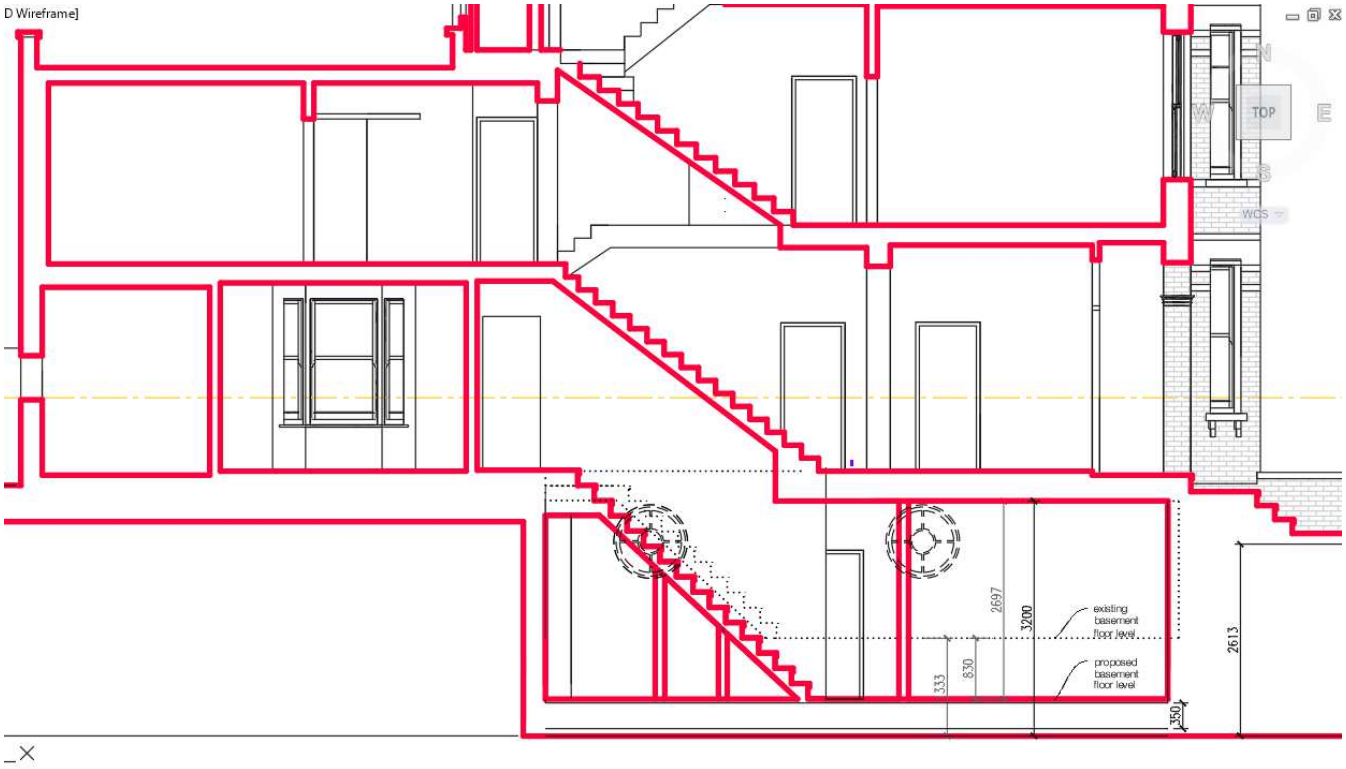

Figure 1.2: *Section view of the proposed basement*

Ground level has been taken as 42.50m AOD and proposed basement level as 39.30m AOD. Existing drawings can also be found in **Appendix A**.

1.3 Limitations

The conclusions and recommendations made in this report are made on the basis of the site-specific ground investigations undertaken by SASL undertaken between February and March 2022. The ground investigation was designed by SASL, and the results of the work should be viewed in the context of the range of data sources consulted and the information provided along with the number of locations where the ground was sampled. No liability can be accepted for inaccuracies in the factual data, information in other data sources or conditions not revealed by the sampling or testing.

The effect of the proposed construction on **existing subterranean assets (including services and tunnels) is outside the scope of this report** and should be covered under a separate assessment. It should be noted that the movements described in this report are indicative only for the purposes of providing pre-planning guidance with regards to the development and should not be relied upon for detailed design. It is anticipated the actual movement observed on site will be heavily affected by the level of workmanship and therefore should be reviewed at detailed design following discussions with the structural engineer and appointed contractor.

2.0 Baseline Conditions

2.1 Site Description

The site is located on the corner of Gascony Avenue and Smyrna Road in West Hampstead, London, at approximate postcode NW6 4NE. It is bound by a residential property (No 72 Gascony Avenue) to the east, Gascony Avenue to the north, Smyrna Road to the west and a residential block of flats to the south.

The site comprises a 3-storey semi-detached residential property with a part basement. The nearby surrounding areas to the site are mainly residential. The property is under the authority of Camden Council.

Ground level has been taken as 42.50m AOD in the vicinity of the site from online sources (including Google Earth).

Details of the buildings located in close proximity to the property which have been considered in the analysis are summarised in **Table 2.1** below.

Table 2.1: A summary of the neighbouring properties in close proximity to 72 Gascony Avenue.

Building Name	Description	Approximate Height (from ground level to top of roof)	Distance from Proposed Basement
No 72 Gascony Avenue	3-storey residential building	~12.5m with a 9m high rear extension	Shares PW to the east

2.2 Geology

BGS Data

BGS Geology of Britain Viewer 3D (1), and also a 1:50,000 Geological Survey of Britain (England and Wales) map 256 (2) shows that the site is underlain directly by the London Clay Formation (bedrock). Deposits of the overlying Claygate Member are indicated to be over 1.6 kilometre to the north of the site.

A historical borehole (BGS Reference TQ28SE2472) located 300m north-west of the site identifies 1.00m thick Made Ground and Possible Made Ground overlying stiff to very stiff brown and grey silty London CLAY proven to depths of a least 71.45m. No groundwater was encountered.

2.3 Hydrogeology

According to online information (https://magic.defra.gov.uk/ (3), the London Clay bedrock is designated as unproductive strata, which are defined as rock layers with low permeability that have negligible significance for water supply or river base flow

3.0 Ground Investigation

3.1 Encountered Ground Conditions

A site-specific Ground Investigation was undertaken by SASL at the site in February and March 2022. This investigation comprised the following:

- The drilling of 1 No Continuous Flight Auger borehole to a maximum depth of 15m bgl (BH1);
- The installation of a groundwater monitoring standpipe within Borehole BH1;
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the borehole;
- Laboratory testing to determine the engineering properties of the soils encountered in the exploratory hole;
- Factual reporting on the results of the investigation.

The borehole logs including a location plan are contained in the SASL Factual report in **Appendix B**, whilst the ground conditions encountered are summarised in **Table 3.1** below.

Table 3.1: *Summary of Ground Conditions encountered in SASL Ground Investigation February 2022*

Strata	Depth to top of Strata (m bgl)	Elevation at top of Strata (m AOD)	Thickness (m)	Description
Made Ground	0.0	42.50	0.7	Crushed brick and concrete slab over sandy clay with brick and concrete fragments
London Clay	0.7	41.80	14.3*	Firm becoming stiff silty sandy CLAY containing partings of silty fine sand and gypsum crystals.

*thickness only proven to base of borehole.

3.2 Groundwater

Groundwater was not encountered in the borehole carried out by Site Analytical Services.

Two rounds of groundwater monitoring has been carried out on 3rd March 2022 and 10th March 2022 and the results are summarised in **Table 3.2** below.

Table 3.2: *Results of groundwater monitoring*

Borehole	Depth to Water (m bgl)	
	03/03/2022	10/03/2022
BH1	6.14 (36.36m AOD)	6.14 (36.36m AOD)

3.3 In Situ and Laboratory Testing

A summary of laboratory and in-situ test results undertaken within the geological strata encountered during the SASL ground investigation is presented below. Further detailed results are available in the SASL Factual Report (**Appendix B**).

3.3.1 Hand Vane Testing

19 No. Hand Vane tests were carried out in the London Clay Formation in BH1 at depths from 1m to 15m bgl. The tests recorded undrained shear strengths between 73kPa and >140kPa, which is the limit of the equipment.

The London Clay corresponds to a medium to high strength material in accordance with BS 5930:2015+2020 (4).

These results will be further interpreted in **Section 4.3**.

3.3.2 Atterberg Limit Tests

4. No samples underwent testing for Atterberg Limits, with results in the London Clay ranging from Liquid Limit values of between 63% and 69%, with an average of 67%, and Plasticity Index values of between 39% and 42%, with an average of 41%. It can be concluded that from these results the London Clay classifies as a high and very high plasticity clay.

The results are displayed in the Casagrande Plot in **Figure 3.1** below.

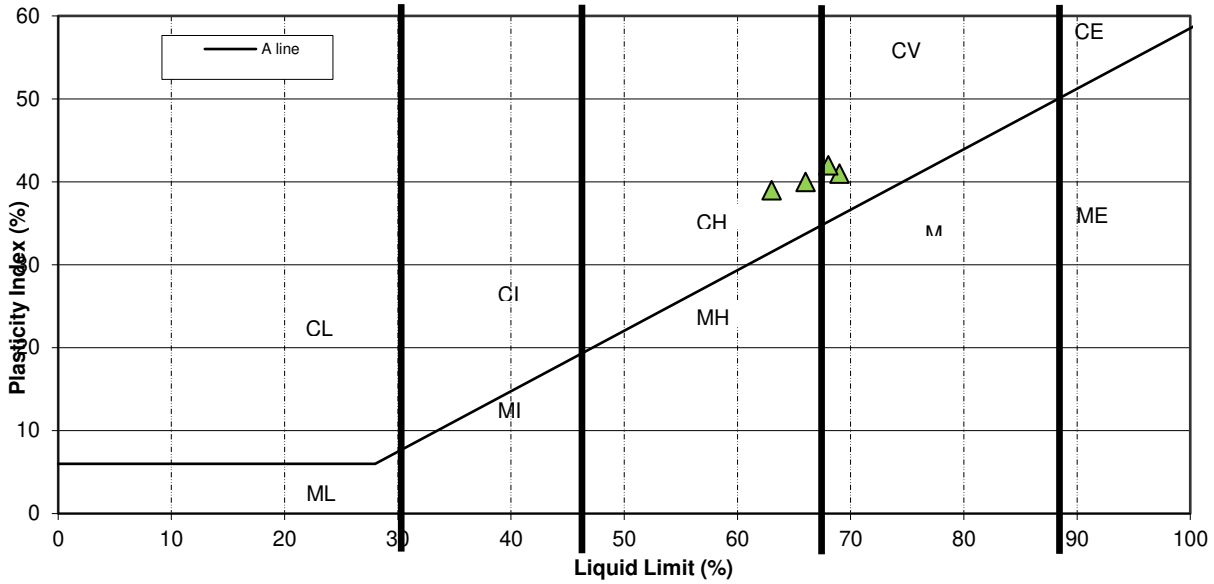

Figure 3.1: *Casagrande Plot displaying the results of the Atterberg testing*

4.0 Prediction of Ground Movements and Damage Assessment

4.1 Introduction

In connection with the proposed basement construction, a ground movement and damage assessment has been undertaken at the site. The purpose of this assessment is to determine the effects of the proposed basement excavation upon neighbouring structures.

The soil behaviour over the footprint of the excavated area is different from the behaviour outside and the associated ground movements require assessment using different approaches.

In the area of the new basement the soil will tend to move as a result of change in vertical load on the ground due to excavation and demolition. Movements in the long term would also be expected as a result of changes in the pore pressure in the clay layer/cohesive band under the basement.

Around the site the construction activities that may result in ground movements during and after the works are mainly related to the excavation, which would induce a reduction of vertical and lateral stresses in the ground along the excavation boundaries.

The magnitude and distribution of ground movements inside and outside the excavated area are a function of changes of load in the ground and also, critically, are a function of workmanship.

Ground movements within the area of the proposed excavation have been estimated using Geotechnical Software (PDISP by OASYS) whilst the expected movements and impact assessment of the area around the site and surrounding structures have been estimated using Geotechnical Software (XDISP by OASYS). The latter software relies on CIRIA report C580 Embedded Retaining Walls - Guidance for Economic Design (5) (superseded by C760, 2017 (6)) which is based on field measurements of movements from a number of basement constructions across London.

The calculations provided are specific to the proposed development and the advice herein should be reviewed if the development proposals are amended.

4.2 Adjacent Properties

The properties or structures more likely to be affected by ground movements associated with the proposed basement construction, are shown in **Table 2.1** whilst the labelled walls under analysis are detailed in **Figures 4.1a and b** below:

Figure 4.1a: *Plan showing the analysed walls relative to the proposed basement (Google Images 2022)*

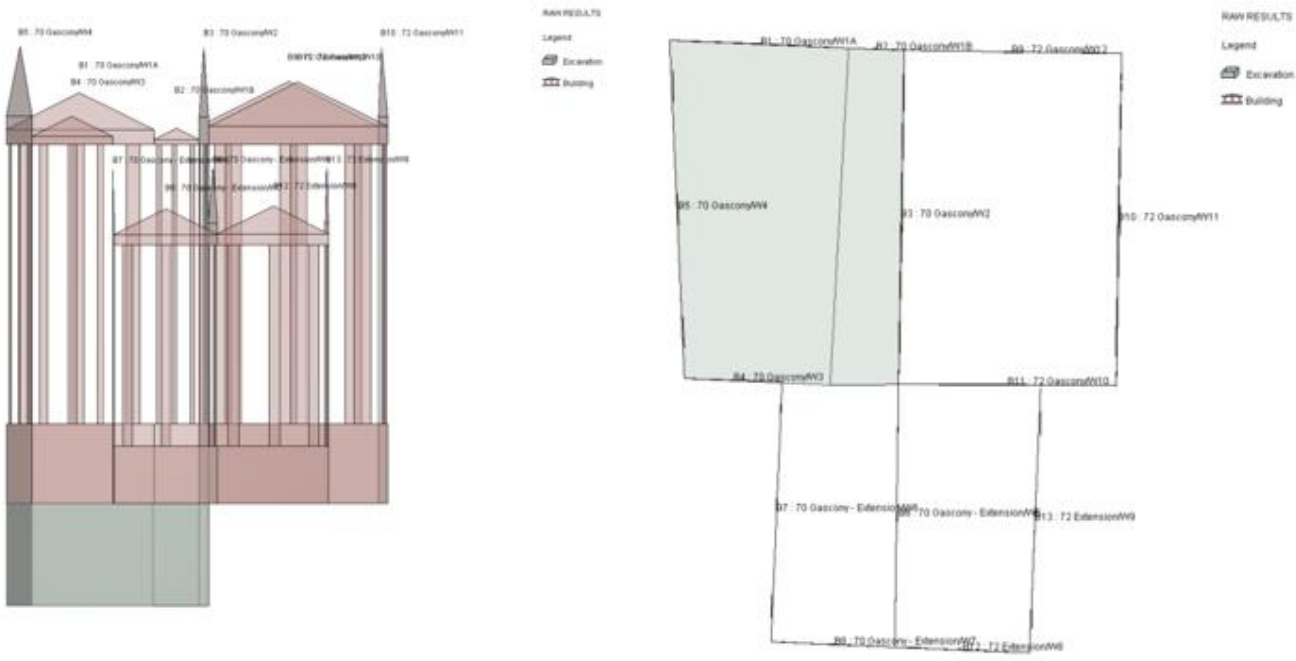

Figure 4.1b: XDISP *Plan Output showing the analysed walls relative to the proposed basement*

4.3 Ground Model

The ground model utilised for this assessment is based on the site-specific ground investigation undertaken by SASL at the site (February and March 2022). It should be noted that Curtins can take no liability for inaccuracies in the factual data from the site specific site investigations.

The ground conditions adopted within the model and analysis are in accordance with the ground conditions inferred from borehole BH1 as a conservative case and comprise:

- General surrounding ground level: 42.50m AOD.
- Base of Made Ground: 41.80m AOD
- Base of London Clay investigated 27.50m AOD

The method of Ground Movement Analyses undertaken requires soils stiffness parameters to be used. In accordance with BS8004:2015 section 4.3.1.6 'Soil Stiffness' (7) it is acknowledged that both the drained and undrained stiffness moduli of soils (E', E_u) are highly dependent on the strain level applicable to the engineering problem considered. The change in axial strain will directly influence the resultant stiffness of the soil, and in turn the stiffness of the soil will influence the strain exhibited.

Therefore, in order to define stiffness modulus applicable to the engineering problem considered, it is necessary to assess the magnitude of axial strain which the soil will be subjected to. In accordance with the recommendations made in BS8004:2015 (7), the strain generally applicable to foundations design is in the range of 0.075 to 0.2%.

The material properties used for the analysis of the ground movements have been interpreted. Where necessary, determination of characteristic parameters has been based on a cautious estimate of results derived from laboratory, published correlations and field tests, complemented with engineering judgement. The parameters are not considered to be absolute and should not be used for design.

Made Ground

Case history values were consulted where estimating the linear elastic parameters for Made Ground. Specifically values for the drained case were adopted from:

'Burland, Standing, Jardine (2001). Volume 1 – Projects and Methods. Building response to Tunnelling – Case Studies from construction of the Jubilee Line Extension, London. CIRIA Special Publication 200, Section 12.2.3, page 180'

Using the results of this paper it has been assumed that the Poisson's Ratio (υ') would slightly increase for the undrained case (υ) from 0.2 to 0.3 but the Shear Stiffness / modulus (G) would be the same in the Made Ground for both the drained and undrained cases.

A bulk unit weight of 16kN/m^3 is considered appropriate for design based on guidance from BS8004 (2015).

London Clay

The London Clay was typically described as a firm becoming stiff silty sandy CLAY.

Based on the maximum (i.e., most conservative) axial strain of 0.2% prescribed in BS8004:2015 (7), the following correlation has been used to determine the Young's Modulus (E_u) of the London Clay Formation. The relationship has been taken from ICE manual of geotechnical engineering (2012), Volume II, chapter 53.7.2 (Page 792) (11) and matches ratio of Young's Modulus/Undrained shear strength (E_u/s_u) at 0.2% axial strain recommended in Tomlinson (7th, 2001 (12) based on works by Jardine et al. (1986):

$E_u = 330 \times s_u$ (kN/m^2)

The ratio of end of construction (undrained) settlement to total settlement (fully drained) was taken as 60% as specified in ICE manual of geotechnical engineering (2012), Volume II, chapter 53.6 (Page 783) (11). Therefore:

$E' = 200 \times s_u$ (kN/m^2)

Stiffness parameters EU and E' have been assessed based on the undrained shear strength profile of the London Clay Formation inferred from the hand vane testing data. The maximum soil stiffness has been limited to the maximum Cu recovered in the hand vane testing (140kPa). This is considered to be very conservative given the undrained shear strength of the London Clay will tend to increase in strength in depth beyond 140kPa at deeper depths.

A bulk unit weight of 20kN/m^3 is considered appropriate for design based on BS8002 (2015) guidance. In addition, a drained (υ') and undrained (υ) Poisson's ratio of 0.2 and 0.5 respectively were utilised as specified in Tomlinson 7th ed (page 74).

A unit weight of 20 kN/m^3 is considered appropriate for the London Clay based on guidance from BS 8004 (2015) (7).

The design parameters adopted for this analysis are summarised in **Table 4.1** below.

Table 4.1: *Summary of Design Parameters*

Strata		Bulk Density (kN/m3)	Level at top (m AOD)	Short Term (Undrained)		Long Term (Drained)	
				E_u (kPa)	Poisson's Ratio	E' (kPa)	Poisson's Ratio
Made Ground		16	42.50	3000	0.30	3000	0.2
London Clay Formation	Top	20	41.80	24090	0.50	14600	0.2
	Base			46200		26500	

4.4 Construction and Load Cases

The new basement will be constructed using mass concrete underpinning to the party walls, and the peripheral walls.

According to the Structural Engineer calculations show that the existing structure plus the proposed development will load the soil to a maximum of 100kN/m^2 below the proposed underpins and therefore this has been used for the model.

This assessment is specific to the construction sequence and load case described. If any changes are made to the proposed development, then this assessment should be revised and updated accordingly.

4.5 Ground Movements (Settlement & Heave)

Following excavation to the proposed foundation formation level the soil at this level and along the boundary of the excavation will tend to heave as a result of the change in soil stress conditions. The magnitude and distributions of ground movements inside the excavated area are a function of the excavation size and shape.

The stress conditions and resultant settlement/heave have been assessed using the Boussinesq's method and geotechnical software PDISP by Oasys. PDISP calculates vertical movements due to a uniformly distributed load applied to a specified plane of geometry within a 3-D space. The Boussinesq analysis method is used in this analysis.

The following assumptions have been made within the PDISP analysis:

- Assumes Boussinesq stress distributions.
- Uniform pressure loading.
- No allowance is made for the stiffness of the structures (foundation slab).
- It is anticipated that there will be no delay in construction following the excavation of the basement due to the proposed underpinning construction method. Therefore drained parameters have been utilised to demonstrate 'worst case' settlements for the modelling.

Structural loading at foundation level and calculations for use in the ground movement analysis have been provided by the structural engineer. The maximum excavation depths have been used for the purposes of this report with worst case ground movements provided.

Removal of the overburden calculated using assumed unit weights 16kN/m^3 for Made Ground and 20kN/m^3 for the London Clay Formation, and the thickness of strata removed, will cause maximum unloading stresses of up to -66kPa at the base of the new basement slab. For the existing basement, a maximum unloading stress of -26kPa will occur at the base of the lowered basement. The model includes geotechnical parameters obtained from the borehole at 42.50m AOD (i.e. ground floor level).

The vertical boundary of the model was fixed at 15m below ground level (-27.50m AOD). At this depth the effective vertical stress due to foundation unloading decreases to in excess of 20% of the effective overburden as required in EC7.

PDISP Results

The results show that in the long-term following construction of the basement, maximum settlement is expected to be less than 20mm. (**Figure 4.2**). Full inputs are contained in **Appendix C**.

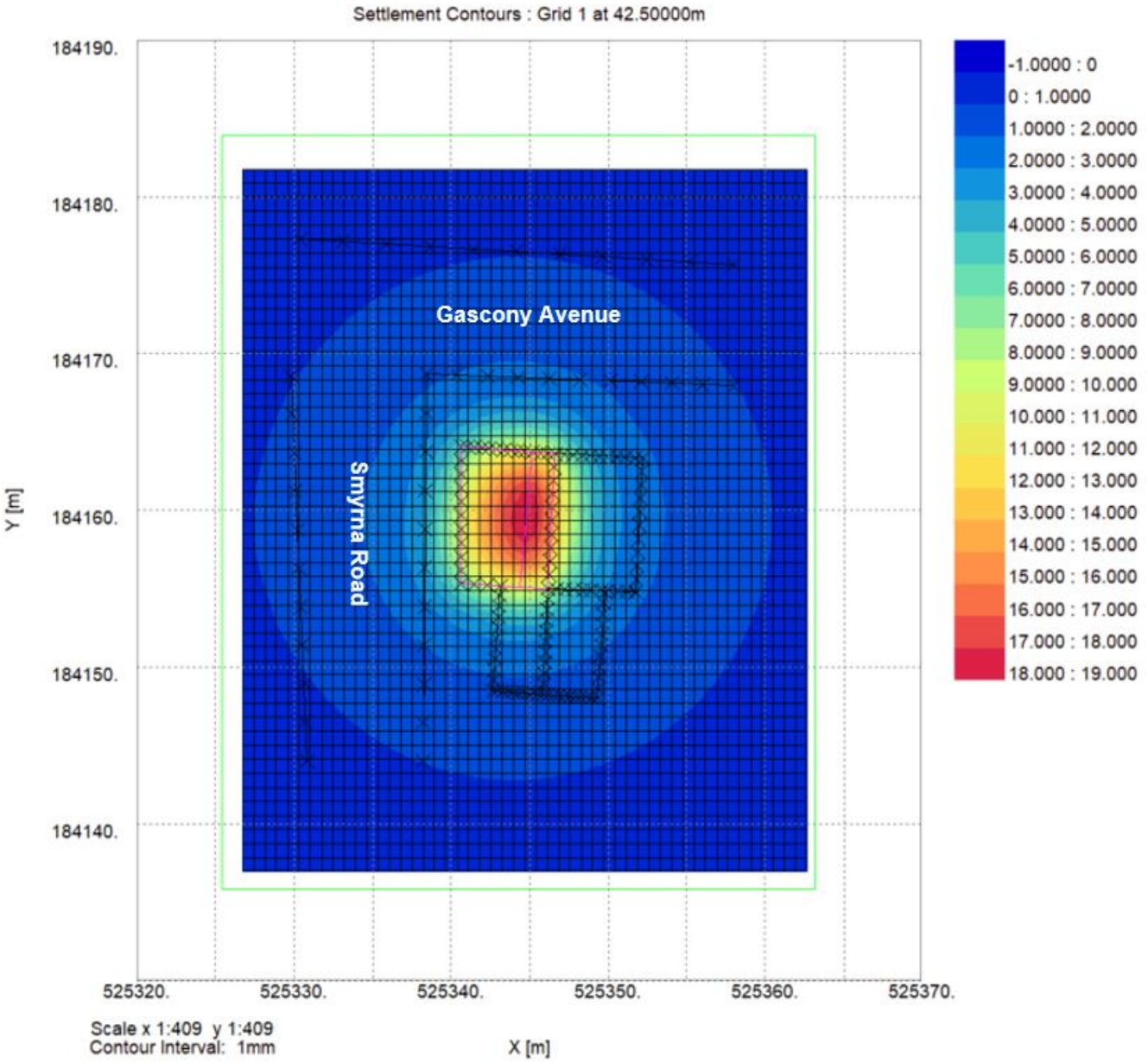

Figure 4.2: *Results from PDISP in drained conditions, showing maximum observed settlements*

PDISP uses individual layer properties to calculate the displacements resulting from applied stresses. The heave values described are considered to be overestimated and therefore conservative. It should be noted, Bowles in his text (Foundation Analysis and Design-Fifth Edition) states that "In general, where heave is involved, considerable experience and engineering judgement are necessary in estimating probable soil response, for currently there are no reliable theories in for the problem".

Final designs for the basement retaining walls, basement slabs and internal load-bearing basement walls and columns should be designed to support heave movements. These movements should be driven into account particularly at party walls where additional loadings are proposed. Any proposed drainage system or pipe works within the vicinity should be designed to accommodate the predicted movements.

Roads & Utilities.

The proposed basement is adjacent to Gascony Avenue to the north and Smyrna Road to the west. In order to analyse the effect upon the road due to the construction of the basement, the roads have been modelled as displacement lines within PDISP. The settlement at these points can then be estimated. From the results in **Figure 4.2**, it can be seen that <5mm of settlement is estimated on both Gascony Avenue and Smyrna Road.

The results of the PDISP analysis are based on an unrestrained excavation as the model is unable to take account of the mitigating effect of the temporary works bounding the excavation, which in reality will combine to restrict these movements within the basement excavation. The movements predicted at or just beyond the site boundaries are unlikely to be realised and should not therefore have a detrimental impact upon any nearby structures.

Following receipt of the Groundwise Searches Ltd services survey (Ref: 32750RB-GWS, dated 02/02/23), it can be seen that within the vicinity of the proposed basement, there is 1 No. foul sewer and 2 No. low pressure gas mains along Gascony Avenue, and 1 No. low pressure gas main along Smyrna Road. **The effect of the basement construction on services is out of the scope of this report and must be assessed separately**.

4.6 Building Damage Assessment

Ground movements have been analysed using XDISP by Oasys and a building damage assessment has been undertaken based on the results of the analysis. Contours of vertical and horizontal ground movements are presented in **Figure 4.5**, with the fill input in **Appendix D**. As detailed in the proposal drawings in **Appendix A**, the basement is to be constructed to a depth of approximately 3.2m bgl (approx. 39.30m AOD).

The XDISP analysis considers both 'excavation in front of a high stiffness wall in stiff clay' (CIRIA C760 Fig. 6.15(b) and 'installation of contiguous bored pile wall in stiff clay' (CIRIA 760 Fig. 6.8b) to simulate the effects from the underpinning, piling and excavation on neighbouring structures. The combined cumulative movements resulting from the wall installation (which includes the underpinning) and basement excavation have been used to carry out an assessment of the likely damage to adjacent properties as a conservative approach.

Stiffened walls have been used in the analysis which assumes adequate propping and workmanship. The combined cumulative movements resulting from the wall installation and basement excavation have been used to carry out an assessment of the likely damage to adjacent properties. The underpinning and excavation levels have been treated as being at the same level for the purposes of the assessment.

The property has an existing basement, however, to be conservative, this has been ignored in the model and a full excavation beneath property has been modelled.

In accordance with guidance from Oasys (https://www.oasys-software.com) and to avoid re-entrant corners, no movements have been modelled to those sides of the excavations that form attachments within the centre of the proposed basement but cannot be eliminated. The existing lower ground floors and basements beneath the adjacent buildings has been ignored in the modelling for conservatism.

Building Damage Assessment

The building damage assessment has been carried out on the relevant adjacent structures, as detailed in **Figure 4.1a & b**.

Tensile strains induced within the building walls have been evaluated based on the deflection ratios Δ/L and horizontal extension mechanisms estimated from the analyses. The assessment considers the well-established Burland (1977) (13) damage classification method, as presented and summarised in **Figure 4.3** and **4.4** below. This method involves a relatively simple but robust means of assessment, which is widely adopted and is considered to comprise an industry standard/best practice basis for impact assessments of this typology. Potential damage categories are directly related to the tensile strains induced by the proposed construction stages, arising from a combination of direct tension, and bending induced tensile mechanisms.

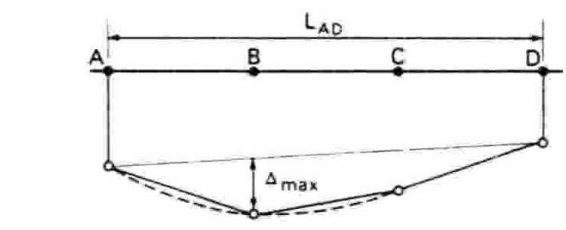

Figure 4.3: *Definition of relative deflection Δ and deflection ratio Δ/L*

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain ε_{lim} (per cent)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.0–0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection.	< 1	0.05–0.075
2 Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.	< 5	0.075–0.15
3 Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5–15 or a number of cracks > 3	0.15–0.3
4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 but also depends on number of cracks	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	usually > 25 but depends on number of cracks.	

Figure 4.4: *Building damage classification – relationship between category of damage and limiting strain ε_{lim} (After Burland et al. 1977* **(13)**, *Boscardin and Cording 1989* **(14)**, *and Burland 2001* **(15)**)

Results

A building impact/damage assessment has been undertaken, assuming the existing buildings walls to behave as equivalent beams subject to a combination of bending, shear, and axial extension/compression mechanisms, resulting from greenfield ground movements evaluated.

On the basis of the available information the predicted level of damage to the houses at 70 to 72 Gascony Avenue, arising from the excavation of a basement at 70 Gascony Avenue is “very slight” or less, as defined in **Figure 4.4**. The above analyses assumes a high standard of workmanship. The results of the assessment are presented in **Figure 4.5** and **Table 4.2** below, with the wall reference relating to the labels in **Figure 4.1**.

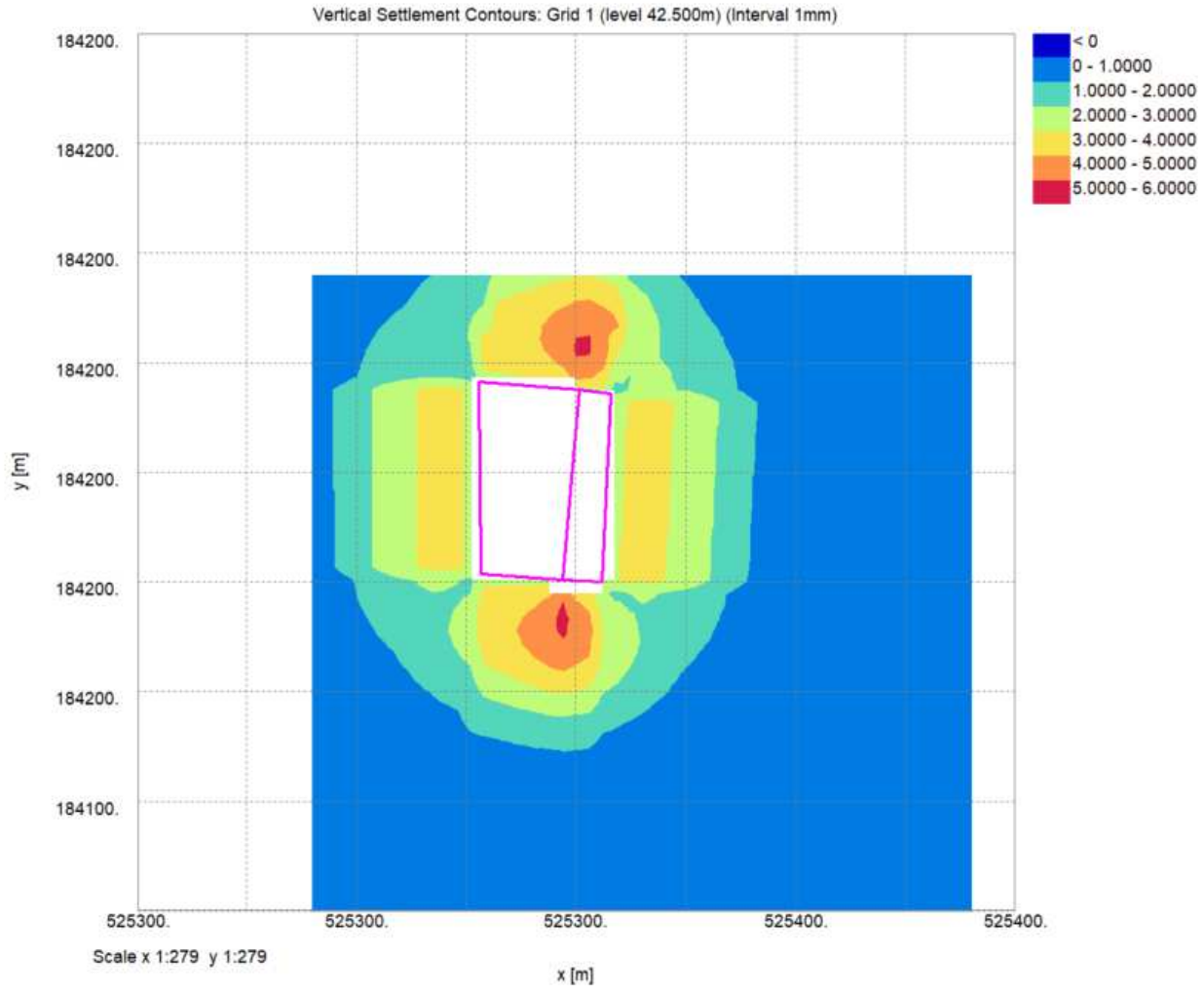

Figure 4.5: *XDisp output for the proposed basement*

Table 4.2: *Evaluated damage categories from XDISP*

Wall Reference	Details	Damage Category and Detail	
1A	70 Gascony Front	0	Negligible
1B	70 Gascony Front	0	Negligible
2	Party Wall 70-72	0	Negligible
3	70 Gascony Rear House	0	Negligible
4	70 Gascony Side	1	Very Slight
5	Extension Party Wall	1	Very Slight
6	No. 70 Extension Side	1	Very Slight
7	No. 70 Extension Rear	0	Negligible
8	No. 72 Extension Rear	0	Negligible
9	No. 72 Extension Side	0	Negligible
10	72 Gascony Rear	0	Negligible
11	72 Gascony Side	0	Negligible
12	72 Gascony Front	0	Negligible

It should be noted that these movements are likely to be more affected by the quality of the workmanship and propping of the basement excavations. The construction details adopted at the junctions with the party walls and at return walls will also have a significant influence on the likelihood of any future movements at these locations. Extra care should be taken in these sections to provide appropriate support to the existing walls to prevent any excessive deflection.

Despite these results it is considered that appropriate consideration to the support and stability of neighbouring walls will be needed in the detailed structural design of the basement. Movement monitoring of the walls is recommended during the construction stage and trigger levels should be set in order to protect the neighbouring properties as a precautionary measure.

5.0 Conclusions

A Ground Movement Assessment has been carried out for 70 Gascony Avenue with the following conclusions:

- Providing that appropriate consideration is given to the detailed design of the basement in order to limit future movement, that good workmanship and construction sequences are used with appropriate support during excavations, then the proposed basement construction is unlikely to cause significant damage to the surrounding structures. Based on the predicted ground movements, the adjacent house at 72 Gascony Avenue, are expected to be within the CIRIA C760 (6) Damage Category 1 (very slight) or less.
- Early movement monitoring of the boundary walls to the neighbouring buildings is recommended during the construction stage and trigger levels should be set in order to protect the neighbouring properties as a precautionary measure.
- A specification for movement monitoring should be incorporated into the final construction scheme for the proposed development to monitor the adjacent properties and establish the extent of any future potential movement to the building.
- Any temporary and permanent works should be designed to mitigate eventual movement.
- Groundwater levels should be taken into account with the final design.

6.0 References

1**Geology of Britain 3Dhttp://mapapps.bgs.ac.uk/geologyofbritain3d/**

2**British Geological Society*North London, England and Wales Sheet 256, Bedrock and Superficial Deposits, 1:50,000*British Geological Society2006**

3**Magic Maphttps://magic.defra.gov.uk/MagicMap.aspx**

4**BSI Standards Publication*BS 5930:2015+A1:2020 Code of Practice for Ground Investigations*BSI Standards Publication2015**

5**CIRIA*CIRIA C580 Embedded Retaining Walls - Guidance for Economic Design*CIRIA2003**

6***CIRIA C760 Guidance on embedded retaining wall design*CIRIA2017**

7**BSI Standards Publication*BS 8004:2015+A1:2020 Code of Practice for Foundations*BSI Standards Publication2015**

8***Hand Book of Geotechnical Investigation and Design Tables*Taylor & Francis2007978-0-415-43038-8**

9**British Standards Institution*BS 8002:2015 - Code of Practice for Earth Retaining Structures*British Standards Institution2015**

10 ***The Standard Penetration Test in insensitive clays and soft rocks. Proceedings of he European Symposum on Penetration Testing*1975**

11***ICE manual of geotechnical engineering (2012), Volume II*ICE2012**

12**Foundation Design and ConstructionPearson200174**

13***Burland, J., Broms, B. and de Mello, V. 1977. Behaviour of foundations and structures. Proc. 9th ICSMFE, State of-the-art Vol., 495-546***

14***Boscardin, M. D., & Cording, E. J. (1989). Building response to excavation-induced settlement. Journal of Geotechnical Engineering, 115, 1-21. doi:10.1061/(asce)0733-9410(1989)115:1(1)***

15***Burland, J.B. 2001. Building Response to Tunnelling: Case Studies from Construction of the Jubilee Line Extension. Report number: CIRIA Special Publication 200***

7.0 Appendices

Appendix A Proposed and Existing Development Plans

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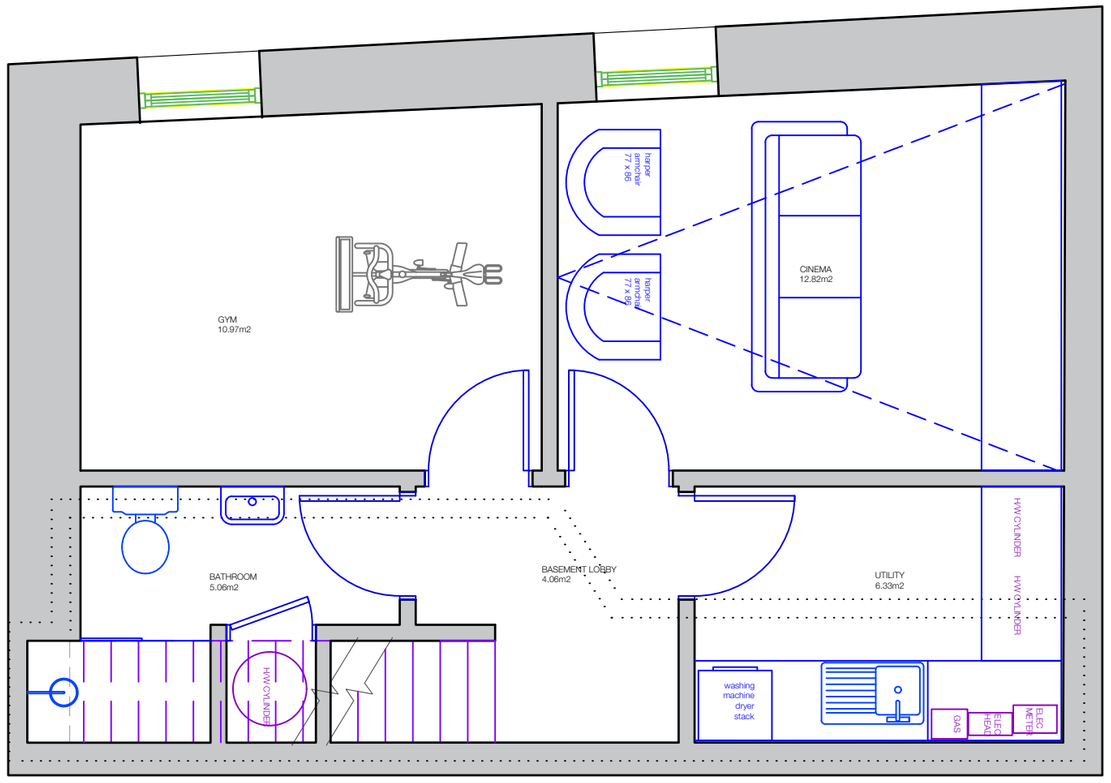

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FELIXDB

12 Chichester Road
London NW6 5QN

t. 07966264656

felix@felixdb.co.uk

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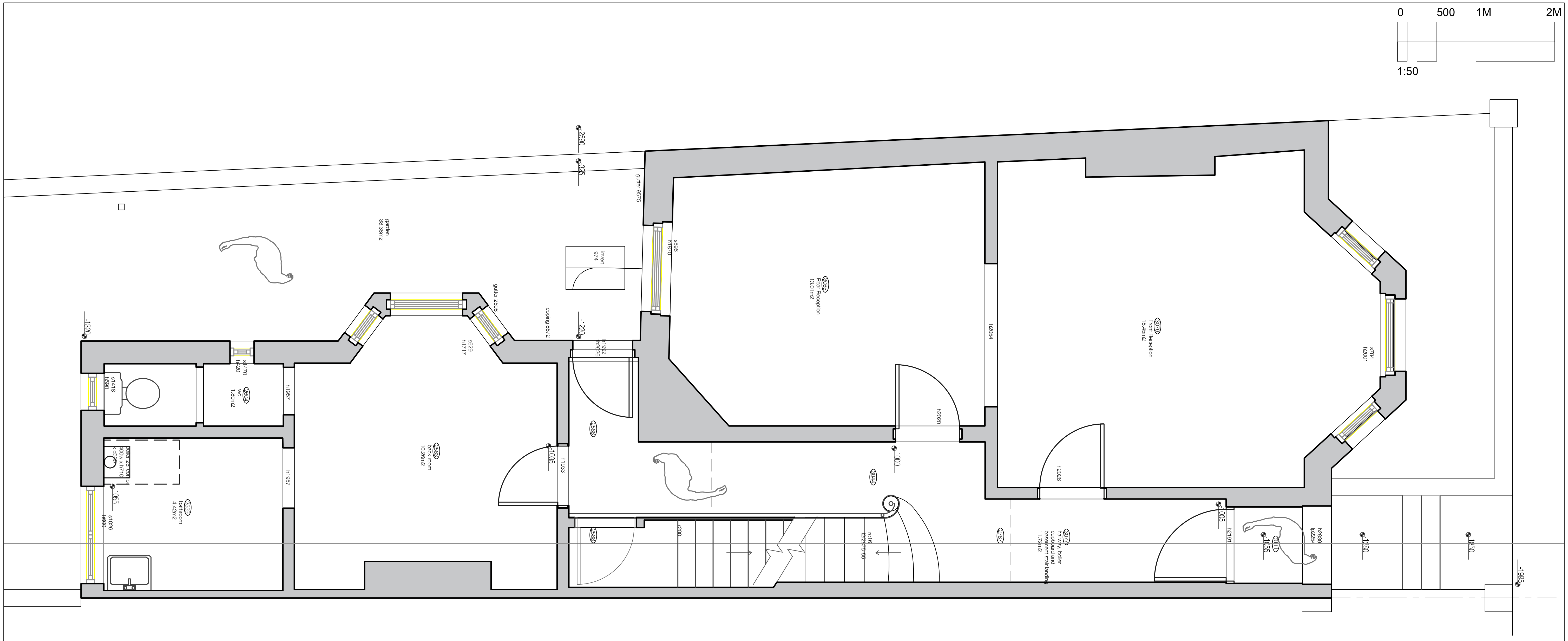
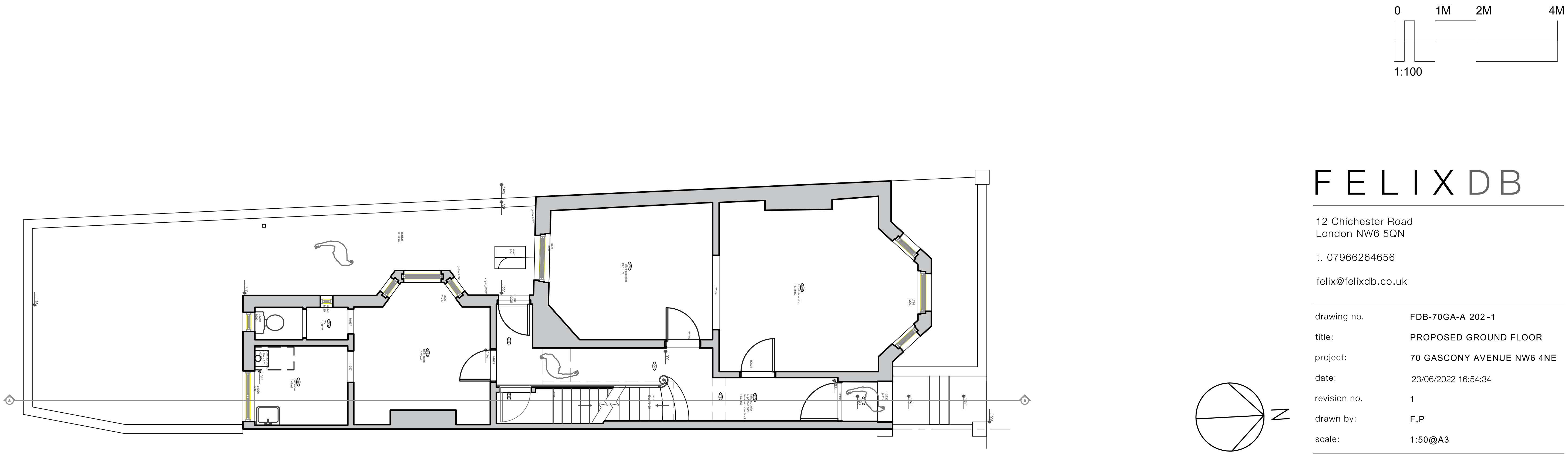
project:	70 GASCONY AVENUE NW6 4NE
date:	23/06/2022 16:54:33
revision no.	1
drawn by:	F.P
scale:	1:50@A3

dimensions to be checked on site before construction





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London NW6 5QN

t. 07966264656

felix@felixdb.co.uk

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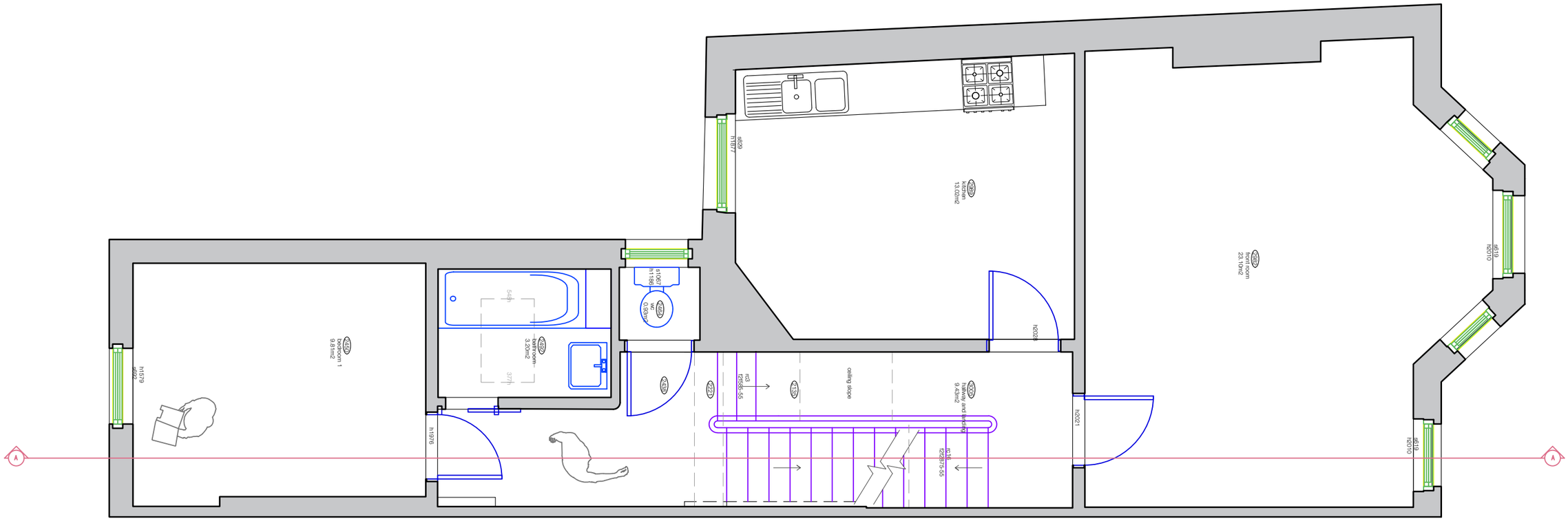

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London NW6 5QN

t. 07966264656

felix@felixdb.co.uk

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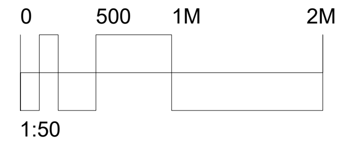
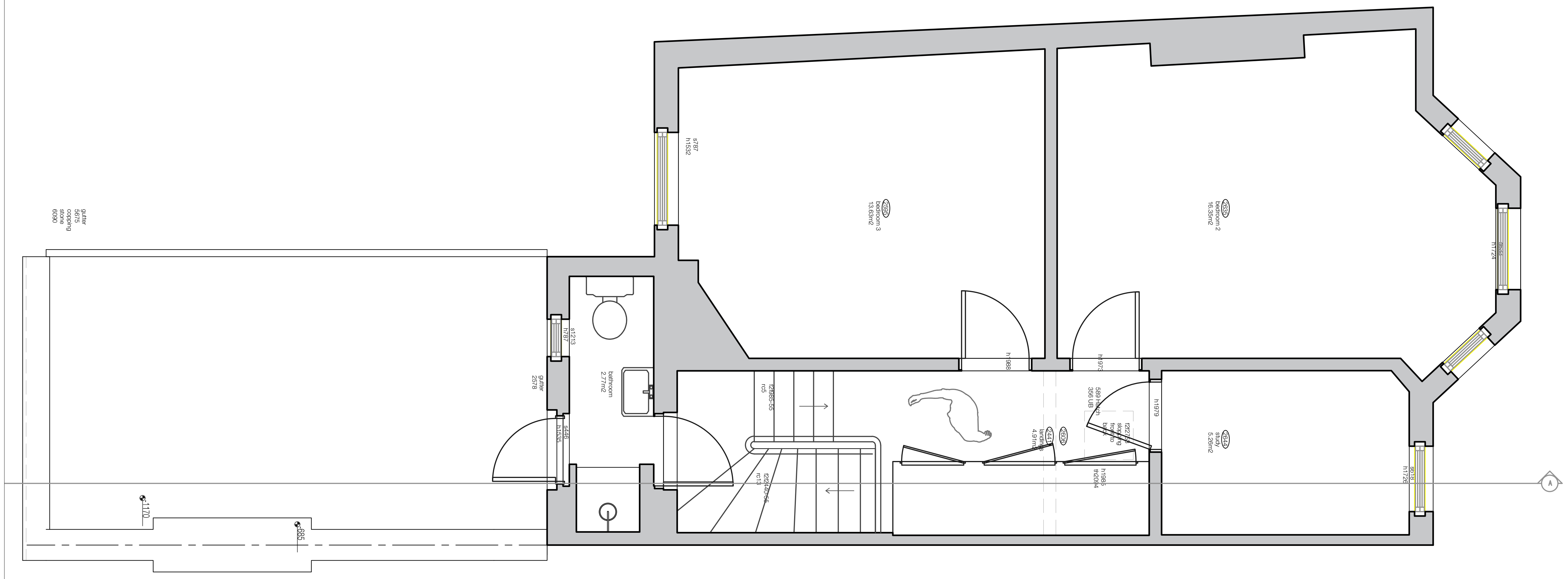
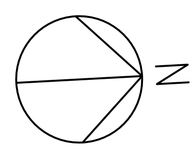
dimensions to be checked on site before construction







FELIXDB

12 Chichester Road
London NW6 5QN

t. 07966264656

felix@felixdb.co.uk

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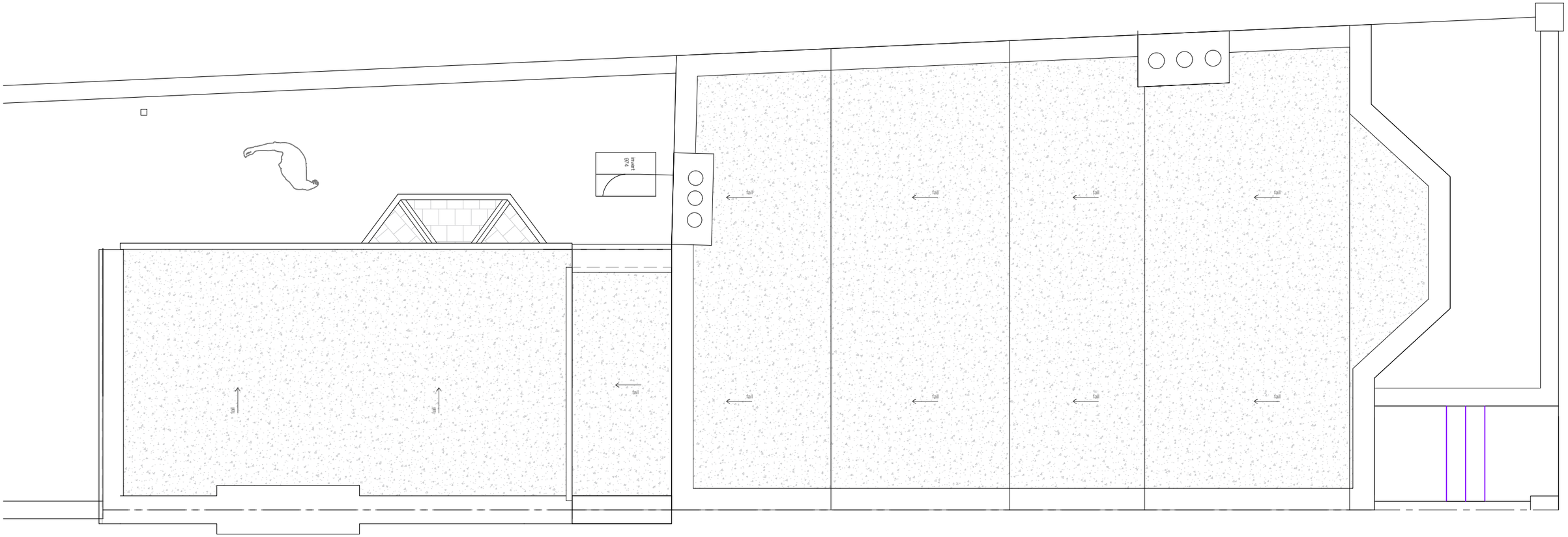

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12 Chichester Road
London NW6 5QN

t. 07966264656

felix@felixdb.co.uk

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dimensions to be checked on site before construction

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drawn by:	F.P
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dimensions to be checked on site before construction

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London NW6 5QN

t. 07966264656

felix@felixdb.co.uk

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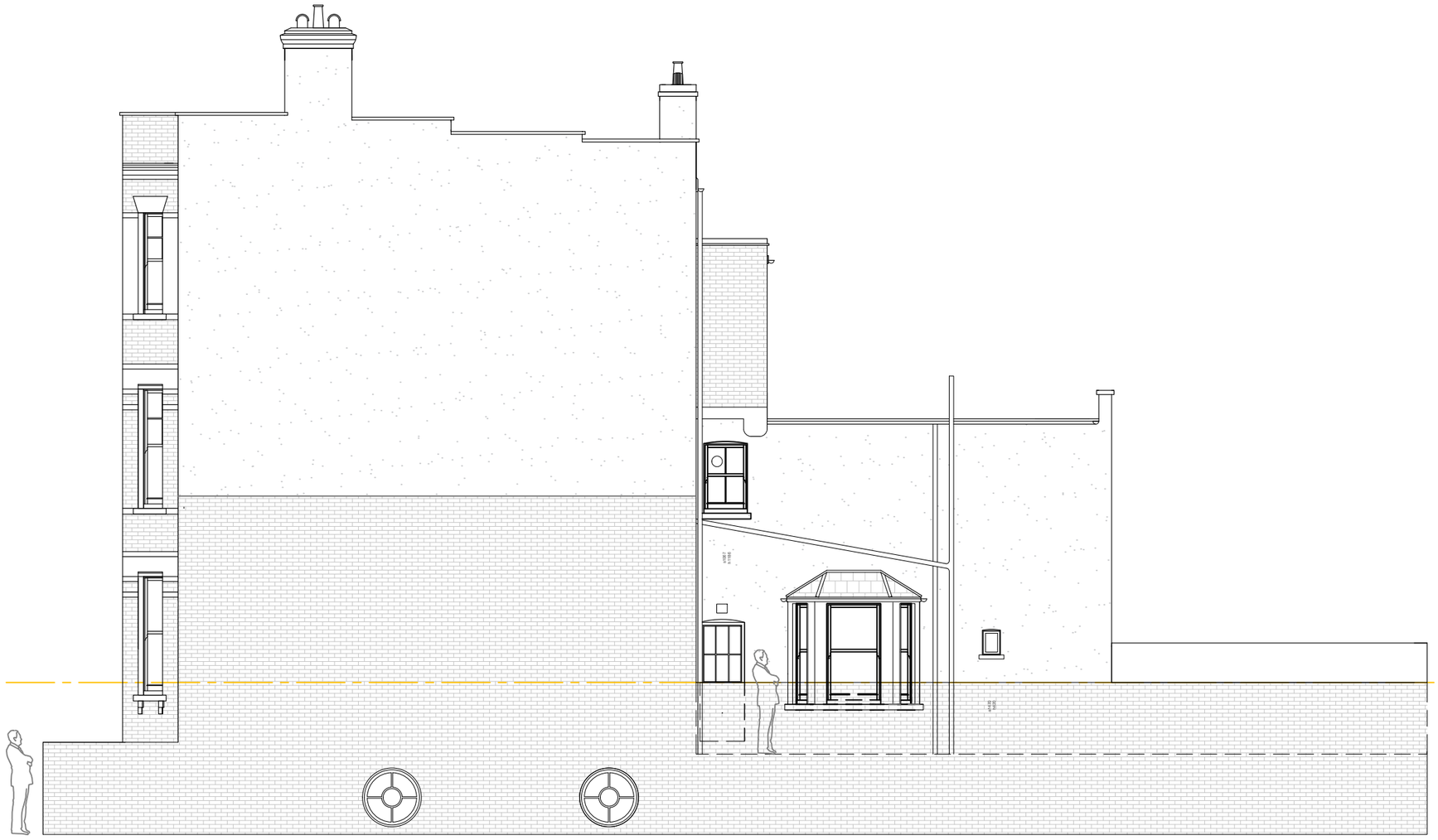

FELIXDB

12 Chichester Road
London NW6 5QN

t. 07966264656

felix@felixdb.co.uk

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FELIXDB

12 Chichester Road
London NW6 5QN

t. 07966264656

felix@felixdb.co.uk

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dimensions to be checked on site before construction

Appendix B SASL Factual Report

Factual Report on a
GEOTECHNICAL GROUND INVESTIGATION

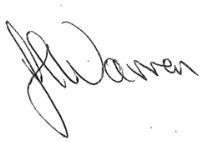
Ref: 22/34911-1 | Date: March 2022

70 Gascony Avenue
London
NW6 4NE

Prepared for:
Felix Padfield

DOCUMENT CONTROL

Project	70 Gascony Avenue, London, NW6 4NE
Document Type	Factual Report on a Ground Investigation
Document Reference	SAS 22/34911-1
Document Status	Final
Revision	0
Changes	-
Date	March 2022
Document Version	V1.0 – 3/21

Checked	Author
	
Jim Warren MRSC Managing Director	Thomas Murray BSc (Hons) MSc FGS Geotechnical Engineer

Reg. Office: Units 14 +15, River Road Business Park,
33 River Road, Barking, Essex IG11 0EA
Business Reg. No. 2255616
020 8594 8134
www.siteanalyticalgroup.co.uk

CONTENTS

1.0 Introduction

1.1 Outline and Limitations of Report

At the request of Felix Padfield, a ground investigation was carried out in connection with a proposed basement development at the above site. A Phase 1 Geotechnical Desk Study is presented under a separate cover in Site Analytical Services Limited Report Reference 22/34911, dated March 2022.

The information was required for the design and construction of foundations and infrastructure for the proposed development at the existing site which includes the construction of a basement level.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory hole made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole locations which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

2.0 Site Details

(National Grid Reference: TQ 253 841)

2.1 Site Location

The site is a corner plot, located on the southern side of Gascony Avenue – 45m to the west of the B510 West End Lane. The site is located in West Hampstead, North-West London, at approximate postcode NW6 4NE. The site is bound by residential terraced properties of similar build and character to the east (72 Gascony Avenue), a residential block to the south (12 Smyrna Road), Smyrna Road to the west and Gascony Avenue to the north.

The site is rectangular in shape and covers an approximate area of 0.02 Hectares with the general area being under the authority of the Camden Council.

2.2 Published Geology

The Geological Survey of Great Britain (England and Wales) covering the area indicates the site to be underlain by the London Clay Formation.

3.0 Scope of Work

3.1 Site Works

The proposed scope of works was agreed by the client prior to the commencement of the investigations. To achieve this, the following works were undertaken:-

- The drilling of one Continuous Flight Auger borehole to a depth of 15.00m below ground level (Borehole 1).
- The installation of a groundwater monitoring standpipe to an approximate depth of 6.00m in Borehole 1, together with two return monitoring visits.
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the exploratory hole.
- Laboratory testing to determine the engineering properties of the soils encountered in the exploratory hole.

3.2 Ground Conditions

The approximate location of the exploratory hole is illustrated on the site sketch plan, Figure 1 below.

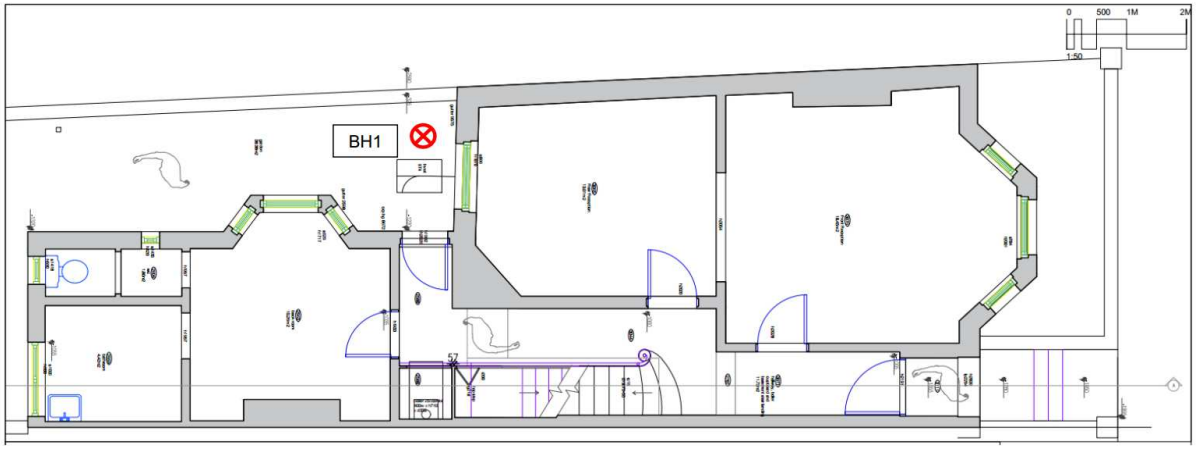


Figure 1. Site Sketch Plan

The borehole revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised Made Ground up to 0.70m in thickness resting on the London Clay Formation at depth.

These ground conditions are summarised in the following table. For detailed information on the ground conditions encountered in the borehole, reference should be made to the exploratory hole records presented in Appendix A.

Strata	Depth to top of strata (mbgl)	Depth to top of strata (mAODl)	Depth to base of strata (mbgl)	Depth to base of strata (mAOD)	Description
Made Ground	0.00	42.50	0.70	41.80	Crushed brick and concrete slab over sandy clay with brick and concrete fragments
London Clay Formation	0.70	41.80	15.00	27.50	Silty sandy CLAY containing partings of silty fine sand and gypsum crystals.

Summary of Ground Conditions in Exploratory Hole

3.3 Groundwater

Groundwater was encountered in the borehole as detailed in the table below.

It must be noted that the speed of excavation is such that there may well be insufficient time for further light seepages of groundwater to enter the borehole and hence be detected, particularly within more cohesive soils.

Water was encountered at of 6.12m below ground level in Borehole 1 after a period of approximately two to three weeks. The water encountered was purely surface water trapped in the cap at the base of the standpipe and not groundwater.

Isolated pockets of groundwater may also be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (February to March 2022) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

3.1 In-Situ Tests

In predominantly cohesive soils, in-situ shear vane tests were made at regular depth increments in order to assess the undrained shear strength of the materials. The results indicate that the natural soils are of a generally high strength in accordance with BS 5930 (2015).

The results of the in-situ tests are shown on the appropriate exploratory hole records contained in Appendix A.

3.2 Classification Tests

Atterberg Limit tests were conducted on four selected samples taken from the cohesive portion of the natural soils in Borehole 1 and showed the samples tested to fall into Class CH according to the British Soil Classification System.

These are fine grained silty clay soils of medium to high plasticity and as such generally have a low permeability and a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values of between 39% and 42%, with three samples being at or above the 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential.

The results of the tests are presented on Table 1, contained in Appendix B.

3.3 Chemical Attack on Buried Concrete

Using the results contained in Appendix B, the following table provides the highest values encountered for the BRE SD1 Suite D specification and the equivalent DS and ACEC classes, based on a static ground water:

Strata	pH	2:1 Water Soluble SO4 (g/l)	2:1 Water Soluble Chloride (mg/l)	2:1 Water Soluble Nitrate (mg/l)	Total Sulphate (%)	Magnesium (mg/kg)	DS Class	ACEC Class
London Clay Formation	7.4 to 7.7	3.5	69	<2.0	1.10	870	DS-4	AC-3s

Worst case DS and ACEC classes based on the BRE SD1 Suite D results

4.0 List of Appendices

Appendix A – Borehole Logs

Appendix B – Laboratory Test & Groundwater Monitoring Data

5.0 References

1. British Standards Institution, 2015. Code of practice for foundations, BS 8004, BSI, London.

2. British Standards Institution, 1990. Methods for test for soils for civil engineering purposes, BS1377, BSI, London

3. British Standards Institution, 1994. Code of practice for earth retaining structures, BS8002, BSI, London

4. British Standards Institution, Code of Practice for Site Investigations, BS5930: 2015, BSI, London

5. British Standards Institution, 2004. Geotechnical Design, BS EN 1997-1 BSI, London

6. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.

APPENDIX A

Borehole Logs

Site Analytical Services Ltd.

Site	Borehole Number
70 GASCONY AVENUE, LONDON, NW6 4NE	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	42.50	FELIX PADFIELD	2234911
	Location	**Dates**	**Engineer**	**Sheet**
	TQ253841	21/02/2022	MARTIN REDSTON ASSOCIATES	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.30)	MADE GROUND: Crushed brick and concrete		
0.25	D1				42.20	0.30	MADE GROUND: Dark brown sandy clay containing brick and concrete fragments		
0.50	D1					(0.40)			
0.75	D2				41.80	0.70	Firm, brown orange sandy CLAY		
1.00	D3								
1.00	V1 73					(1.10)			
1.50	D4								
1.50	V2 85				40.70	1.80	Stiff, brown orange sandy CLAY		
2.00	D5								
2.00	V3 92								
2.50	D6								
2.50	V4 106								
3.00	D7								
3.00	V5 118								
3.50	D8								
3.50	V6 137					(3.80)			
4.00	D9								
4.00	V7 140+								
4.50	D10								
4.50	V8 140+								
5.00	D11								
5.00	V9 140+								
					36.90	5.60	Stiff, dark brown grey silty sandy CLAY containing partings of silty fine grained sand and occasional gypsum crystals		
6.00	D12								
6.00	V10 140+								
7.00	D13								
7.00	V11 140+								
						(4.40)			
8.00	D14								
8.00	V12 140+								
9.00	D15								
9.00	V13 140+								

Remarks
Groundwater was not encountered during boring/excavation
V= Vane Test - Results in kPa
D= Disturbed Sample
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	EW

Figure No. 2234911.BH1

Site Analytical Services Ltd.

Site	Borehole Number
70 GASCONY AVENUE, LONDON, NW6 4NE	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	42.50	FELIX PADFIELD	2234911
	Location	**Dates**	**Engineer**	**Sheet**
	TQ253841	21/02/2022	MARTIN REDSTON ASSOCIATES	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.00 10.00	D16 V14 140+				32.50	10.00	Stiff, dark brown grey silty sandy CLAY containing partings of silty fine grained sand and occasional gypsum crystals		
11.00 11.00	D17 V15 140+								
12.00 12.00	D18 V16 140+					(5.00)			
13.00 13.00	D19 V17 140+								
14.00 14.00	D20 V18 140+								
15.00 15.00	D21 V19 140+				27.50	15.00	Complete at 15.00m		

Remarks
Groundwater was not encountered during boring/excavation
V= Vane Test - Results in kPa
D= Disturbed Sample

Scale (approx)	Logged By
1:50	EW

Figure No. 2234911.BH1

Site Analytical Services Ltd.

Site	Borehole Number
70 GASCONY AVENUE, LONDON, NW6 4NE	BH1

Installation Type
Single Installation

Dimensions
Internal Diameter of Tube [A] = 50 mm
Diameter of Filter Zone = 100 mm

Client
FELIX PADFIELD

Job Number
2234911

Location
TQ253841

Ground Level (mOD)
42.50

Engineer
MARTIN REDSTON ASSOCIATES

Sheet
1/1

Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
					Bentonite Seal
			41.50	1.00	
					Slotted Standpipe
			36.40	6.10	
					Bentonite Seal
			35.40	7.10	
					General Backfill
			27.50	15.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings				Depth Sealed (m)
					5 min	10 min	15 min	20 min	

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)

Instrument Groundwater Observations

Inst. [A] Type : Slotted Standpipe

Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	

Remarks
Lockble cover set in cement

APPENDIX B

Laboratory Test & Groundwater Monitoring Data

PLASTICITY INDEX & MOISTURE CONTENT DETERMINATIONS

BH/TP No.	Depth (m)	Natural Moisture (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 μm (%)	Modified Plasticity Index (%)	Class
BH1	1.00	30	66	26	40	100	40	CH
	2.00	29	69	28	41	100	41	CH
	3.00	30	68	26	42	100	42	CH
	4.00	28	63	24	39	100	39	CH

Table 1

GROUNDWATER MONITORING

GROUNDWATER MONITORING RECORD					
Date	**Monitoring Position**	**Depth to Water (mBGL)**	**Depth to Water (mAOD)**	**Depth to base of well (mBGL)**	**Depth to base of well (mAOD)**
03/03/2022	BH1	Dry	-	6.14	36.36

Table 2

GROUNDWATER MONITORING RECORD					
Date	**Monitoring Position**	**Depth to Water (mBGL)**	**Depth to Water (mAOD)**	**Depth to base of well (mBGL)**	**Depth to base of well (mAOD)**
10/03/2022	BH1	16.12	36.38	6.14	36.36

Table 2a

Steve Barrett
Site Analytical Services Ltd
Units 14 -15
River Road Business Park
33 River Road
Barking
Essex
IG11 0EA

t: 0208 5948134
f: 0208 5948072
e: SAS -

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 22-42307

Project / Site name:	70 Gascony Avenue, London, NW6 4NE	**Samples received on:**	28/02/2022
Your job number:	22 34911	**Samples instructed on/ Analysis started on:**	28/02/2022
Your order number:	9943	**Analysis completed by:**	07/03/2022
Report Issue Number:	1	**Report issued on:**	07/03/2022
Samples Analysed:	3 soil samples		

Signed: Karolina Marek

Karolina Marek
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 22-42307
Project / Site name: 70 Gascony Avenue, London, NW6 4NE
Your Order No: 9943

Lab Sample Number				2187627	2187628	2187629
Sample Reference				BH1	BH1	BH1
Sample Number				D4	D8	D14
Depth (m)				1.50	3.50	8.00
Date Sampled				21/02/2022	21/02/2022	21/02/2022
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	20	20	19
Total mass of sample received	kg	0.001	NONE	2.0	2.0	2.0
Whole Sample Crushed		N/A	NONE	Crushed	Crushed	Crushed

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	7.4	7.4	7.7
Total Sulphate as SO4	%	0.005	MCERTS	1.10	0.797	0.416
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	2.5	3.5	2.5
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	29	36	69
Total Sulphur	%	0.005	MCERTS	0.453	0.305	0.492
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	< 2.0	< 2.0	< 2.0

Heavy Metals / Metalloids

Magnesium (water soluble)	mg/kg	5	NONE	420	870	550

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 22-42307
Project / Site name: 70 Gascony Avenue, London, NW6 4NE

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
2187627	BH1	D4	1.5	Brown clay.
2187628	BH1	D8	3.5	Brown clay.
2187629	BH1	D14	8	Brown clay.

Analytical Report Number : 22-42307
Project / Site name: 70 Gascony Avenue, London, NW6 4NE

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Total Sulphate in soil as %	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In house method.	L038-PL	D	MCERTS
Total Sulphur in soil as %	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In house method.	L038-PL	D	MCERTS
Crush Whole Sample	Either: Client specific preparation instructions - sample(s) crushed whole prior to analysis; OR Sample unsuitable for standard preparation and therefore crushed whole prior to analysis.	In house method, applicable to dry samples only.	L019-PL	D	NONE
Water Soluble Nitrate (2:1) as N in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In house method.	L082-PL	D	MCERTS
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Appendix C PDISP Results

Titles

Job No.: 081114
Job Title: 70 Gascony Avenue
Sub-title:
Calculation Heading: Ground Movement Assessment Drained
Initials: AS
Checker:
Date Saved:
Date Checked:
Notes:
File Name: PDisp1 amended Feb 2023.pdd
File Path: \\LOFS03\Projects\081000.000-081999.000\081114 - 70 Gascony GMA\Q3-Design\3B-Models\GE\LP - Feb 2023

History

Date	Time	By	Notes
02-Mar-2022	08:47	Andrew.Smith	New
02-Mar-2022	10:12	Andrew.Smith	
02-Mar-2022	15:53	Andrew.Smith	
07-Mar-2022	09:44	Andrew.Smith	
17-Mar-2022	16:29	Andrew.Smith	
23-Mar-2022	11:50	Andrew.Smith	
23-Mar-2022	16:32	Andrew.Smith	
22-Apr-2022	10:45	Andrew.Smith	
22-Apr-2022	11:28	Andrew.Smith	
01-Feb-2023	12:21	Andrew.Smith	
01-Feb-2023	13:47	Andrew.Smith	
01-Feb-2023	13:50	Andrew.Smith	
01-Feb-2023	14:07	Andrew.Smith	
03-Feb-2023	15:53	Liam.Pallett	
03-Feb-2023	19:17	Liam.Pallett	
08-Feb-2023	10:27	Liam.Pallett	
08-Feb-2023	11:21	Liam.Pallett	Open

Analysis Options

General
Global Poisson's ratio: 0.20
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: -27.50 [m OD]
Displacements at load centroids: Yes
GSA piled raft data : No

Elastic
Elastic : Yes

Consolidation
Consolidation : No

Soil ProfilesSoil Profile 1

Layer ref.	Name	Level at top [mOD]	Number of intermediate displacement levels	Youngs Modulus : Top [kN/m²]	Youngs Modulus : Btm. [kN/m²]	Poissons ratio	Non-linear curve
1	Made Ground	42.500	5	3000.0	3000.0	0.20000	None
2	London Clay Formation	41.800	5	23600.	28000.	0.20000	None

Non-linear Curve Coordinates - Non-linear Curve 1

Point	Strain [%]	Factor

Soil Zones

Zone	Name	X min [m]	X max [m]	Y min [m]	Y max [m]	Profile
1	Soil Zone #	525320.	525360.	184140.	184180.	Soil Profile 1

Polygonal Load Data

Load ref.	Name	Position : Level [m]	Position : Polygon : Coords. [m]	Position : Polygon : Rect. tolerance [%]	No. of Rectangles	Value : Normal (local z) [kN/m²]
1	Load	39.30000	(5.25e+05,1.84e+05)	10.000	3	34.000
			(5.25e+05,1.84e+05)			
			(5.25e+05,1.84e+05)			
			(5.25e+05,1.84e+05)			
			(5.25e+05,1.84e+05)			
2	Load	39.30000	(5.25e+05,1.84e+05)	10.000	1	74.000
			(5.25e+05,1.84e+05)			
			(5.25e+05,1.84e+05)			
			(5.25e+05,1.84e+05)			

Polygonal Loads' Rectangles

No.	Centre : x [m]	Centre : y [m]	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 : Load					
(Edge 5 optimal)					
1	525336.53682	184155.42441	84.739	0.079872	1.2555
2	525337.72461	184159.58395	84.739	8.6287	4.1622
3	525325.66555	184159.12815	84.739	0.054593	2.2922
Load 2 : Load					
(Edge 1 optimal)					
1	525340.62760	184159.37707	87.171	8.6105	1.6176

Displacement Lines

Name	X1 [m]	Y1 [m]	Z1 [m]	X2 [m]	Y2 [m]	Z2 [m]	Intervals [No.]	Calculate	Detailed Results
70 Front - Higher	525335.60600	184164.10000	42.50000	525340.17030	184163.73440	42.50000	10	Yes	No
70 Front - Lower	525341.59870	184163.62010	41.20000	525340.17000	184163.73400	41.20000	3	Yes	No
70 / 72 PW	525341.59870	184163.62010	41.20000	525341.17430	184155.02020	41.20000	10	Yes	No
70 Rear Higher	525335.65000	184155.35000	42.50000	525338.15000	184155.20000	42.50000	3	Yes	No
70 Side	525335.65000	184155.35000	42.50000	525335.60600	184164.10000	42.50000	10	Yes	No
Extension PW	525341.17430	184155.02020	42.50000	525340.85000	184148.25000	42.50000	10	Yes	No
70 Extension Side	525338.15000	184155.20000	42.50000	525337.65000	184148.50000	42.50000	10	Yes	No
70 Extension Rear	525337.65000	184148.50000	42.50000	525340.85000	184148.25000	42.50000	10	Yes	No
72 Extemsion Rear	525340.85000	184148.25000	42.50000	525344.30000	184148.00000	42.50000	10	Yes	No
72 Extension Side	525344.30000	184148.00000	42.50000	525344.79290	184154.80140	42.50000	10	Yes	No
72 Rear	525341.17430	184155.02020	42.50000	525346.75000	184154.80000	42.50000	10	Yes	No
72 Side	525346.75000	184154.75000	42.50000	525347.20530	184163.35500	42.50000	10	Yes	No
72 Front	525347.20530	184163.35500	42.50000	525341.59870	184163.62010	42.50000	10	Yes	No
Road 1	525325.38000	184177.32000	42.50000	525353.00000	184175.68310	42.50000	10	No	No
Road 2	525324.80000	184168.60000	42.50000	525325.83360	184144.00000	42.50000	10	No	No
Road 3	525333.21960	184144.00000	42.50000	525333.45000	184168.70000	42.50000	10	No	No
Road 4	525333.45000	184168.70000	42.50000	525353.00000	184167.98250	42.50000	10	No	No

Displacement Grids

Name	Extrusion: Direction	X1 [m]	Y1 [m]	Z1 [m]	X2 [m]	Y2 [m]	Z2 [m]	Intervals Along Line [No.]	Extrusion: Distance [m]	Extrusion: Intervals Along [No.]	Calculate	Detailed Results
Grid 1	Global Y	525321.73244	184136.92947	42.50000	525357.67253	-	42.50000	50	44.87269	50	Yes	No

Appendix D XDISP Input and Output

Oasys

Titles

Job No.:
Job Title:
Sub-title:
Calculation Heading:
Initials:
Checker:
Date Saved: 03-Feb-2023
Date Checked:
Notes:
File Name: 081114 - Gascony Avenue.xdd
File Path: \\LOFS03\Projects\081000.000-081999.000\081114 - 70 Gascony GMA\Q3-Design\3B-Models\GE\LP - March 2023

History

Date	Time	By	Notes
03-Feb-2023	11:59	Liam.Pallett	New
03-Feb-2023	19:16	Liam.Pallett	
08-Feb-2023	10:10	Liam.Pallett	
20-Mar-2023	09:49	Liam.Pallett	
20-Mar-2023	09:55	Liam.Pallett	
20-Mar-2023	10:12	Liam.Pallett	
20-Mar-2023	13:41	Liam.Pallett	

Displacement Lines

Ref.	Name	x1 [m]	y1 [m]	z1 [m]	x2 [m]	y2 [m]	z2 [m]	Intervals [No.]	Surface type for tunnels	Interpolate imported displacements	Calculate
1	W1A	525335.60600	184164.10000	42.50000	525340.17030	184163.73440	42.50000	10	Surface	Yes	Yes
2	W1B	525341.59870	184163.62010	42.50000	525340.17000	184163.73400	42.50000	3	Surface	Yes	Yes
3	W2	525341.59870	184163.62010	42.50000	525341.17430	184155.02020	42.50000	10	Surface	Yes	Yes
4	W3	525335.65000	184155.35000	42.50000	525338.15000	184155.20000	42.50000	3	Surface	Yes	Yes
5	W4	525335.65000	184155.35000	42.50000	525335.60600	184164.10000	42.50000	10	Surface	Yes	Yes
6	W5	525341.17430	184155.02020	42.50000	525340.85000	184148.25000	42.50000	10	Surface	Yes	Yes
7	W6	525338.15000	184155.20000	42.50000	525337.65000	184148.50000	42.50000	5	Surface	Yes	Yes
8	W7	525337.65000	184148.50000	42.50000	525340.85000	184148.25000	42.50000	10	Surface	Yes	Yes
9	W8	525340.85000	184148.25000	42.50000	525344.30000	184148.00000	42.50000	10	Surface	Yes	Yes
10	W9	525344.30000	184148.00000	42.50000	525344.79290	184154.80140	42.50000	10	Surface	Yes	Yes
11	W10	525341.17430	184155.02020	42.50000	525346.75000	184154.80000	42.50000	10	Surface	Yes	Yes
12	W11	525346.75000	184154.75000	42.50000	525347.20530	184163.35500	42.50000	10	Surface	Yes	Yes
13	W12	525347.20530	184163.35500	42.50000	525341.59870	184163.62010	42.50000	10	Surface	Yes	Yes
14	Road 1	525325.38000	184177.32000	42.50000	525353.00000	184175.68310	42.50000	10	Surface	No	No
15	Road 2	525324.80000	184168.60000	42.50000	525325.83360	184144.00000	42.50000	10	Surface	No	No
16	Road 3	525333.21960	184144.00000	42.50000	525333.45000	184168.70000	42.50000	10	Surface	No	No
17	Road 4	525333.45000	184168.70000	42.50000	525353.00000	184167.98250	42.50000	10	Surface	No	No

Displacement Grids

Ref.	Name	Extrusion: Direction	Base line start: X [m]	Base line start: Y [m]	Base line start: Z(level) [m]	Base line end: X [m]	Base line end: Y [m]	Base line end: Z(level) [m]	Base line: Intervals [No.]	Extrusion: Distance [m]	Extrusion: Intervals [No.]	Surface type for tunnels	Calculate
1	1	Global X	525328.00000	184140.00000	42.50000	-	184169.00000	42.50000	50	30.00000	50	Surface	Yes

Polygonal Excavations

Ref. 1
Excavation Name: Excavation - New
Surface level [m]: 42.500
Contribution: Positive

Corner	x [m]	y [m]	Base Level [m]	Arc Enabled	Stiffened	Prev. Side: d [m]	Prev. Side: p1 [%]	Prev. Side: p2* [%]	Next Side: d [m]	Next Side: p1 [%]	Next Side: p2* [%]
1	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
2	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
3	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
4	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	525340.	184160.	525340.	184160.	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))
2	525340.	184160.	525340.	184160.	No vertical ground movement	No horizontal ground movement
3	525340.	184160.	525340.	184160.	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))
4	525340.	184160.	525340.	184160.	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))

Ref. 2
Excavation Name: Excavation - Existing
Surface level [m]: 42.500
Contribution: Positive

Corner	x [m]	y [m]	Base Level [m]	Arc Enabled	Stiffened	Prev. Side: d [m]	Prev. Side: p1 [%]	Prev. Side: p2* [%]	Next Side: d [m]	Next Side: p1 [%]	Next Side: p2* [%]
1	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
2	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
3	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
4	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	525340.	184160.	525340.	184160.	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))
2	525340.	184160.	525340.	184160.	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))
3	525340.	184160.	525340.	184160.	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))
4	525340.	184160.	525340.	184160.	No vertical ground movement	No horizontal ground movement

Ref. 3
Excavation Name: Underpinning of Excavation - New
Surface level [m]: 42.500
Contribution: Positive

Corner	x [m]	y [m]	Base Level [m]	Arc Enabled	Stiffened	Prev. Side: d [m]	Prev. Side: p1 [%]	Prev. Side: p2* [%]	Next Side: d [m]	Next Side: p1 [%]	Next Side: p2* [%]
1	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
2	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
3	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
4	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	525340.	184160.	525340.	184160.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
					Fig. 6.8(b))	Fig. 6.8(a))
2	525340.	184160.	525340.	184160.	No vertical ground movement	No horizontal ground movement
3	525340.	184160.	525340.	184160.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))
4	525340.	184160.	525340.	184160.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))

Ref. 4
Excavation Name: **Underpinning of Excavation - Existing**
Surface level [m]: 42.500
Contribution: Positive

Corner	x [m]	y [m]	Base Level [m]	Arc Enabled	Stiffened	Prev. Side: d [m]	Prev. Side: p1 [%]	Prev. Side: p2* [%]	Next Side: d [m]	Next Side: p1 [%]	Next Side: p2* [%]
1	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
2	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
3	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
4	525340.	184160.	39.300	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	525340.	184160.	525340.	184160.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))
2	525340.	184160.	525340.	184160.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))
3	525340.	184160.	525340.	184160.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))
4	525340.	184160.	525340.	184160.	No vertical ground movement	No horizontal ground movement

Circular Excavations

Vertical Ground Movement Curves

Curve Name: **No vertical ground movement**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z)(%)]

[0.000,0.000,0.000][1.000,0.000,0.000][0.000,1.000,0.000][1.000,1.000,0.000]

Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination:

Curve Name: **Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z)(%)]

[0.000,0.000,0.040][2.000,0.000,0.000]

Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -2.0E-2x + 4.0E-2
Coeff. of Determination: 1.0

Curve Name: **Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z)(%)]

[0.000,0.000,0.039][0.100,0.000,0.049][0.200,0.000,0.056][0.300,0.000,0.062]
[0.400,0.000,0.067][0.500,0.000,0.070][0.600,0.000,0.072][0.700,0.000,0.073]
[0.800,0.000,0.073][0.900,0.000,0.072][1.000,0.000,0.070][1.100,0.000,0.068]
[1.200,0.000,0.065][1.300,0.000,0.061][1.400,0.000,0.058][1.500,0.000,0.054]
[1.600,0.000,0.050][1.700,0.000,0.046][1.800,0.000,0.042][1.900,0.000,0.038]
[2.000,0.000,0.034][2.100,0.000,0.030][2.200,0.000,0.027][2.300,0.000,0.023]
[2.400,0.000,0.020][2.500,0.000,0.017][2.600,0.000,0.014][2.700,0.000,0.012]
[2.800,0.000,0.010][2.900,0.000,0.008][3.000,0.000,0.007][3.100,0.000,0.005]
[3.200,0.000,0.004][3.300,0.000,0.004][3.400,0.000,0.003][3.500,0.000,0.002]
[3.600,0.000,0.002][3.700,0.000,0.002][3.800,0.000,0.001][3.900,0.000,0.001]
[4.000,0.000,0.000]

Curve Fitting Method: Polynomial
x Order: 4
y Order: 0
Polynomial: z = $-2.6455E-3x^4 + 2.8495E-2x^3 - 1.0051E-1x^2 + 1.0569E-1x + 3.8990E-2$
Coeff. of Determination: 9.9991E-1

Horizontal Ground Movement Curves

Curve Name: **No horizontal ground movement**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z)(%)]
[0.000,0.000,0.000][1.000,0.000,0.000][0.000,1.000,0.000][1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 0
y Order: 0
Polynomial: z = 0.0
Coeff. of Determination:

Curve Name: **Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z)(%)]
[0.000,0.000,0.041][0.050,0.000,0.038][0.100,0.000,0.036][0.150,0.000,0.034]
[0.200,0.000,0.032][0.250,0.000,0.030][0.300,0.000,0.029][0.350,0.000,0.027]
[0.400,0.000,0.025][0.450,0.000,0.023][0.500,0.000,0.022][0.550,0.000,0.020]
[0.600,0.000,0.019][0.650,0.000,0.018][0.700,0.000,0.016][0.750,0.000,0.015]
[0.800,0.000,0.014][0.850,0.000,0.013][0.900,0.000,0.011][0.950,0.000,0.010]
[1.000,0.000,0.009][1.050,0.000,0.008][1.100,0.000,0.007][1.150,0.000,0.006]
[1.200,0.000,0.005][1.250,0.000,0.004][1.300,0.000,0.004][1.350,0.000,0.003]
[1.400,0.000,0.002][1.450,0.000,0.001][1.500,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 3
y Order: 0
Polynomial: z = $-4.2486E-3x^3 + 1.9096E-2x^2 - 4.6221E-2x + 4.0729E-2$
Coeff. of Determination: 1.0000

Curve Name: **Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z)(%)]
[0.000,0.000,0.150][4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.75E-2x + 1.50E-1
Coeff. of Determination: 1.00

Damage Category Strains

Ref.	Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
1	Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Buildings - Geometry

Ref.	Building Name	Sub-Building Name	Displacement Line	Distance Along Line: Start	Distance Along Line: End	Vertical Offsets from Line for Vertical Movement	Vertical Displacement Limit Sensitivity	Damage Category Strains	Poisson's Ratio	E/G

						Calculations					
				[m]	[m]	[m]	[mm]				
1	70	Gascony	W1A	W1A	0.00000	4.57800	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
2	70	Gascony	W1B	W1B	0.00000	1.43300	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
3	70	Gascony	W2	W2	0.00000	8.61000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
4	70	Gascony	W3	W3	0.00000	2.50400	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
5	70	Gascony	W4	W4	0.00000	8.75000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
6	70	Gascony - Extension	W5	W5	0.00000	6.77700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
7	70	Gascony - Extension	W6	W6	0.00000	6.71800	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
8	70	Gascony - Extension	W7	W7	0.00000	3.20900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
9	72	Gascony	W12	W12	0.00000	5.61200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
10	72	Gascony	W11	W11	0.00000	8.61700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
11	72	Gascony	W10	W10	0.00000	5.58000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
12	72	Extension	W8	W8	0.00000	3.45900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
13	72	Extension	W9	W9	0.00000	6.81900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

Specific Buildings - Bending Parameters

Ref.		Building Name	Sub-Building Name	Height	Default	Hogging: 2nd Mom. of Area (per unit width)	Hogging: Dist. of Bending Strain from N.A.	Hogging: Dist. of N.A. from Edge of Beam in Tension	Sagging: 2nd Mom. of Area (per unit width)	Sagging: Dist. of Bending Strain from N.A.	Sagging: Dist. of N.A. from Edge of Beam in Tension
				[m]		[m³]	[m]	[m]	[m³]	[m]	[m]
1	70	Gascony	W1A	12.500	Yes	651.04	12.500	12.500	162.76	6.2500	6.2500
2	70	Gascony	W1B	12.500	Yes	651.04	12.500	12.500	162.76	6.2500	6.2500
3	70	Gascony	W2	12.500	Yes	651.04	12.500	12.500	162.76	6.2500	6.2500
4	70	Gascony	W3	12.500	Yes	651.04	12.500	12.500	162.76	6.2500	6.2500
5	70	Gascony	W4	12.500	Yes	651.04	12.500	12.500	162.76	6.2500	6.2500
6	70	Gascony - Extension	W5	9.0000	Yes	243.00	9.0000	9.0000	60.750	4.5000	4.5000
7	70	Gascony - Extension	W6	9.0000	Yes	243.00	9.0000	9.0000	60.750	4.5000	4.5000
8	70	Gascony - Extension	W7	9.0000	Yes	243.00	9.0000	9.0000	60.750	4.5000	4.5000
9	72	Gascony	W12	12.500	Yes	651.04	12.500	12.500	162.76	6.2500	6.2500
10	72	Gascony	W11	12.500	Yes	651.04	12.500	12.500	162.76	6.2500	6.2500
11	72	Gascony	W10	12.500	Yes	651.04	12.500	12.500	162.76	6.2500	6.2500
12	72	Extension	W8	9.0000	Yes	243.00	9.0000	9.0000	60.750	4.5000	4.5000
13	72	Extension	W9	9.0000	Yes	243.00	9.0000	9.0000	60.750	4.5000	4.5000

Specific Building Damage Results - Detail

Stage: Ref.	Stage: Name	Specific Building: Ref.	Specific Building: Name	Sub-building Name	Vertical Offset from Line for Vertical Movement Calculations [m]	Segment	Start [m]	Length [m]	Curvature	Deflection Ratio	Average Horizontal Strain [%]	Max Tensile Strain [%]	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature [m]	Damage Category
0	Base Model	1	70 Gascony	W1A	0.0	1	0.0	4.5780	None	0.016412	-5.7098E-6	0.015864	572.09E-9	0.0018290	200.13	0 (Negligible)
		2	70 Gascony	W1B	0.0	1	0.0	0.0	None	0.0	0.0	35.763E-9	0.0043394	0.0044552	85.613	0 (Negligible)
		3	70 Gascony	W2	0.0	1	0.0	2.5831	None	0.010258	-0.11881	0.024481	0.0035771	-462.70E-6	1486.6	0 (Negligible)
						2	2.5831	3.0687E-12	None	0.0	0.0	35.763E-9	0.0	0.0	2.4280E+15	0 (Negligible)
						3	2.5831	2.1526	None	0.046851	0.0	0.046498	0.0	0.0029356	1173.2	0 (Negligible)
						4	4.7357	3.8743	Hogging	0.031438	-0.053118	0.023385	0.0023968	0.0029356	692.97	0 (Negligible)
		4	70 Gascony	W3	0.0	1	0.0	0.0	None	0.0	0.0	35.763E-9	0.0025699	0.0025756	259.04	0 (Negligible)
		5	70 Gascony	W4	0.0	1	0.0	2.6250	Hogging	0.054531	-0.11657	0.041966	0.0035095	0.0024596	284.20	0 (Negligible)
						2	2.6250	3.5000	None	0.0	0.0	35.763E-9	0.0	0.0	-	0 (Negligible)
						3	6.1251	2.6249	Hogging	0.064348	-0.23163	0.060425	0.0069982	-0.0029094	239.92	1 (Very Slight)
		6	70 Gascony - Extension	W5	0.0	1	0.0	5.3888	Sagging	0.047096	-0.037370	0.033663	0.0058679	-0.0036038	194.73	0 (Negligible)
						2	5.3888	1.3882	None	0.0050087	0.049382	0.050563	-507.33E-6	854.52E-6	2559.0	1 (Very Slight)
		7	70 Gascony - Extension	W6	0.0	1	1.3437	4.7666	None	0.018455	0.051883	0.065911	0.0046940	-0.0029611	603.72	1 (Very Slight)
						2	6.1103	0.60771	None	0.0	0.052437	0.052437	-524.09E-6	810.16E-6	18419.	1 (Very Slight)
		8	70 Gascony - Extension	W7	0.0	1	0.0	0.97388	None	0.0011418	-963.18E-6	891.39E-6	10.013E-6	938.34E-6	1238.4	0 (Negligible)
						2	0.97388	0.57790	None	0.049360	-0.0065995	0.046827	138.29E-6	-0.0010509	719.43	0 (Negligible)
						3	1.5518	1.6572	None	0.0036367	-299.96E-6	0.0034898	138.29E-6	-0.0010509	1093.1	0 (Negligible)
		9	72 Gascony	W12	0.0	1	0.0	4.4716	None	0.0072922	0.038135	0.042021	-468.76E-6	-414.81E-6	3843.0	0 (Negligible)
						2	4.4716	1.1404	None	0.012701	-0.11921	0.024955	0.0029541	269.38E-6	809.83	0 (Negligible)
		10	72 Gascony	W11	0.0	1	0.0	6.0319	None	2.4424E-9	473.23E-9	464.92E-9	-4.7323E-9	2.1669E-6	24.709E+9	0 (Negligible)
						2	6.0319	2.5851	None	0.012792	-943.09E-6	0.012289	28.304E-6	577.83E-6	1197.5	0 (Negligible)
		11	72 Gascony	W10	0.0	1	0.0	5.5800	Sagging	0.038278	-0.048035	0.027228	0.010186	-0.0037292	135.22	0 (Negligible)
		12	72 Extension	W8	0.0	1	0.0	1.0300	None	0.019076	-0.0050611	0.017228	98.187E-6	0.0010351	319.21	0 (Negligible)
						2	1.0300	0.69686	None	59.047E-6	-0.0086586	0.0017320	94.463E-6	184.29E-6	72325.	0 (Negligible)
						3	1.7268	1.7322	None	308.88E-6	-0.0059934	0.0012117	83.472E-6	184.29E-6	45398.	0 (Negligible)
		13	72 Extension	W9	0.0	1	0.0	0.31234	None	0.0	0.0073533	0.0073533	-73.527E-6	-189.11E-6	48681.	0 (Negligible)
						2	0.31234	1.5369	None	0.0013476	0.0018764	0.0024989	-73.527E-6	-252.84E-6	26787.	0 (Negligible)
						3	1.8492	1.1566	None	0.0011256	-0.011289	0.0023499	196.42E-6	-252.84E-6	52227.	0 (Negligible)
						4	3.0059	0.89542	None	0.0020737	-0.018970	0.0039804	196.42E-6	-256.99E-6	36195.	0 (Negligible)
						5	3.9013	2.9177	None	0.0019890	-0.037420	0.0075673	456.30E-6	-256.99E-6	16766.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Our Locations

Birmingham
2 The Wharf
Bridge Street
Birmingham
B1 2JS
T. 0121 643 4694
birmingham@curtins.com

Bristol
Quayside
40-58 Hotwell Road
Bristol
BS8 4UQ
T. 0117 302 7560
bristol@curtins.com

Cambridge
50 Cambridge Place
Cambridge
CB2 1NS
T. 01223 631 799
cambridge@curtins.com

Cardiff
3 Cwrt-y-Parc
Earlswood Road
Cardiff
CF14 5GH
T. 029 2068 0900
cardiff@curtins.com

Douglas
Varley House
29-31 Duke Street
Douglas
Isle of Man
IM1 2AZ
T. 01624 624 585
douglas@curtins.com

Dublin
11 Pembroke Lane
Dublin 2
D02 CX82
Ireland
T. +353 1 507 9447
dublin@curtins.com

Edinburgh
1a Belford Road
Edinburgh
EH4 3BL
T. 0131 225 2175
edinburgh@curtins.com

Glasgow
Queens House
29 St Vincent Place
Glasgow
G1 2DT
T. 0141 319 8777
glasgow@curtins.com

Kendal
Units 24 & 25 Riverside Place
K Village
Lound Road
Kendal
LA9 7FH
T. 01539 724 823
kendal@curtins.com

Leeds
Ground Floor
Rose Wharf
78-80 East Street
Leeds
LS9 8EE
T. 0113 274 8509
leeds@curtins.com

Liverpool
51-55 Tithebarn Street
Liverpool
L2 2SB
T. 0151 726 2000
liverpool@curtins.com

London
40 Compton Street
London
EC1V 0BD
T. 020 7324 2240
london@curtins.com

Manchester
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG
T. 0161 236 2394
manchester@curtins.com

Nottingham
56 The Ropewalk
Nottingham
NG1 5DW
T. 0115 941 5551
nottingham@curtins.com

curtins

Curtins Consulting Ltd registered in England and Wales No: 2054159
Registered office: 51-55 Tithebarn Street, Liverpool, L2 2SB