mason navarro pledge

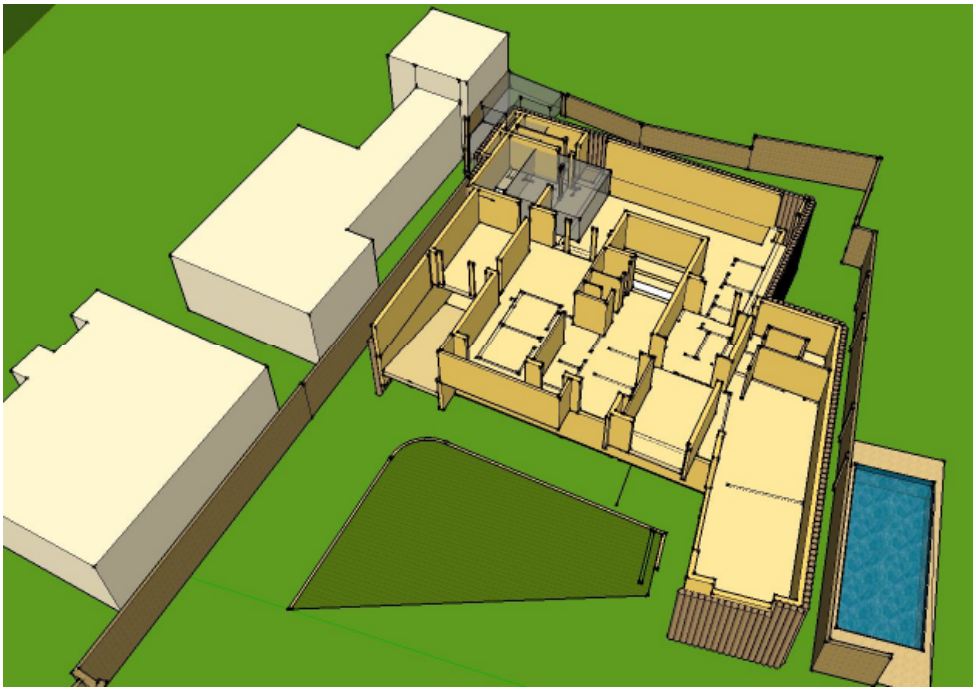
Bancroft Court
Hitchin
Hertfordshire SG5 1LH

Telephone: 01462 632012
Fax: 01462 632233
Email: office@mnp.co.uk
www.mnp.co.uk

DAMAGE ASSESSMENT REPORT OF NEIGHBOURING STRUCTURES DUE TO EXCAVATION AT

99A FROGNAL, HAMPSTEAD, LONDON, NW3 6XR

REF: 214073 – MARCH 2014



99a Frognal, London – New dwelling with basement.

RIBA Stage C – Damage Assessment Report

Structural and Civil Engineering
March 2014
Report no: 214073-R01-01

Author: Stuart Pledge BEng(Hons) CEng MIStructE

Checker: Stephen Vernon CEng BEng(Hons) MICE MIStructE

Approver: Frank Navarro CEng BEng(Hons) MIStructE

CONTENTS

Report prepared by:

Stuart Pledge
BEng (Hons) CEng MIStructE
Director

1. EXECUTIVE SUMMARY

1.1. As a consequence of the proposed basement excavation at no.99a Frognal a damage assessment study has been undertaken. This study follows a detailed ground movement analysis and Basement Impact Assessment prepared by Geotechnical and Environmental Associates (GEA).

1.2. The study undertaken by GEA using XDisp models the potential ground movement during both piling installation and during bulk excavation with the movements accumulated. Their analysis models the building footprint and reviews movement at existing foundation level.

1.3. The movement (vertical, lateral and rotational angular distortion) is then analysed within xdisp and converted in to a damage category using the recommendations of both Burland and Boscardin and Cording whose later work included categorising the elastic strains within panels.

1.4. The GEA report concludes that predicted damage for all but 2 structures was within category 1 (very slight) or less. Their study concludes that the southern wall to the swimming pool to no.5 Oak Hill Park falls marginally within the slight category (2). The northern wall to no.4 Oak Hill Park marginally falls within category 2.

1.5. Refinement of the analysis has been undertaken by a specialist piling company to adjust the prop positions and analysis method. This reduces lateral piling movements and brings the damage potential in to category 1 in all locations.

1.6. Structural surveys have been undertaken of the structures to check for existing defects and to confirm the nature of the construction. Other than some minor cracking to the extended section of no.4 and an outward lean to the boundary wall, the structures were free from defect that would inhibit development at 99A.

1.7. Mitigation for these defects and potential methods to monitor movements and provide an action plan have been provided in the report.

1.8. A detailed construction methodology and sequence should be developed around the piling sequence outlined in the report with attention paid to the propping levels.

1.9. The report concludes that damage potential is within acceptable limits and movements can be controlled by adopting standard basement techniques of piling, propping, liner walls and RC floor slabs.

2. INTRODUCTION

2.1 A basement impact assessment (BIA) has been prepared by GEA (ref J13053A dated 30 January 2014) in support of a planning application. That report appraises ground movements based on a mix of contiguous and secant piled walls (secant adopted for the deeper western boundary excavation for the new swimming pool area. The study includes setting capping beam and slab levels and excavation depths to match the architectural proposals and identifies temporary propping levels.

2.2 Their report includes an X-disp ground movement study to assess impact on neighbouring buildings/structures and concludes a damage potential against the Burland scale.

2.3 The buildings subject to study were as follows:-

- Garages at Northwood Lodge
- Apartment block of Northwood Lodge
- 4a Oak Hill Park
- 4 Oak Hill Park
- 4 Oak Hill Park Mews
- 5 Oak Hill Park Mews
- 6 Oak Hill Park Mews
- Swimming pool to 5 Oak Hill Park Road

2.4 The neighbouring buildings are referenced below.

Figure 1 – site plan showing building references

Aerial photograph

2.5 The ground movement study concluded damage potential was generally negligible (category 0) or very slight (category 1). This is with the exception of the southern wall of the swimming pool to 5 Oak Hill Park Road and the northern wall of the neighbouring dwelling at 4 Oak Hill Park. In both cases the damage potential was only marginally in to category 2, slight and the aim of this report is to refine the analysis and provide mitigation strategies through propping and sequence improvements and detailed pile design to reduce the damage potential. In addition we have identified key locations for level monitoring targets through construction.

2.6 We carried out a detailed inspection of no.4 Oak Hill Park and boundary walls and viewed the swimming pool from the 99a Frognal garden during a site visit on the 6th March 2014. The main purpose of the visit was to confirm the local conditions matched the survey and proposed drawing and to identify the construction types and building age. Any existing defects that could affect the study have been recorded and factored in to the damage potential. We assessed the presence of window and door apertures that could give rise to higher strains and lead to enhanced cracking.

2.7 In parallel the Client engaged a specialist piling contractor (Foundation Piling) to carry out a detailed analysis to refine the initial Wallap piled wall designs undertaken by GEA.

2.8 Our site survey concluded that the buildings and structures that sit within damage category 0 and 1 can continue to be excluded from further study as the damage potential is minimal. Our survey concluded that boundary walls should be incorporated in to this study and shoring measure indicated to protect them during construction.

2.9 Full details of the new buildings at no.99a Frognall Way are highlighted on the following documents:-

Douglas and King:-

FROg ga 99A – lower ground floor plan

FROg ga 100A – ground floor plan

FROg ga 101A – first floor plan

FROg ga 102A – second floor plan

FROg ga 200A – section AA/BB

FROg ga 201A – section CC/DD

FROg ga 300A – south and north elevations

FROg ga 301A – east and west elevations

These drawings form the basis of our study.

3. BASIS OF THE STUDY AND DISCUSSION REGARDING DAMAGE ASSESSMENT ANALYSIS METHODS

3.1. Geotechnical

- GEA prepared a phase 1 desk study report (ref J10088 dated May 2010) and undertook site specific soil testing with preparation of an interpretive report (ref J13053 dated May 2013).

- The testing determined that the expected geology was encountered comprising made ground over Bagshot formation over the Claygate member over London Clay. The water table was not determined but has conservatively been set for the deeper piled wall to the western boundary behind the swimming pool.

3.2 Analysis Method and assessment stages.

Stage 1 assessment – xdisp study

- GEA have prepared an Xdisp model to appraise the ground movement due to the excavation. Xdisp was produced by the software house of Arup to appraise ground movements due to tunnelling and excavation. The programme calculates the lateral and vertical ground displacements due to pile installation and excavation in front of the embedded wall.

- These displacements allow the movement to be conveyed in to a damage assessment category using the Burland (1997) assessment method. Buildings are specified by their locations and bending properties within Xdisp which then determines the damage category based on tensile strains. Boscardin and Cording (1989) introduced an interaction diagram (see figure 1) relating to angular distortion and a series of limiting tensile strains (E_{lim}) in order to place building damage in to the category defined by Burland *et al*.

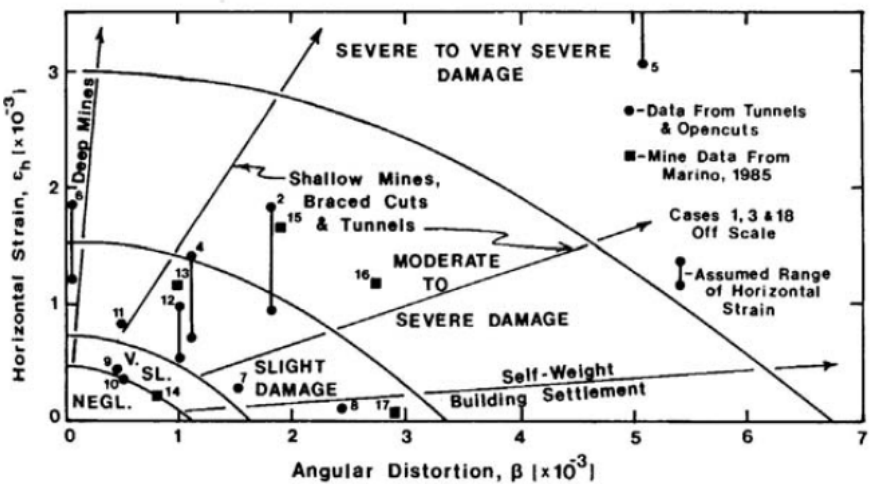


Figure 2 – Boscardin and Cording damage assessment charts

- Tables 1 shows the standard Burland damage categories with the relevant limiting tensile strains defined by Boscardin and Cording.

Category	Description	Limiting tensile strain (%)
0 (negligible)	Negligible – hairline cracks	0 - 0.05
1 (very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm)	0.05 – 0.075
2 (slight)	Cracks easily filled, redecoration probably required. Some repointing may be required externally (crack width <5mm)	0.075 – 0.15
3 (moderate)	The cracks require some opening up and cab 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 (crack with 5 to 15mm or a number of cracks >3mm)	0.15 – 0.3
4 (severe)	Extensive brick repair work involving breaking out and replacing sections of walls, especially over doors and windows (Crack width 15mm to 25mm but also depends on number of cracks).	>0.03
5 (very severe)	This requires a major repair involving partial or complete rebuilding (crack width usually >25mm but depends on number of cracks).	>0.03

Table 1 – Burland damage categories with Boscardin & Cording limiting tensile strains

- Furthermore reference has been made to the work of Mair *et al* who studied masonry structures to address the limitations presented by the Burland and Wroth and Boscard and Cording studies which present largely elastic structures.

- Xdisp has been used by Arup on multiple projects across the world including over a 1000 buildings on the route of Crossrail. They used the software to screen buildings in order to eliminate large numbers of buildings from further assessment *(reference Arup article in Ground Engineering dated June 2012)*. GEA and MNP are using the findings from this study to carry out a stage 1 assessment.

- According to Rankine (1988) a building experiencing a maximum slope of 1/500 and a settlement less than 10mm has a negligible risk of damage. The study shows that building movements under the footprints of all structures except the southern edge of the swimming pool and the northern elevation of no. 4 Oak Hill Park are below this threshold and can be excluded from further investigation.

  This forms the basis of our appraisal.

  Stage 2 assessment – visual survey

- A structural survey of the buildings at no.4 Oak Hill Park and a survey of the swimming pool has been undertaken by the author, Stuart Pledge BEng (Hons) CEng MIstructE. The findings of the survey are discussed further on in the report. These findings identify key areas within the building where building movements that may classify the building damage to negligible or slight are interrogated further and recommendations made to limit damage potential.

- In addition, further assessments have been carried out through the superstructure of the building to look for differential displacements so that tensile strains due to extensional movement can be assessed.

  Stage 3 assessment

3.2.6 In the event any part of the building remains in damage category 2 or greater or relevant defects exist within the building then a detailed evaluation of these components is carried out.

4. STAGE 1 DAMAGE ASSESSMENT - XDISP CONCLUSIONS

4.1 GEA have modelled the adjacent buildings and noted the walls to be studied. The key plan is set out below and should be used when appraising the displacement data in the xdisp output.

Figure 3 - Xdisp key plan

4.2 The following table confirms the lateral pile deflections as calculated by GEA. North being relevant to the no.5 Oak Hill Park swimming pool and south being relevant to no.4 Oak Hill Park dwelling. West is now excluded from the study as the ground profile slopes towards the Northwood Lodge which is at a substantially lower level and unaffected by the development.

Wall Section	Pile Toe Level (m OD)	Pile Diameter (mm)	Pile Length (m)	Predicted Wall Deflection (mm)
North	110.0	450 Contiguous	12.4	10 - 15
South	110.0	450 Contiguous	10.0	5 - 10
West	110.0	600 Secant	13.0	15 - 20

Table 2 - pile deflections

4.3 GEA have accumulated their pile deflections from Wallap with the ground movements to confirm the following global deflections.

Phase of Works	Movement (mm)	
	Vertical Settlement	Horizontal Movement
Area A - Northwest corner - proposed swimming pool		
Pile Installation (secant wall)	6 mm to 7 mm	10 mm to 12.5 mm
Basement Excavation (excavation in front of sand)	25 mm to 30 mm	15 mm to 20 mm*
Area B – Southern section – proposed car park and ramp		
Pile Installation (contiguous wall)	1.5 mm to 2.0 mm	1.5 m to 2.0 mm
Basement Excavation (excavation in front of sand)	12.5 m to 15 mm	5 mm to 10 mm*
Area C – Northern elevation – proposed cinema and games room		
Pile Installation (contiguous wall)	2 mm to 3 mm	2 mm to 3 mm
Basement Excavation (excavation in front of sand)	20 mm to 25 mm	10 mm to 12 mm*
*Note: Horizontal movements from basement excavation have been predicted using movements calculated within the retaining wall design using the WALLAP programme		

Table 3 - global deflections - pile installation and excavation separately studied

Phase of Works	Movement (mm)	
	Vertical Settlement	Horizontal Movement
Area A		
Piling phase and excavation phase combined	30 mm to 40 mm	25 mm to 35 mm*
Area B		
Piling phase and excavation phase combined	15 mm to 20 mm	10 mm to 15 mm*
Area C		
Piling phase and excavation phase combined	25 mm to 30 mm	15 mm to 25 mm*
*Note: Horizontal movements calculated from horizontal movements due to pile installation using X-Disp added to the horizontal movement resulting from basement excavation using WALLAP		

Table 4 - global deflections - pile installation and excavation accumulated

4.4 The following table confirms the outcome of the xdisp damage assessment. This confirms the areas remaining in category 2 and thus requiring further study.

Building Damage Assessment		
Sensitive Structure	**Elevation**	**Burland Scale**
Garages of Northwood Lodge (located 8 m to the west of proposed basement)	Northern	Category 0 (Negligible)
	Eastern	Category 1 (Very Slight)
	Southern	Category 0 (Negligible)
Apartment block of Northwood Lodge (located 11 m to the west of proposed basement)	Northeast	Settlement less than settlement trough limit sensitivity
	Southwest	Settlement less than settlement trough limit sensitivity
4a Oak Hill Park (located 2 m to the south of proposed basement)	Western	Category 0 (Negligible)
	Northern	Category 1 (Very Slight)
	Eastern	Category 0 (Negligible)
4 Oak Hill Park (located 3 m and 4 m to south of proposed basement)	Northern	Category 2 (Slight)
4 Oak Hill Park Mews (located 7 m to the southeast of proposed basement)	Western	Settlement less than settlement trough limit sensitivity
4 Oak Hill Park Mews (located 7 m to the southeast of proposed basement)	Northern	Settlement less than settlement trough limit sensitivity
5 Oak Hill Park Mews (located 12 m to the southeast of proposed basement)	Northern	Settlement less than settlement trough limit sensitivity
6 Oak Hill Park Mews (located 17 m to the southeast of proposed basement)	Northern	Settlement less than settlement trough limit sensitivity
6 Oak Hill Park Mews (located in excess of 20 m to the southeast of proposed basement)	Eastern	Settlement less than settlement trough limit sensitivity
Swimming pool of 5 Oak Hill Way (located 2 m to the north of proposed basement)	Southern	Category 2 (Slight)
	Eastern	Category 0 (Negligible)
	Northern	Category 0 (Negligible)
	Western	Category 0 (Negligible)

Table 5 – damage categories

4.5 The following is an extract from GEA's report confirming the permanent prop levels (slabs) and temporary prop levels and sequence assumptions for the BIA.

Prop positions. Slab and temporary props

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 110.00
Maximum finite element length = 0.80 m
Youngs modulus of wall E = 2.8000E+07 kN/m2
Moment of inertia of wall I = 9.0890E-03 m4/m run
E.I = 254492 kN.m2/m run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Strut/ anchor no.	Elev.	Strut spacing m	X-section area of strut sq.m	Youngs modulus kN/m2	Free length m	Inclin -ation (degs)	Pre- stress /strut kN	Tension allowed
1	121.00	3.00	0.010000	2.000E+08	4.00	0.00	0	No
2	117.30	3.00	0.010000	2.000E+08	4.00	0.00	0	No
3	114.40	1.00	0.500000	3.000E+07	1.00	0.00	0	No
4	120.00	1.00	0.250000	3.000E+07	1.00	0.00	0	No

SURCHARGE LOADS

Surch -arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	123.00	0.00(A)	20.00	3.00	10.00	=	N/A	1.00 -
2	113.60	-0.00(P)	20.00	20.00	160.00	=	N/A	1.00 -

Construction stages

Note: A = Active side, P = Passive side
Limit State Categories P/U = Permanent Unfavourable
P/F = Permanent Favourable
Var = Variable (unfavourable)

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 123.00
	No analysis at this stage
2	Excavate to elevation 120.50 on PASSIVE side
3	Install strut or anchor no.1 at elevation 121.00
4	Excavate to elevation 116.80 on PASSIVE side
5	Install strut or anchor no.2 at elevation 117.30
6	Excavate to elevation 113.60 on PASSIVE side
7	Apply water pressure profile no.2 (Mod. Conserv.)
8	Install strut or anchor no.3 at elevation 114.40
9	Install strut or anchor no.4 at elevation 120.00
10	Remove strut or anchor no.2 at elevation 117.30
11	Remove strut or anchor no.1 at elevation 121.00
12	Apply surcharge no.2 at elevation 113.60
	No analysis at this stage
13	Change properties of soil type 1 to soil type 5
	Ko pressures will be reset
14	Change properties of soil type 2 to soil type 6
	Ko pressures will be reset
15	Change properties of soil type 3 to soil type 7
	Ko pressures will be reset
16	Change properties of soil type 4 to soil type 8
	Ko pressures will be reset

Figure 4 - extract from GEA calcs

4.6 The following sketch confirms the prop positions in section.

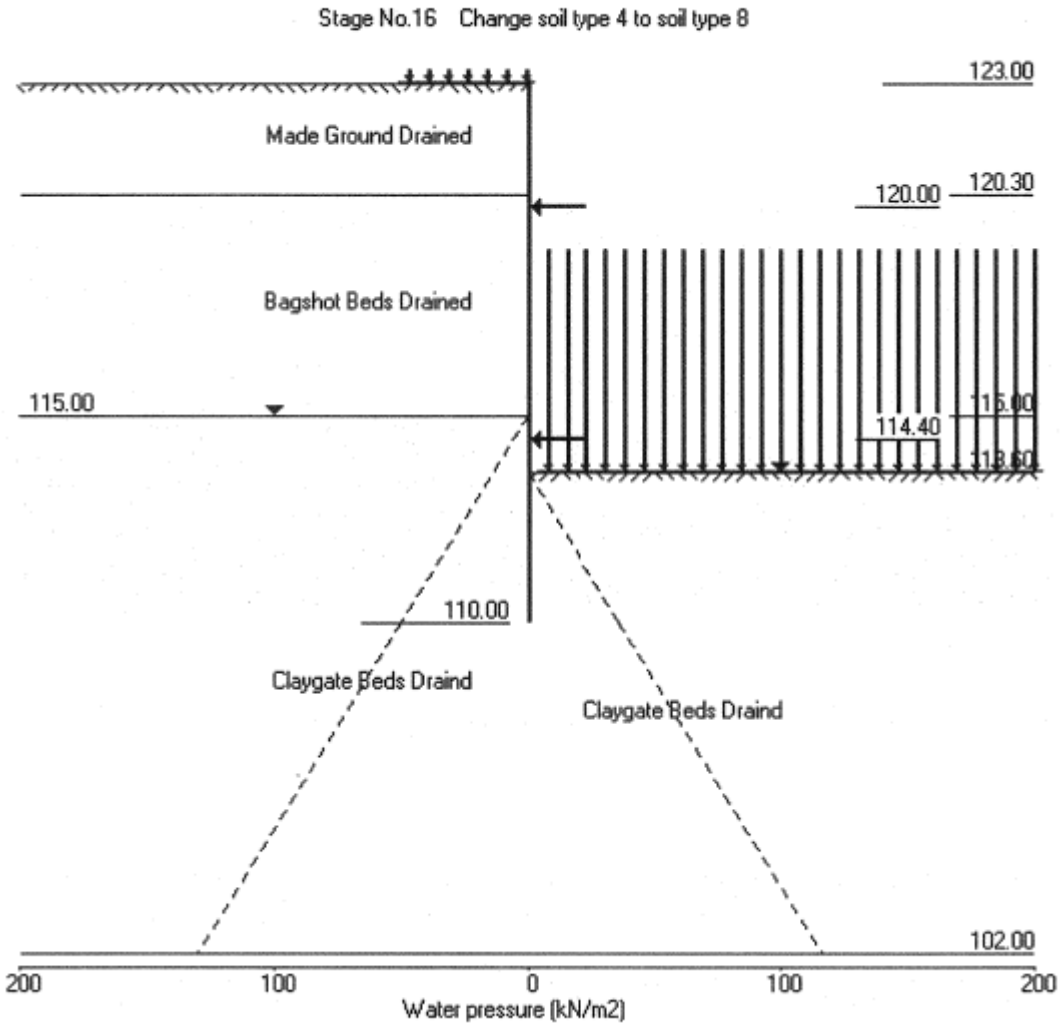
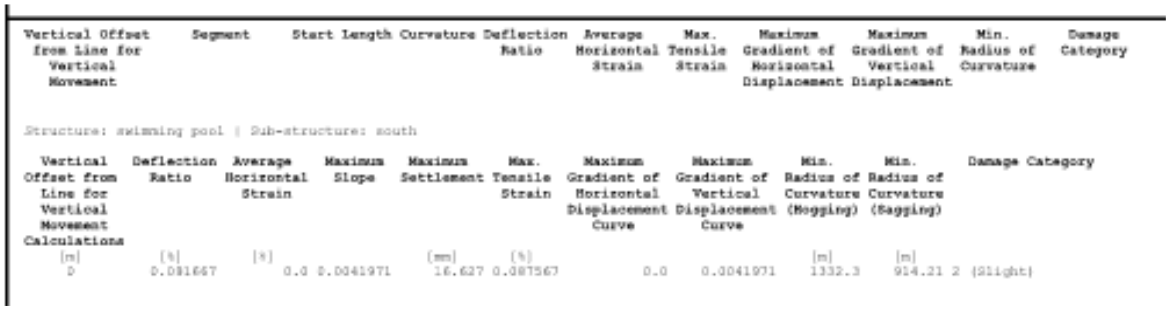


Figure 5 – extract from GEA calcs

4.7 The following extract from x-disp confirms the strains for the southern wall to the swimming pool to 5 Oak Hill Park. Note the strain is marginally beyond the strain boundary for category 1 damage potential.

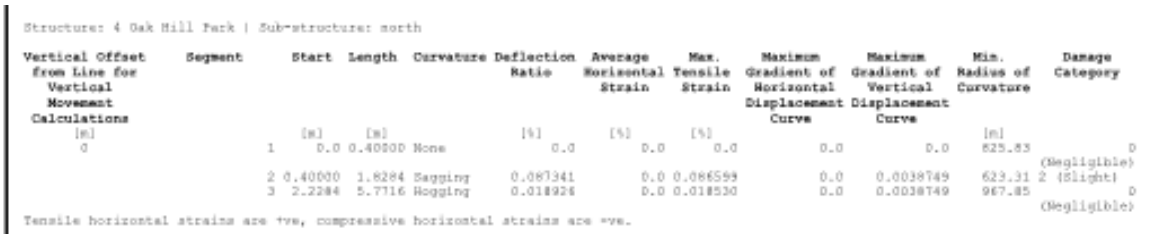


Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature	Damage Category

Structure: swimming pool | Sub-structure: south

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0	0.081667	0.0	0.0041971	16.627	0.087567	0.0	0.0041971	1332.3	914.21	2 (Slight)

Figure 6 - Area C - southern swimming pool wall



Structure: 4 Oak Hill Park | Sub-structure: north

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0	1	0.0	0.40000	None	0.0	0.0	0.0	0.0	0.0	825.83	0 (Negligible)
	2	0.40000	1.8284	Sagging	0.087341	0.0	0.086599	0.0	0.0038749	623.31	2 (Slight)
	3	2.2284	5.7716	Hogging	0.018926	0.0	0.018530	0.0	0.0038749	967.85	0 (Negligible)

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

Figure 7 - Area B - northern elevation to 4 Oak Hill Park

4.8 The following table summarises the findings.

Item	Displacement vertical	Curvature	Max strain	Damage category
Area C – no.5 Oak Hill pool southern wall	16.6mm	sagging	0.0875%	Slight (2)
Area B – 4 Oak Hill Park northern elevation	8.2mm	sagging	0.0865%	Slight (2)

Table 6 - maximum strains

4.9 The strains that exceed 0.075% (category 1) are for a very limited length of each wall. 3.5m for the area C wall and 1.5m for area B.

5. STAGE 2 DAMAGE ASSESSMENT – VISUAL SURVEY

5.1 The xdisp analysis has concluded a very slight to slight 'potential' for damage. It should be noted that the basis of the assessment is to analyse differential displacement along structural panels and conservatively ignores the actual stiffness and connectivity of the panel in question. This will provide a worst case assessment of the strain.

5.2 The buildings to no.4 Oak Hill Park are relatively modern in construction dating back to circa 1960. Extensions to the rear of the main building and a vertical extension to 4a were constructed circa 1970.

5.3 The front and side elevations to no.4a were robust in construction comprising stretcher bond brickwork in sand/cement mortar. There was no evidence of defect or signs of movement. See photograph 1. The building had solid flank walls at 90 degrees to the back wall providing good buttresses. The walls were bonded at the corners. The top mansard construction was an extension to the original building.

5.4 No.4 Oak Hill Park was set on 2 storeys with the ground floor similar in construction to 4a with the first floor covered in a cladding system. See photograph 2 and 3.

5.5 The rear wall of no.4 was similar in construction type to the front and was also generally free from defect. See photograph 4.

5.6 The rear extension seen in photograph 5 had doors and a side window exiting on to the rear yard. The rearmost wall lacked a return buttress and some minor movement was noted where the lintol met the original rear wall. Some monitoring of this existing crack should be undertaken before and during the basement excavation. It was a localised issue.

5.7 A wall separated no.4 from the development site. See photographs 5 and 6. The wall was approximately 2.5m tall with a wider low plinth and frequent buttress piers. The wall had an outward lean of approximately 70mm at the head. This was longstanding with no evidence of progression. Level monitoring will be required at the head of the wall and we recommend flying shores are adopted to prevent any progression.

5.8 Photographs 7 and 8 highlight the building was extended off the head of the original retaining wall. The wall was at least 2 bricks thick (440mm) formed in stock bricks consistent with the Hampstead area.

5.9 Photographs 10 and 11 highlight the original boundary wall was constructed prior to the elevated garden being constructed on the side of 99A Frognal. There were no defects that could affect development. We recommend level monitoring of the wall is undertaken.

5.10 To the opposite boundary, a wall separates the gardens to no.5 Oak Hill Park. Beyond the wall a swimming pool had been constructed. The pool was covered but appeared

to date back approximately 20 years or so. There were no visible defects although close inspection was not feasible. See photographs 12-14.

5.11 In order to understand the relative levels and proximity to neighbouring structures a model of the proposed development has been prepared. The dots indicate the location of level monitoring targets to be installed on the neighbouring structures and boundary walls.

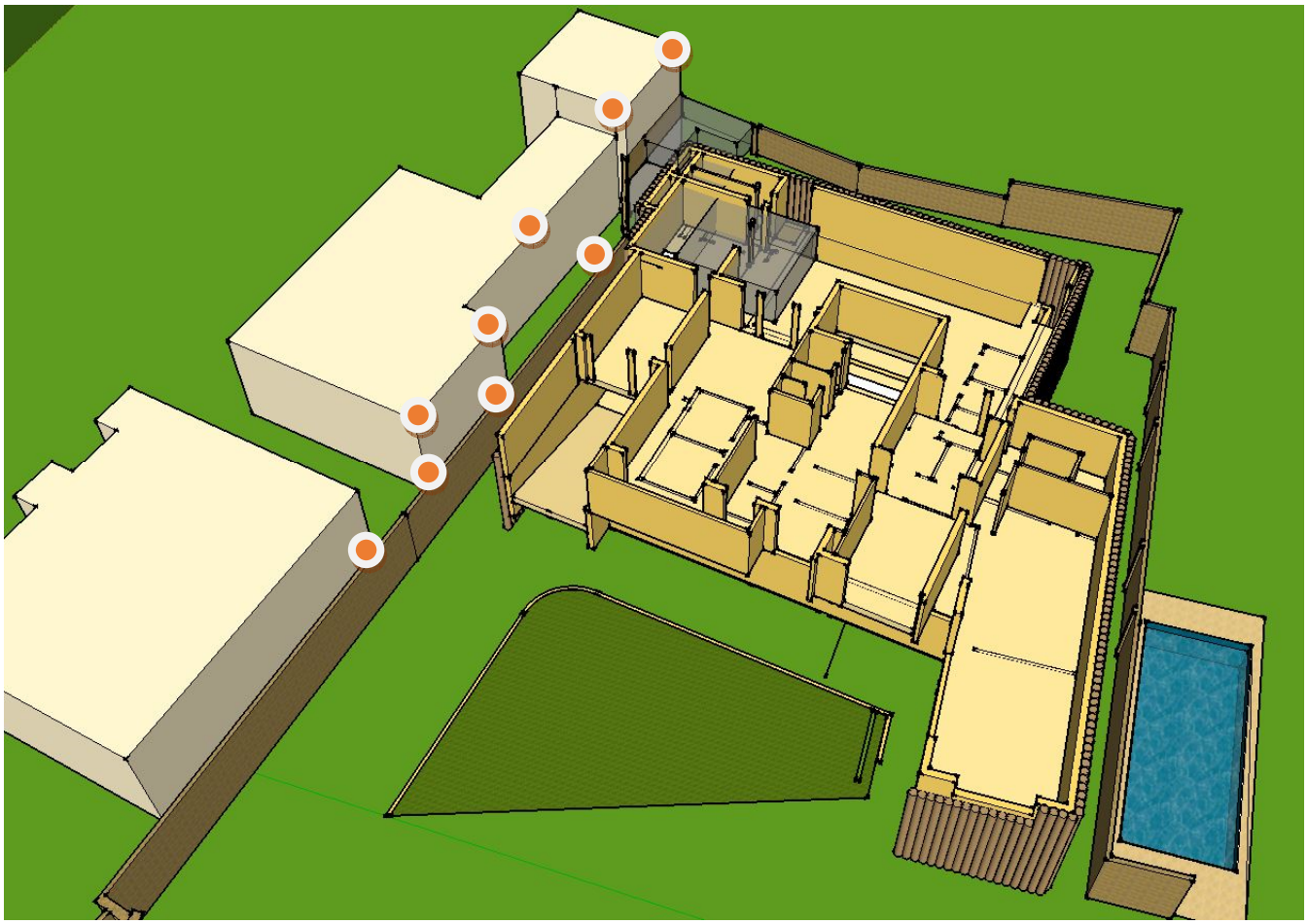


Figure 8 - target monitors to no.4 Oak Hill Park.

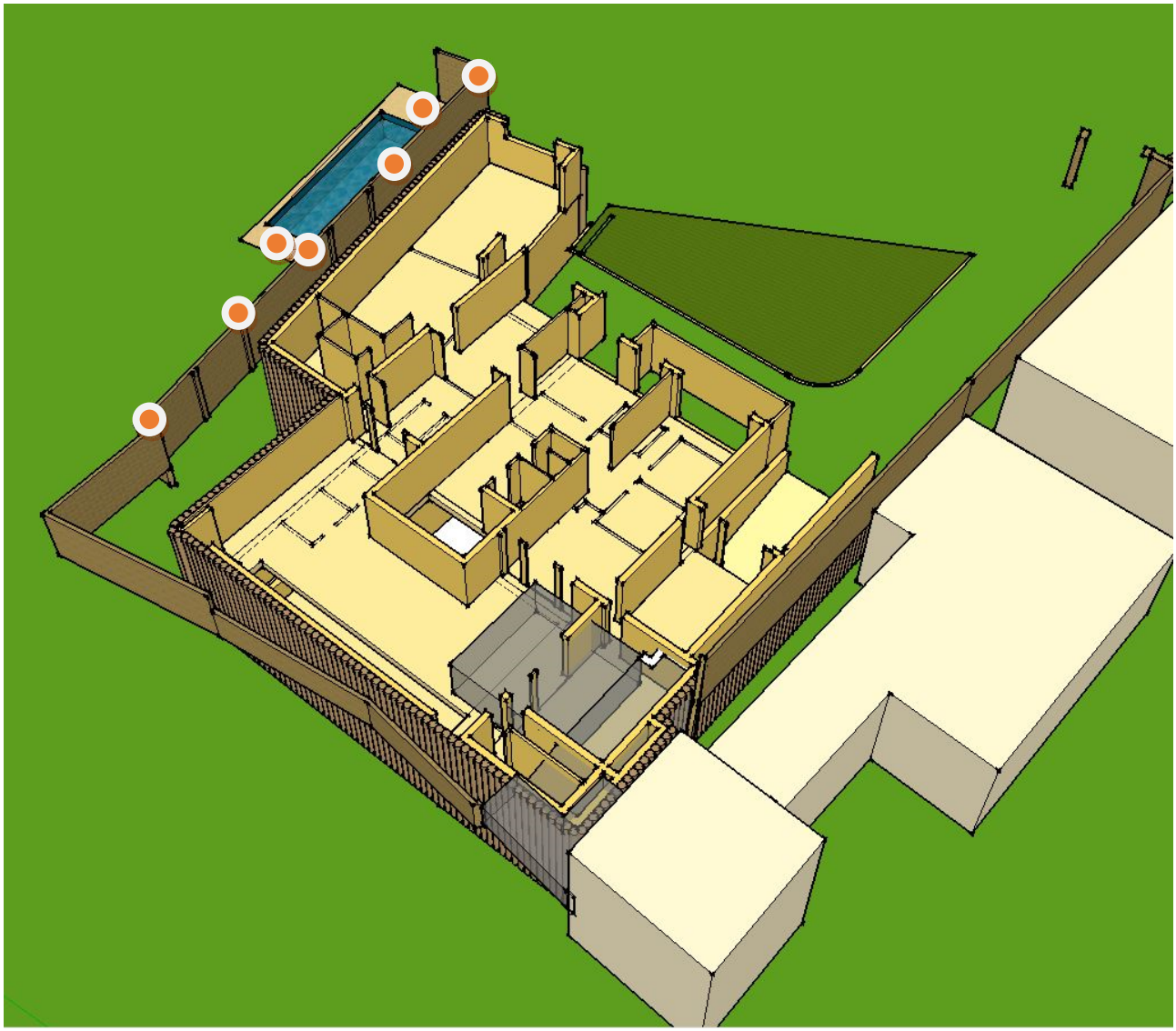


Figure 9 – target monitors to no.5 Oak Hill Park boundary.

6. MITIGATION MEASURES TO REDUCE THE DAMAGE CATEGORY

6.1 A hit and miss pile installation should be considered for the piled wall anywhere within 7m of the neighbouring walls to no.4 and no.5 Oak Hill Park. The piling contractor should install every 4th pile. This allows the correction parameters to be adopted in accordance with fig 2.8, CIRIA C580 and also follows good practice for secant wall installation.

6.2 Working with specialist piling contractor Foundation Piling, a re-run of the Wallap calculations has been undertaken. Full Wallap calculations run in to hundreds of pages. The calculations are available upon request. The following are extracts from correspondence from Mr Peterson at Foundation Piling:-

- I have expanded on these calculations for the North, South and West walls allowing analysis using the programme's finite element facility allowing the soil spring stiffness to be modelled as a continuum.

- For completeness at this stage I have not adjusted any of the soil parameters assumed by GEA. I have however raised the temporary prop at the West wall slightly (by 0.5) and by introducing the FE analyses adjusted the wall friction angles and adhesion to reflect a rough interface, along with allowing soil arching. The modified calculations in general, see an increase in design moments and prop forces but a reduction of at least 20% in the anticipated deflections.

- These calculations are still conservative, as the beneficial effects of reduced lateral active pressure resulting from the downward sloping active backface have not been taken into account.

- With respect to the predicted damage to the neighbouring properties, the Northern elevation of No 4 Oak Hill Park and the Southern elevation of the swimming pool of No 5 Oak Hill Way were only just within category 2. This revised appraisal allows these zones to be re-categorised as category 1.

6.3 Below is an extract of the updated Wallap calculations that confirms the revised propping levels. Note the top prop is elevated by 0.5m.

STRUTS and ANCHORS

Strut/ anchor no.	Elev.	Strut spacing m	X-section area of strut sq.m	Youngs modulus kN/m2	Free length m	Inclin -ation (degs)	Pre- stress /strut kN	Tension allowed
1	121.00	3.00	0.010000	2.000E+08	4.00	0.00	0	No
2	117.30	3.00	0.010000	2.000E+08	4.00	0.00	0	No
3	115.50	1.00	0.500000	3.000E+07	1.00	0.00	0	No
4	120.00	1.00	0.250000	3.000E+07	1.00	0.00	0	No

Figure 10 - updated propping levels.

6.4 The net effect is to bring the damage potential in to category 1. No further mitigation should be required however the following should be considered during detailed design.

6.5 Pre-stressing can be incorporated to the propping system using flat jacks. MNP are currently utilising this system on a double basement project at Downshire Hill, Hampstead. The ability to jack walers apart has proved an important aspect of the action plan to 'lock off' and reverse lateral movements.

6.6 There are no major sequence improvements recommended at this stage. The Wallap calculations have been prepared against an organised and traditional sequence. De-propping sequences should be carefully prepared to protect the key boundary's.

6.7 Piling rig selection should be carefully reviewed to ensure sufficient space is available to boundary walls. The foundation spreads should be determined to avoid auger clashes with foundation causing unwanted movements..

6.8 The above forms stage C recommendations. A detailed construction method statement should be prepared post planning stage and the pile design reviewed.

6.9 The following outline shoring should be considered. Walers fixed to the boundary wall and diagonal props. This can be incorporated in the general propping system.

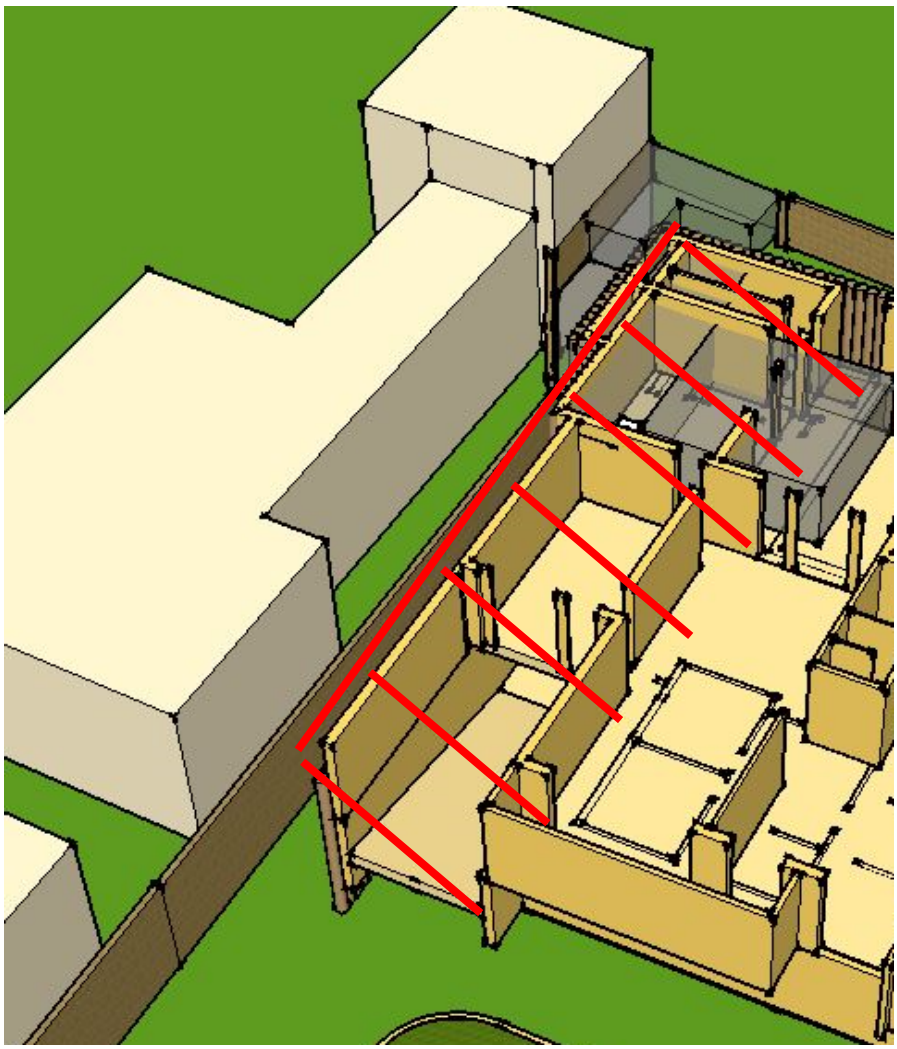


Figure 11 - outline shoring proposals

7. SETTING LEVEL MONITORING MOVEMENT TARGET VALUES

7.1 Movement trigger values should be set to accord with the predicted building movement. Trigger levels set too tight will cause an unnecessary cessation of work on site and targets set too slack will not allow a pause in works to occur early enough in order to instruct any active propping.

7.2 Target monitors should be set up in pairs on the elevation to check for separation. These figures apply to both level monitoring and visual daily monitoring.

Category	**Limiting movements to walls at ground level (during piling operation only in brackets). *In italics for separation between pairs of targets on elevations***	**Predicted Damage category**	**Action**
Green	5(3)*2*	0 – Negligible	Continue regular monitoring – movements as predicted.
Amber 1	7(5)*2*	Boundary of Cat 0/1	Continue regular monitoring – or increase frequency. Review data for movement trends.
Amber 2	10(5)*3*	80% Through Cat 1	Review data for trends; for accelerating movements; develop and install contingency measures via active propping. For decelerating movements increase monitoring frequency.
Red	15 (7)*5*	Boundary of Cat 1/2	Construction pause, review monitoring data trends and implement active propping as prepared contingency.

table 7 – trigger levels

8. RISK SCHEDULE

8.1 A detailed and specific risk schedule should be prepared post planning stage that should consider construction, design and geotechnical risks.

9. CONCLUSION

9.1 The study undertaken by GEA confirms that the building movement at existing foundation level will cause very slight to slight damage as classified under the Burland system and when analysed in conjunction with the elastic strain limits set down by Boscardin and Cording (defined as hairline cracks).

9.2 The movement seen was only marginally in to category 2 and for limited lengths of wall.

9.3 Refinement of the piled wall design has been undertaken by Foundation Piling by adjusting the prop positions and the method of analysis which has reduced the lateral pile deflections by 20%. The ground movements estimated under the x-disp study by GEA is sufficiently refined and will not adjusted. However the cumulative assessment of movements due to pile installation and bulk excavation reduce the global movements and bring the damage in to category 1, very slight.

9.4 In addition visual structural surveys of the structures has been undertaken by MNP. Generally the structures neighbouring the site are robust and without visible defect. Some existing cracking exists to an extension to the rear of no.4 Oak Hill Park where it abuts the original building. Some consideration should be given to local repairing these fractures prior to construction commencing.

9.5 The boundary wall has a gentle outward lean which will be controlled with walers and props.

9.6 At detailed design stage further refinement and measures can be considered including hit and miss pile sequencing and flat jack prestressed propping.

9.7 This report concludes that damage potential to neighbouring structures is either negligible or very slight and that monitoring regimes and action plans can be adopted early to mitigate any excessive damage.

APPENDIX A – PHOTOGRAPHS

mason navarro pledge

Bancroft Court
Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Ref: 214073

Project: 99a Frognal

Title: Damage Assessment Survey Photographs

1. 4a Oak Hill Park – front.

2. 4 Oak Hill Park - front.

mason navarro pledge

Bancroft Court
Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Ref: 214073

Project: 99a Frognal

Title: Damage Assessment Survey Photographs

3.

4. Rear.

mason navarro pledge

Bancroft Court
Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Ref: 214073

Project: 99a Frognal

Title: Damage Assessment Survey Photographs

5.

6.

mason navarro pledge

Bancroft Court
Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Ref: 214073

Project: 99a Frognal

Title: Damage Assessment Survey Photographs

Note 4a built off original wall.

7.

8.

mason navarro pledge

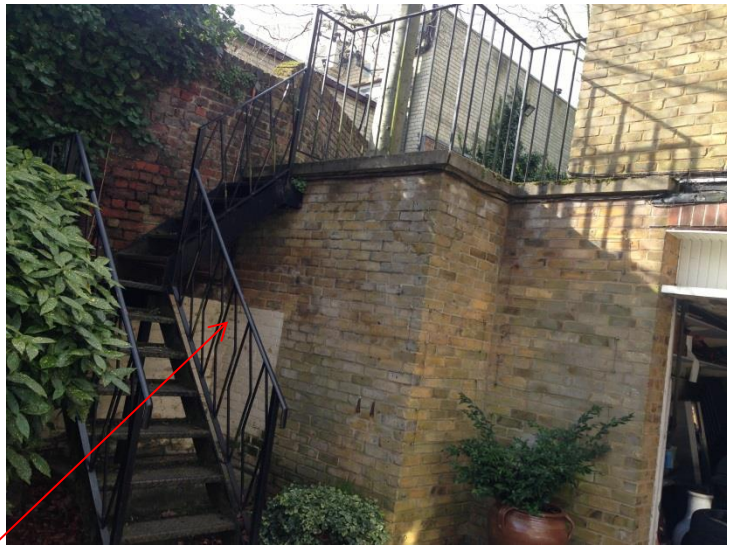
Bancroft Court
Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Ref: 214073

Project: 99a Frognal

Title: Damage Assessment Survey Photographs

9.



10.

Photo 11 is of this junction

mason navarro pledge

Bancroft Court
Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Ref: 214073

Project: 99a Frognal

Title: Damage Assessment Survey Photographs

11.

12. Swimming pool to No. 5

mason navarro pledge

Bancroft Court
Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Ref: 214073

Project: 99a Frognal

Title: Damage Assessment Survey Photographs

13.

14.

mason navarro pledge

Bancroft Court
Hitchin, Herts. SG5 1LH
Tel: 01462 632012 Fax: 01462 632233

Ref: 214073

Project: 99a Frognal

Title: Damage Assessment Survey Photographs