Our Ref: TRL/AM/J12924(rev 1)

29th September 2017

Southern Testing
Environmental & Geotechnical

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For the attention of Ben Miranda
(By email: drbmiranda@googlemail.com)

Project Name: 40A Parkhill Road, London

A PRELIMINARY INFORMATION

This report forms Stage 4 (Ground Movement Analysis) of a Basement Impact Assessment for the proposed basement excavation at this site. Southern Testing have undertaken Stages 1, 2 and 3 in our report (STL ref: J12924) dated 12th April 2017, and revised on 27th September 2017.

A Stage 4 Ground Movement Assessment was requested by the Client following our initial Stage 1, 2 and 3 report, in accordance with Camden Council's planning policies for basement excavations. Their policies and requirements are set out in CPG4 'Basements and Lightwells', the Development Policy DP27 'Basements and Lightwells', and the document 'Camden geological, hydrogeological and hydrological study – guidance for subterranean development'.

The purpose of this Ground Movement Analysis is to enable Camden Council and their Engineers/auditors to assess whether any predicted damage to neighbouring properties and infrastructure is acceptable, or can be satisfactorily ameliorated by the developer, as stated in DP27 and CPG4.

B GROUND MOVEMENT ANALYSIS

1 Layout and levels of proposed development

All levels and layouts of the foundations, excavation and existing and proposed buildings have been supplied by the Client's engineers, along with the existing and proposed ground loadings.

Based on arbitrary levels on the Client's drawings, the existing lower ground floor level of the site is +0.065m. The ground floor of the adjacent building (No. 38 Parkhill Road) is +0.158m. No. 40 Parkhill Road has a lower ground floor level; this is at a level of -0.475m. The adjacent street level (i.e. Parkhill Road) is at +1.325m.

The proposed basement excavation can be split into two general areas: the main basement living space, and the area beneath the front of the site (with car parking at street level). Allowing for the thickness of the proposed basement elements and foundations (as supplied by the Client's engineers), the proposed formation level of the front car park area is -2.100m, giving an excavation depth of 3.425m. The proposed formation level of the main area is about -3.085m, giving an excavation depth of 3.15m.

The dimensions of the existing foundations of the party walls were investigated in our Stage 3 Ground Investigation. It has been assumed that the foundations are consistent across the lengths of the various party and internal walls, and that they are symmetrical about the centre of the wall.

Plans are attached in Appendix A, showing the general arrangement of the proposed basement (Figure A), and the generalised proposed foundation layout (Figure B).

2 Modelling of movements due to vertical stress changes

Following the excavation of a basement, vertical movements are typically modelled as comprising a short-term (undrained) response, followed by a long-term (drained) response. The excavation and construction of the new basement will result in changes in vertical soil loading, and therefore result in short- and long-term displacements in the underlying soils. The magnitude of the movements is related to the geotechnical properties of the soil profile underlying the site, and the net changes in vertical stress caused by the combination of excavation of the soils to form the basement, and the new basement/foundation loadings. It is assumed that there will be no delay in the excavation and construction of the basement.

The proposed basement is to be constructed using a method of underpinning and hit-and-miss techniques.

The predicted vertical ground movements were modelled using the OASYS program PDisp. The PDisp program assumes a linear elastic soil behaviour, and a flexible structure (for the existing and adjacent buildings). It is likely that the stiffness of the structures will not be flexible; rather, it will have a finite value. As a result, the movements will tend to be redistributed or smoothed out when compared to those predicted by PDisp. On this basis, the output from PDisp does not take into account the finite stiffness of the structures. They are, therefore, likely to be conservative: the actual movements affecting the structures would likely be less than those predicted by the PDisp program.

The following ground profile and geotechnical parameters have been assumed for the PDisp analysis:

Soil Type	Depth (mbgl)	Bulk Unit Weight (γ_b) (kN/m^3)	Poisson's Ratio (v)		Undrained Young's Modulus (E_u) (MN/m^2)		Drained Young's Modulus (E_d) (MN/m^2)	
			Undrained	Drained	Top of Stratum	Base of Stratum	Top of Stratum	Base of Stratum
Made Ground	0.00-1.50	18	0.5	0.2	5	5	3.75	3.75
Head	1.50-2.50	18	0.5	0.2	10	10	7.5	7.5
London Clay	>2.50	20	0.5	0.2	10	205	7.5	153.7

For the London Clay, the stiffness parameters were derived based on Burland and Kalra (1986)[1] as follows:

- Undrained Young's Modulus (E_u) = (10+5.2z) (MN/m^2)
- Drained Young's Modulus (E_d) = (7.5+3.9z) (MN/m^2)

  Where z (m) is taken from the surface of the London Clay.

[1] Burland J.B. and Kalra J.C. (1986) Queen Elizabeth Conference Centre: geotechnical aspects, Proc. Inst. Civ. Eng., Part 1,80,1479-1503

The site ground level was taken as an arbitrary value of 0.0m (at street level); the rigid base for the analysis was taken as -40.0m.

3 Vertical movements from excavation and proposed construction loadings

The Client's Structural Engineers provided drawings detailing the proposed foundation arrangement and loadings for the proposed underpinning works, along with estimates of the loadings from the existing buildings. The dimensions and depths of the existing foundations were taken from our investigation (ref. J12924). The provided information was used to estimate the net changes in vertical loadings due to the new foundation loadings, and the unloading caused by the proposed excavation.

The proposed loads in the Structural Engineer's drawings are eccentric across the basal area of each foundation element, typically being higher at the heel of the retaining wall and lower at the toe. The loads are indicated to diminish linearly towards the toe. For the purposes of the analysis, the load areas have been split into two along the width of the floor slab of the retaining walls, with the loads averaged over each sub-area of the floor slab. Loads have been grouped into areas depending on the dimensions of the proposed retaining walls, based on the Structural Engineer's drawings. The arrangement of the proposed loads is shown in Figure B, Appendix A.

Unload pressures of 62.15 kN/m^2 for the front car park area, and 60.52 kN/m^2 for the main basement area, have been adopted. Loadings of the existing structures have been estimated based on the loadings given by the Client's Structural Engineers, and the foundation arrangement which is based on our earlier trial pits. A plan showing the general arrangement of the proposed basement and adjacent buildings is presented in Figure A, Appendix A.

40A Parkhill Road shares party walls with the adjacent properties of 40 Parkhill Road and 38 Parkhill Road. From the drawings supplied by the Client's engineers, 40 Parkhill Road has a lower ground floor at a level of about -0.475m (about 0.5m below the lower ground floor level of the subject site). The lowest floor level of 38 Parkhill Road is about +0.158m (about 0.15m above the lower ground floor level of the subject site).

Displacement lines have been drawn extending away from the edge of the proposed excavation.

3.1 Short-term (undrained) vertical ground movements

PDisp was used to determine the likely movements arising as a result of the combination of unloading due to the excavation of the basement, and application of the proposed construction loads. The analysis indicated peak undrained movements of about 7mm (heave) occurring in the centre of the main basement area (see Figure U1, Appendix B).

In order to illustrate the likely displacements occurring beneath the neighbouring properties (Nos. 40 and 38 Parkhill Road), displacement lines were extended out from the edge of the proposed excavation across the properties. An additional displacement line was drawn extending out from the edge of the proposed basement across the highway (Parkhill Road).

For No. 40 Parkhill Road, the maximum undrained movement at the party wall with the subject site is about 3.1mm. The heave reduces to about 0.35mm at about 8m away from the party wall (i.e. the far side of No. 40). The displacement line is shown in Figure U1-L1 (Appendix B).

For No. 38 Parkhill Road, the maximum undrained heave movements are about 3.7mm at the party wall with the subject site. The heave reduces to about 0.1mm by the far side of the house (see Figure U1-L2, Appendix B).

The maximum heave at the nearest part of the adjacent highway (Parkhill Road) to the excavation is expected to be about 0.6mm, reducing to less than 0.1mm by about 6.5m away from the edge of the excavation (see Figure U1-L3).

3.2 Long-term (drained) vertical ground movements

The movements of the ground following construction were also analysed for the total long-term (drained) case. As for the short-term analysis, the long-term analysis was undertaken for the combination of the unloading due to demolition of the building, excavation of the basement and application of the proposed construction loadings. The PDisp assessment indicates peak long-term drained heave movements of 9mm occurring within the central zones of the proposed basement area (Fig. V1, Appendix B).

As for the short-term movements, displacement lines were drawn in order to illustrate the likely movements affecting the adjacent structures. The arrangement of displacement lines was the same as for the short-term analysis.

For No. 40 Parkhill Road, the maximum drained heave displacement is anticipated to be about 4.4mm at the party wall with the subject site. This reduces to about 0.75mm at the far side of No. 40 Parkhill Road (see Figure V1-L1).

For No. 38 Parkhill road, the maximum drained heave displacement at the party wall with the subject site is anticipated to be about 5.4mm, reducing to about 0.3mm at the far side of the building (see Figure V1-L2, Appendix B).

At the closest point of the adjacent highway (Parkhill Road), the maximum drained heave displacements are anticipated to be about 1.25mm, reducing to about 0.1mm by about 12m from the edge of the proposed excavation (see Figure V1-L3).

The long-term movements calculated by PDisp include the short-term movements.

It should be noted that, as discussed below, vertical movements resulting from the net changes in soil loading occur along with other ground movements which are associated with the excavation of the basement and its construction.

4 Movements due to basement excavation and underpin construction

The new foundations will be formed by sequential hit-and-miss methods of underpinning. The underpins will also form the retaining walls for the proposed basement. The installation of the underpins, and subsequent excavation of the soils in front, will generate both vertical and horizontal movements in the retained soils.

Ground movements resulting from underpinning is not well documented. There is currently no specific method of assessing the magnitude of any such movements. Movements are typically small when underpinning is carried out in a well-controlled manner.

Reference has been made to CIRIA guide C760 'Guidance on embedded retaining wall design' (which updates CIRIA C580 'Embedded retaining walls – guidance for economic design') in order to provide some basis for the estimation of any likely movements resulting from the excavation of soils in front of the underpinned walls. CIRIA C760 provides guidance on the horizontal and vertical movements of the soil adjacent to an embedded retaining wall for both high stiffness (propped) and low stiffness (cantilevered) walls. In this instance, we understand that the construction sequence, and temporary and permanent works designs, will ensure that a robust form of 'stiff propping' will be adopted throughout the works. Therefore, the underpinned wall sections have been modelled as high stiffness wall as defined in CIRIA C760.

CIRIA C760 indicates empirical relationships for the movements produced by the construction, and excavation in front of, a high support stiffness wall as follows:

- Peak horizontal movements will be 0.15% of the total excavation depth, and will occur at the wall. These movements will extend to a distance of four times the excavation depth away from the wall. The magnitude of movements will decrease linearly.
- Peak vertical movements will be 0.07% of the total excavation depth, and will occur about half the excavation depth away from the wall. The vertical movements at the wall will be about 0.04% of the excavation depth. There will be no vertical movements at a distance of about 3.5 times the excavation depth away from the wall; the movements decrease in a non-linear fashion.

The OASYS XDisp software was used to undertake the assessment of the vertical and horizontal movements caused by the construction of the basement walls.

As mentioned above, the guidance in CIRIA C760 is based on empirical data. The data is assumed to include any short-term (undrained) element of ground movement that arises due to net changes in vertical stress (i.e. those caused by the excavation unloading, and new loads of the proposed foundations). Furthermore, as the data was collected over a relatively short period following construction, it is unlikely that the data includes any long-term (drained) movements. Therefore, the total ground movements we have calculated comprise two elements:

1) Movements predicted by CIRIA C760 (and XDisp). As outlined above, these comprise movements relating to the installation of the retaining wall, and excavation in front of the walls, as well as any short-term movements from net changes in vertical loading.
2) Long-term movements caused by the changes in vertical loading (as calculated in PDisp). As noted above, the long-term output from PDisp includes the short-term movements. Therefore, the long-term movements included in the calculation of total ground movements are calculated as the difference between PDisp-calculated long-term movements, and the PDisp-calculated short-term movements (i.e. Figure V1 minus Figure U1).

A summary of the predicted short-term and long-term movements caused by the construction of the basement walls and formation of the new basement is shown in the sections below. For the analysis, we have assumed an excavation depth of 3.15m for the main basement area, and 3.425m for the front area.

Based on the analysis in this section of the BIA, an assessment has been made of the anticipated damage to the nearby structures (40 and 38 Parkhill Road). The following sections show the predicted damage categories. The general damage categories (after Burland et al) are summarised in the table below:

Category	Description
0 (Negligible)	Negligible – hairline cracks
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm)
2 (Slight)	Cracks easily filled, redecoration probably required. Some repointing may be required externally (crack width <5mm).
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 (crack width 5 to 15mm or a number of cracks > 3mm).
4 (Severe)	Extensive 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).
5 (Very Severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks).

4.1 Short-term movements caused by excavation of basement at No. 40A

The tabular output from the XDisp analysis is attached (Figure UX1-TAB, Appendix B. The movements at selected points along each line, along with the predicted damage categories, are summarised in the table below:

		Line 1 No. 40	Line 2 No. 38 Adjacent part of building	Line 2 No. 38 Main building
Figure reference		UX1-L1	UX1-L2	UX1-L2
Approx. horizontal movements (mm)	At closest elevation	3.9 (towards No. 40A)	4.4 (towards No. 40A)	2.6 (towards No. 40A)
	At far side of property	1.0 (towards No. 40A)	2.6 (towards No. 40A)	0.0
Approx. vertical movements (mm)	At closest elevation	1.0 (settlement)	1.15 (settlement)	1.4 (settlement)
	At far side of property	0.2 (settlement)	1.4 (settlement)	0.0
Maximum DAMAGE CATEGORY		Negligible (0)	Very slight (1)	Negligible (0)

With regards to the highway (Parkhill Road), it is anticipated the movements will be as follows:

	Closest point of highway (boundary of site)	12m from edge of excavation
Approx. horizontal movements (mm)	4.6 (towards No. 40A)	0.6
Approx. vertical movements (mm)	2.3 (settlement)	0.00

See Figure UX1-L3 for more details.

4.2 Long-term movements caused by excavation of basement at No. 40A

The tabular output from the XDISP analysis is attached (Fig. VX1-TAB, Appendix B). The movements at selected points along each line, along with the predicted damage categories, are summarised in the table below:

		Line 1	Line 2	Line 2
		No. 40	No. 38 Adjacent part of building	No. 38 Main building
Figure reference		VX1-L1	VX1-L2	VX1-L2
Approx. horizontal movements (mm)	At closest elevation	3.9 (towards No. 40A)	4.4 (towards No. 40A)	2.6 (towards No. 40A)
	At far side of property	1.0 (towards No. 40A)	2.6 (towards No. 40A)	0.0
Approx. vertical movements (mm)	At closest elevation	0.3 (heave)	0.6 (heave)	0.8 (settlement)
	At far side of property	0.2 (heave)	0.8 (settlement)	0.2 (heave)
Maximum DAMAGE CATEGORY		Negligible (0)	Very slight (1)	Negligible (0)

With regards to the highway (Parkhill Road), it is anticipated the movements will be as follows:

	Closest point of highway (boundary of site)	12m from edge of excavation
Approx. horizontal movements (mm)	4.6 (towards No. 40A)	0.6
Approx. vertical movements (mm)	1.6 (settlement)	0.10 (settlement)

See Figure VX1-L3 for more details.

5 Summary of ground movements

A summary of the predicted damage categories caused by the excavation of the basement at No. 40A Parkhill Road is shown in the tables below:

End of Construction (short-term condition)

Building	Category of Damage
40 Parkhill Road	Negligible (0)
38 Parkhill Road – adjacent part of house	Very slight (1)
38 Parkhill Road – main part of house	Negligible (0)

End of Construction (long-term condition)

Building	Category of Damage
40 Parkhill Road	Negligible (0)
38 Parkhill Road – adjacent part of house	Very slight (1)
38 Parkhill Road – main part of house	Negligible (0)

In the case of the highway, in the long-term condition horizontal movements are anticipated to be about 4.6mm towards the proposed basement at the edge of the pedestrian footpath / edge of the site boundary, with about 0.6mm of movement occurring about 12m away from the edge of the proposed excavation. Vertical movements are anticipated to be 1.6mm of settlement at the highway / site boundary, with negligible heave movements about 12m from the edge of the excavation.

6 Conclusion

The categories of damage assume good quality working practice and that a "robust" level of propping is employed.

A formal monitoring system should be employed during construction in order to observe and monitor ground movements, especially in critical areas such as boundaries and with the neighbouring properties. Monitoring data should be checked against predefined trigger limits to give early indications of any deviating or excessive ground movements.

Yours faithfully,

Thomas Lees MSci MSc CGeol FGS
For and on behalf of
Southern Testing Laboratories Limited
DDI: 01342 333 136
Email: tlees@southerntesting.co.uk

Attachments:

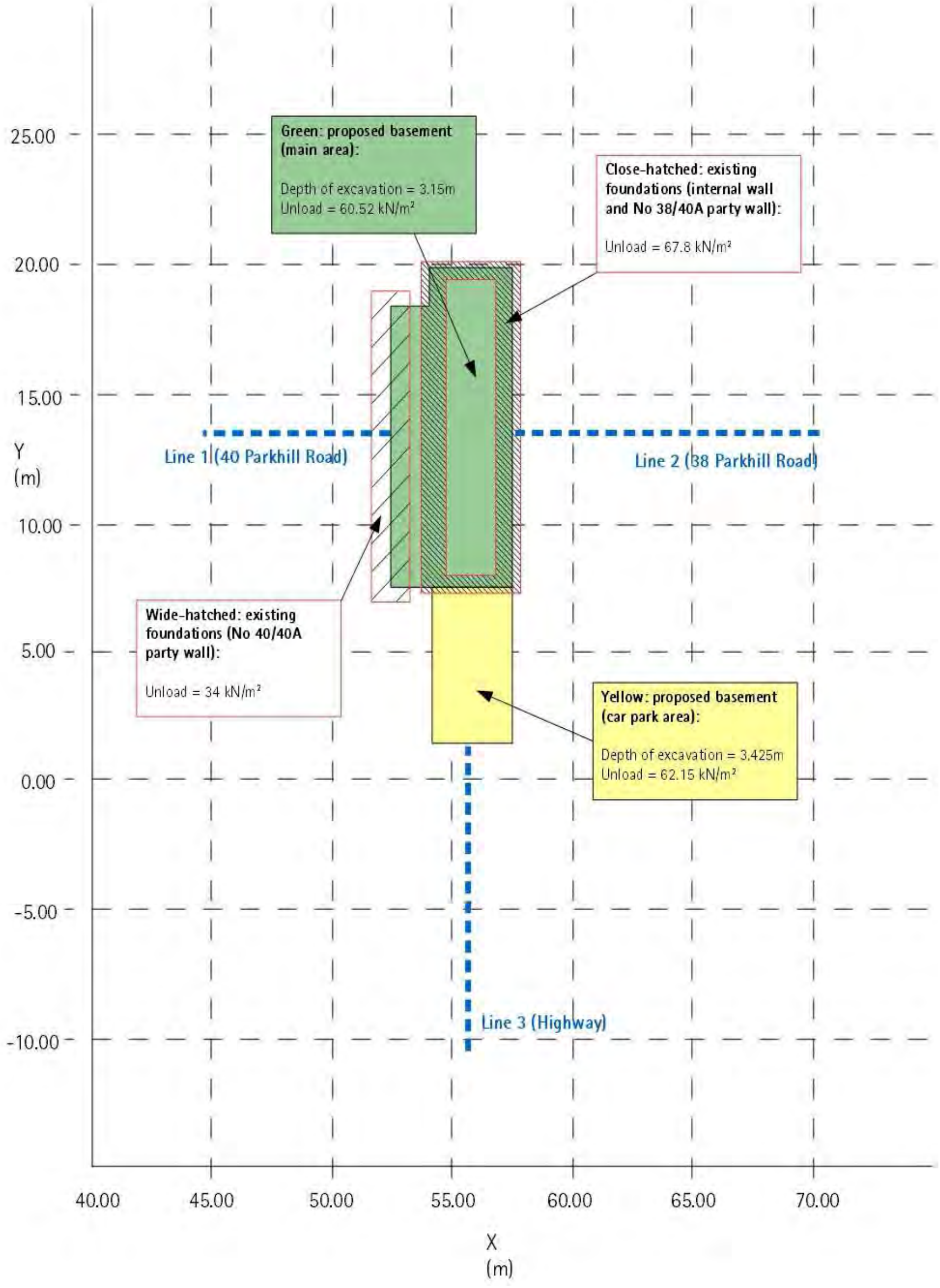
Appendix A - Drawings

Appendix B – Pdisp & Xdisp Analysis Outputs

Figure	Description	Figure	Description
A	General arrangement plan, showing layout of basement areas and displacement lines	UX1-TAB	Results table for short-term horizontal and vertical movements (XDISP)
B	Arrangement of proposed loadings	UX1-L1	Short-term (XDISP) vertical and horizontal displacements along Line 1 – No. 40 Parkhill Road
U1	Contour plot of short-term vertical displacements (PDISP)	UX1-L2	Short-term (XDISP) vertical and horizontal displacements along Line 2 – No. 38 Parkhill Road
U1-L1	Short-term vertical displacements (PDISP) along Line 1 – No. 40 Parkhill Road	UX1-L3	Short-term (XDISP) vertical and horizontal displacements along Line 3 – Highway (Parkhill Road)
U1-L2	Short-term vertical displacements (PDISP) along Line 2 – No. 38 Parkhill Road	VX1-TAB	Results table for long-term horizontal and vertical displacements (XDISP)
U1-L3	Short-term vertical displacements (PDISP) along Line 3 – Highway (Parkhill Road)	VX1-L1	Long-term (XDISP) vertical and horizontal displacements along Line 1 – No. 40 Parkhill Road
V1	Contour plot of long-term vertical displacements (PDISP)	VX1-L2	Long-term (XDISP) vertical and horizontal displacements along Line 2 – No. 38 Parkhill Road
V1-L1	Long-term vertical displacements (PDISP) along Line 1 – No. 40 Parkhill Road	VX1-L3	Long-term (XDISP) vertical and horizontal displacements along Line 3 – Highway (Parkhill Road)
V1-L2	Long-term vertical displacements (PDISP) along Line 2 – No. 38 Parkhill Road		
V1-L3	Long-term vertical displacements (PDISP) along Line 3 – Highway (Parkhill Road)		

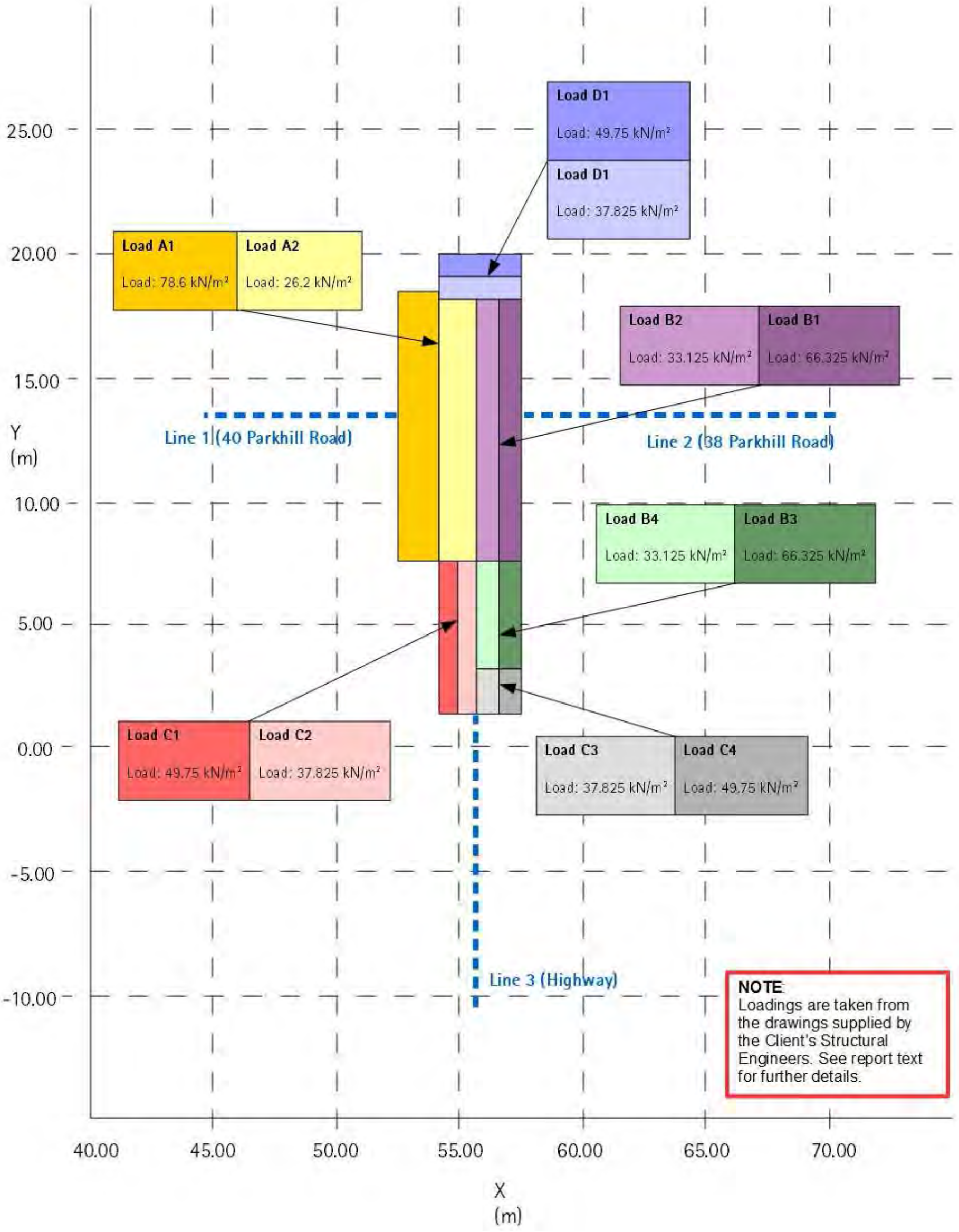
APPENDIX A

Drawings



Site:	40A Parkhill Road, London	STL: J12924	Fig No: A
Date:	30 August 2017	General arrangement of basement	

Southern Testing
Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN
ST Consult



Site:	40A Parkhill Road, London	STL: J12924	Fig No: B
Date:	30 August 2017	General arrangement of proposed loadings.	

Southern Testing
Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN
ST Consult

APPENDIX B

PDisp and XDisp Analysis Outputs

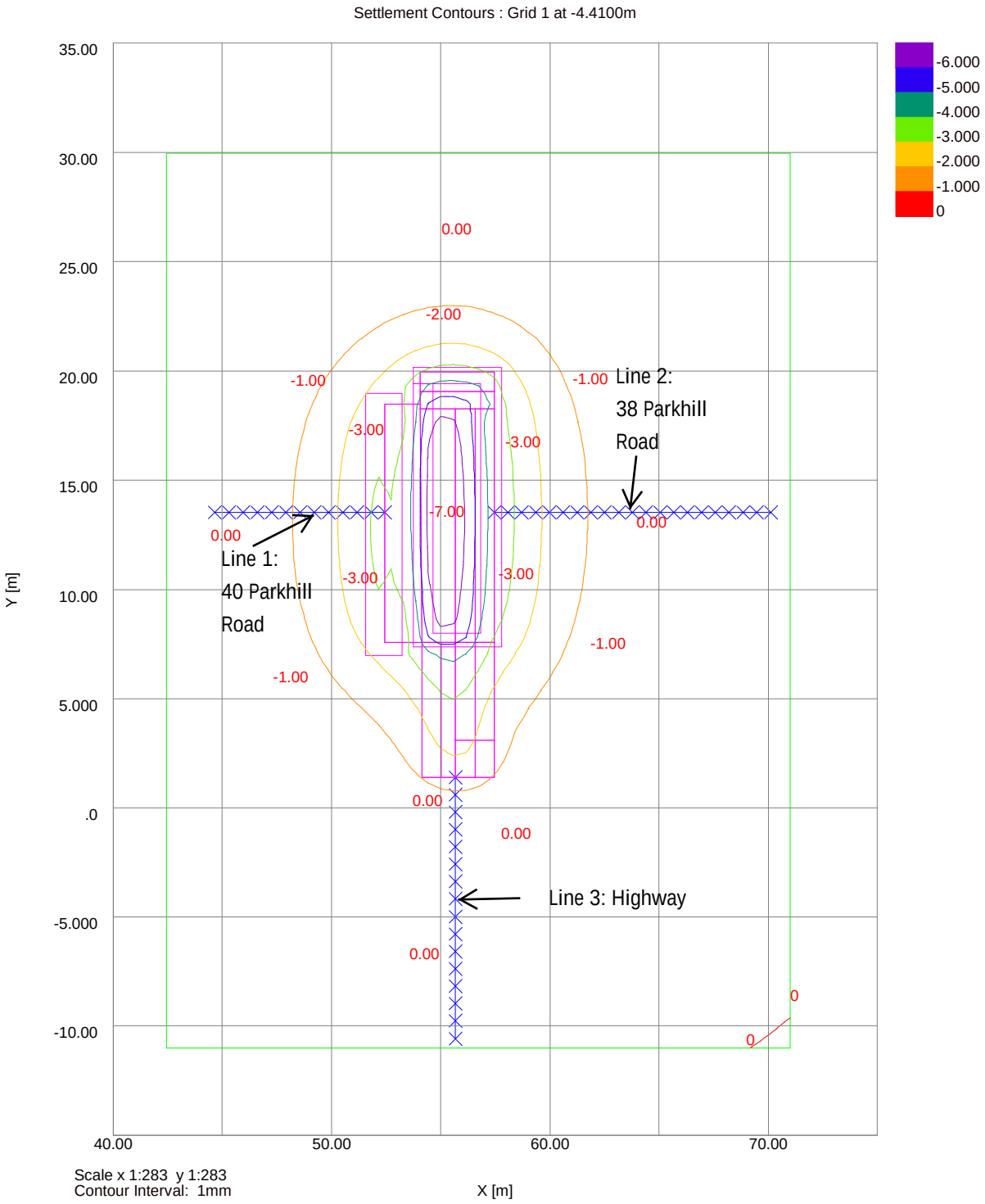


Fig U1
Undrained contour plot

Displacement for Line 1

Distance from (52.44,13.534) in m

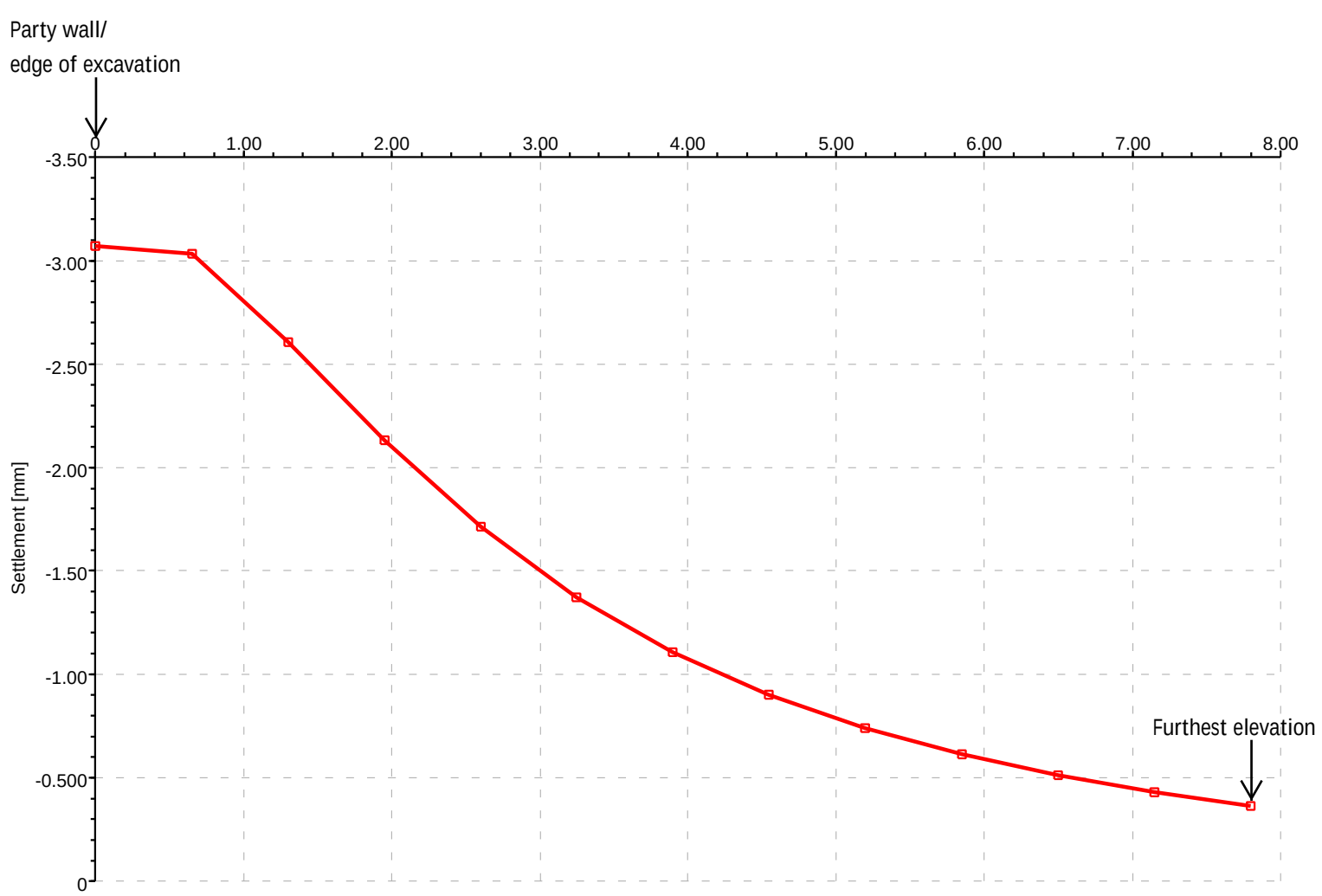


Fig U1-L1:
40 Parkhill Road

Distance from (57.468,13.534) in m

Displacement for Line 2

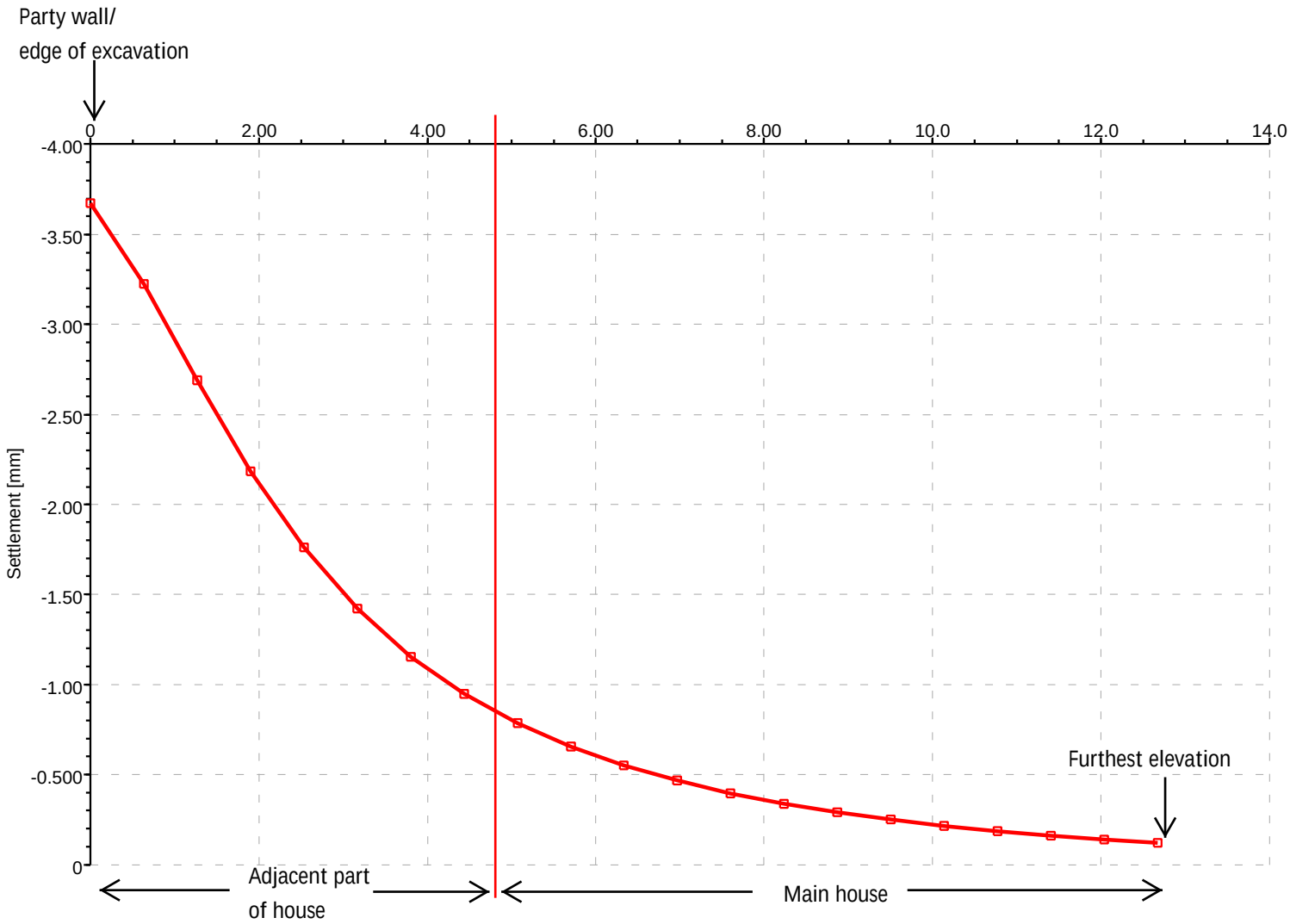


Fig U1-L2:
38 Parkhill Road

Displacement for Line 3

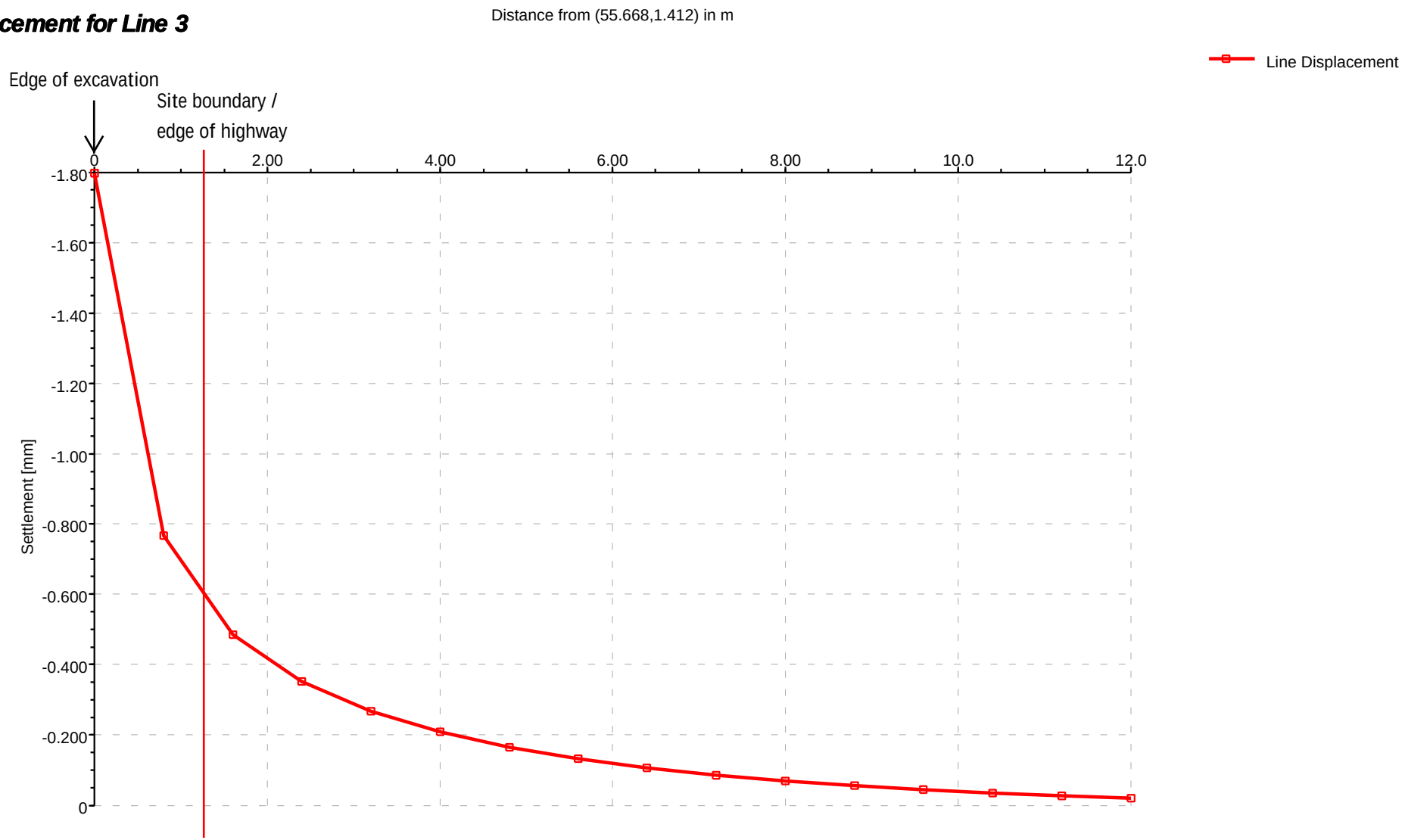


Fig U1-L3:
Highway

Line Displacements

Displacement Line 1: 40 Parkhill Rd

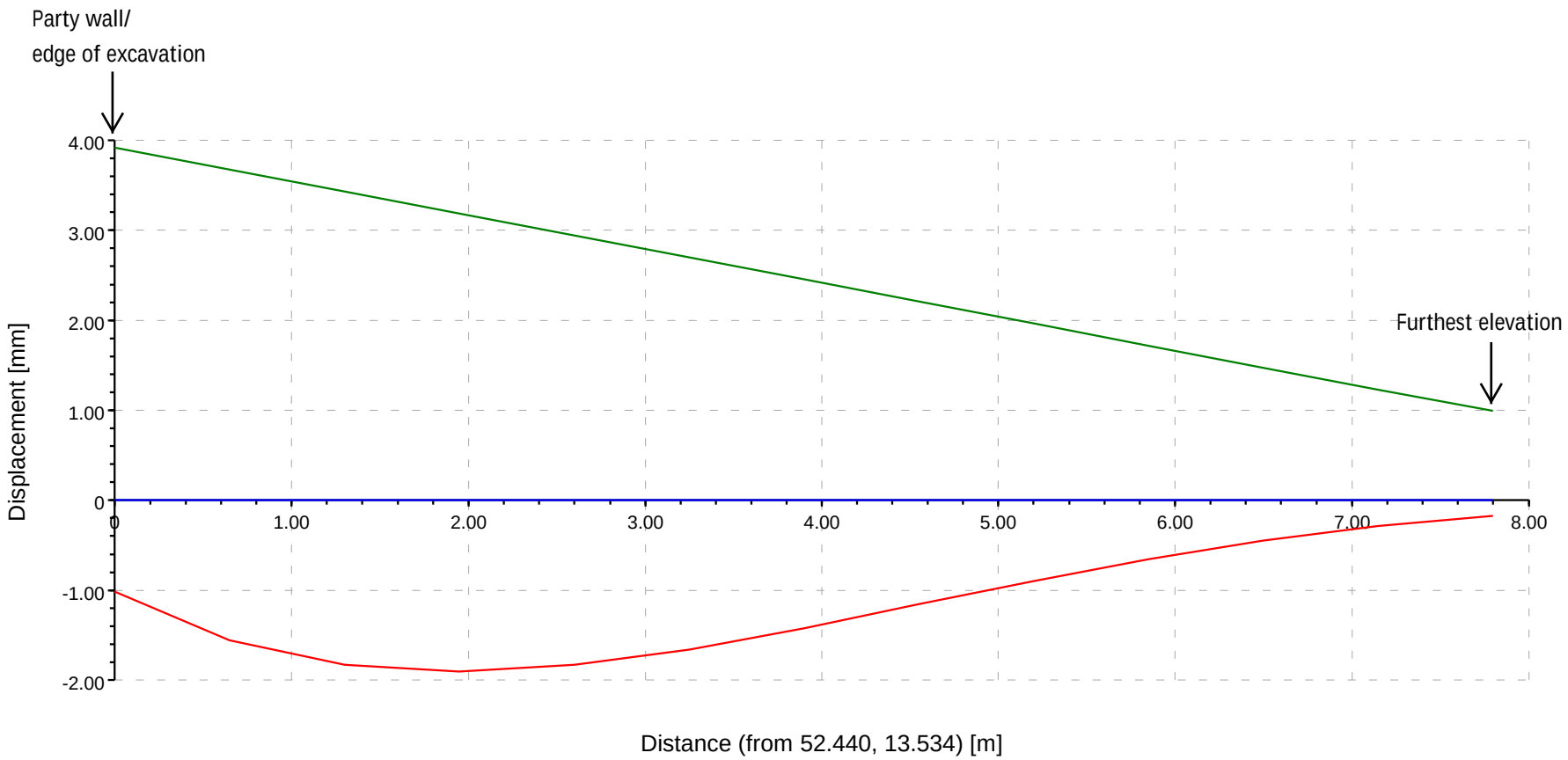


Fig UX1-L1:
40 Parkhill Road

Line Displacements

Displacement Line 2: 38 Parkhill Rd

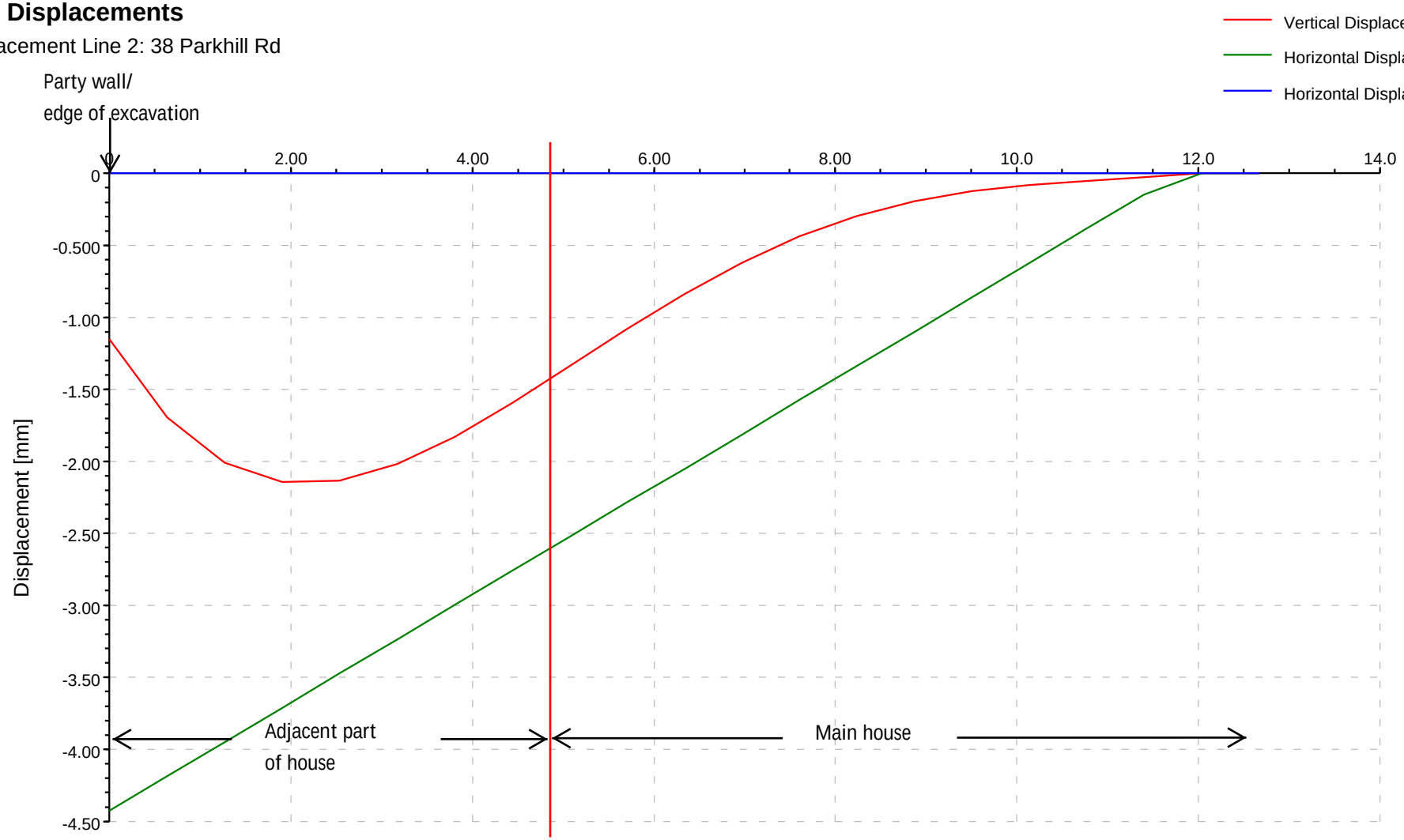


Fig UX1-L2:
38 Parkhill Road

Line Displacements

Displacement Line 3: Highway

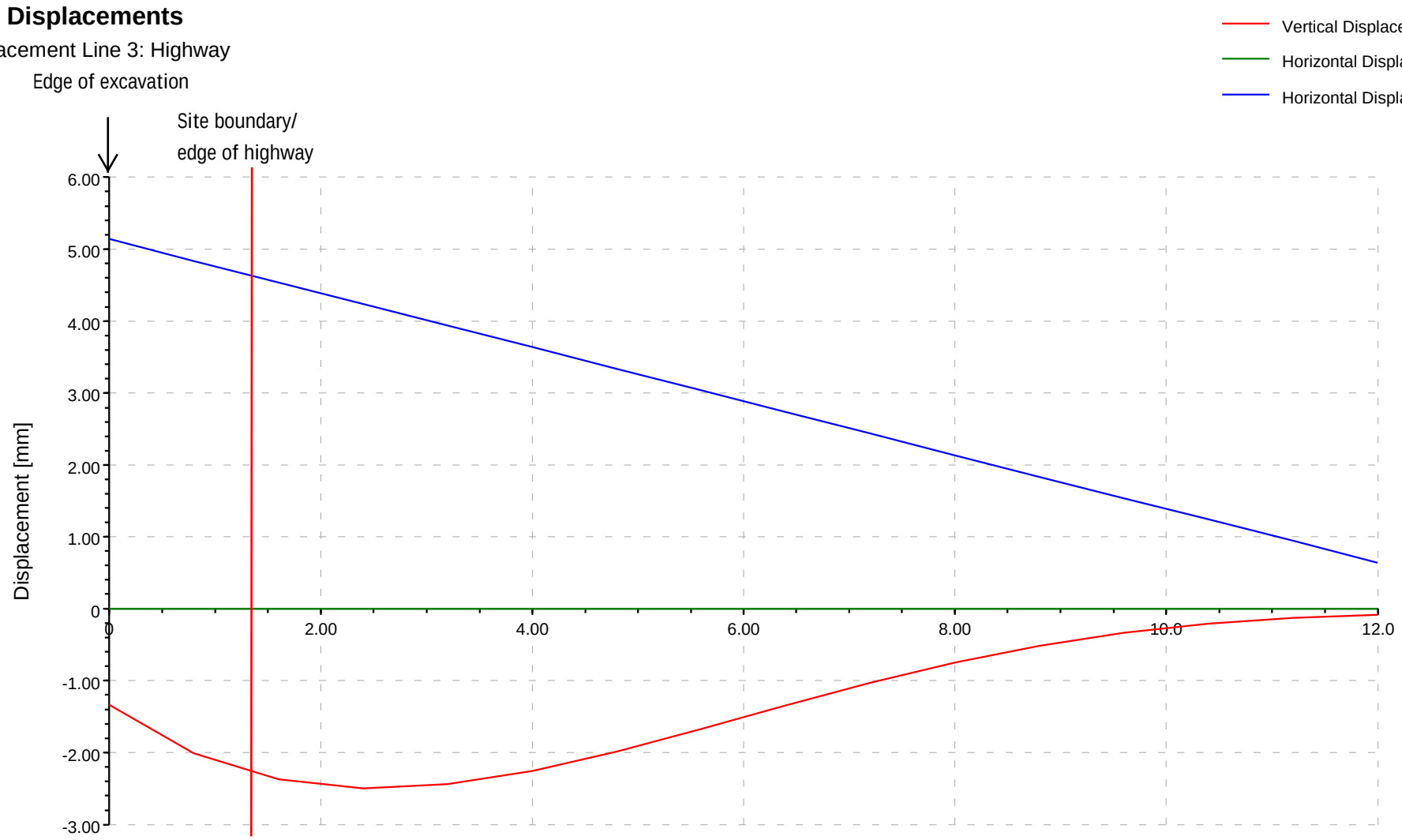


Fig UX1-L3: Highway

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Specific Building Damage Results - Horizontal Displacements

Structure: 40 Parkhill Rd | Sub-structure:

Dist.	Coordinates			Displacements			
	x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	52.44000	13.53400	-1.80000	3.9150	0.0	-3.9150	0.0
0.64975	51.79025	13.53400	-1.80000	3.6713	0.0	-3.6713	0.0
1.2995	51.14050	13.53400	-1.80000	3.4277	0.0	-3.4277	0.0
1.9492	50.49075	13.53400	-1.80000	3.1840	0.0	-3.1840	0.0
2.5990	49.84100	13.53400	-1.80000	2.9404	0.0	-2.9404	0.0
3.2488	49.19125	13.53400	-1.80000	2.6967	0.0	-2.6967	0.0
3.8985	48.54150	13.53400	-1.80000	2.4531	0.0	-2.4531	0.0
4.5482	47.89175	13.53400	-1.80000	2.2094	0.0	-2.2094	0.0
5.1980	47.24200	13.53400	-1.80000	1.9658	0.0	-1.9658	0.0
5.8477	46.59225	13.53400	-1.80000	1.7221	0.0	-1.7221	0.0
6.4975	45.94250	13.53400	-1.80000	1.4784	0.0	-1.4784	0.0
7.1472	45.29275	13.53400	-1.80000	1.2348	0.0	-1.2348	0.0
7.7970	44.64300	13.53400	-1.80000	0.99113	0.0	-0.99113	0.0

Structure: 38 Parkhill Rd (adjacent) | Sub-structure:

Dist.	Coordinates			Displacements			
	x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	57.46800	13.53400	-1.46000	-4.4250	0.0	-4.4250	0.0
0.63360	58.10160	13.53400	-1.46000	-4.1874	0.0	-4.1874	0.0
1.2672	58.73520	13.53400	-1.46000	-3.9498	0.0	-3.9498	0.0
1.9008	59.36880	13.53400	-1.46000	-3.7122	0.0	-3.7122	0.0
2.5344	60.00240	13.53400	-1.46000	-3.4746	0.0	-3.4746	0.0
3.1680	60.63600	13.53400	-1.46000	-3.2370	0.0	-3.2370	0.0
3.8016	61.26960	13.53400	-1.46000	-2.9994	0.0	-2.9994	0.0
4.4352	61.90320	13.53400	-1.46000	-2.7618	0.0	-2.7618	0.0
5.0688	62.53680	13.53400	-1.46000	-2.5242	0.0	-2.5242	0.0
5.7024	63.17040	13.53400	-1.46000	-2.2866	0.0	-2.2866	0.0
6.3360	63.80400	13.53400	-1.46000	-2.0490	0.0	-2.0490	0.0
6.9696	64.43760	13.53400	-1.46000	-1.8114	0.0	-1.8114	0.0
7.6032	65.07120	13.53400	-1.46000	-1.5738	0.0	-1.5738	0.0
8.2368	65.70480	13.53400	-1.46000	-1.3362	0.0	-1.3362	0.0
8.8704	66.33840	13.53400	-1.46000	-1.0986	0.0	-1.0986	0.0
9.5040	66.97200	13.53400	-1.46000	-0.86100	0.0	-0.86100	0.0
10.138	67.60560	13.53400	-1.46000	-0.62340	0.0	-0.62340	0.0
10.771	68.23920	13.53400	-1.46000	-0.38580	0.0	-0.38580	0.0
11.405	68.87280	13.53400	-1.46000	-0.14820	0.0	-0.14820	0.0
12.038	69.50640	13.53400	-1.46000	0.0	0.0	0.0	0.0
12.672	70.14000	13.53400	-1.46000	0.0	0.0	0.0	0.0

Structure: 38 Parkhill Rd (main) | Sub-structure:

Dist.	Coordinates			Displacements			
	x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	57.46800	13.53400	-1.46000	-4.4250	0.0	-4.4250	0.0
0.63360	58.10160	13.53400	-1.46000	-4.1874	0.0	-4.1874	0.0
1.2672	58.73520	13.53400	-1.46000	-3.9498	0.0	-3.9498	0.0
1.9008	59.36880	13.53400	-1.46000	-3.7122	0.0	-3.7122	0.0
2.5344	60.00240	13.53400	-1.46000	-3.4746	0.0	-3.4746	0.0
3.1680	60.63600	13.53400	-1.46000	-3.2370	0.0	-3.2370	0.0
3.8016	61.26960	13.53400	-1.46000	-2.9994	0.0	-2.9994	0.0
4.4352	61.90320	13.53400	-1.46000	-2.7618	0.0	-2.7618	0.0
5.0688	62.53680	13.53400	-1.46000	-2.5242	0.0	-2.5242	0.0
5.7024	63.17040	13.53400	-1.46000	-2.2866	0.0	-2.2866	0.0
6.3360	63.80400	13.53400	-1.46000	-2.0490	0.0	-2.0490	0.0
6.9696	64.43760	13.53400	-1.46000	-1.8114	0.0	-1.8114	0.0
7.6032	65.07120	13.53400	-1.46000	-1.5738	0.0	-1.5738	0.0
8.2368	65.70480	13.53400	-1.46000	-1.3362	0.0	-1.3362	0.0
8.8704	66.33840	13.53400	-1.46000	-1.0986	0.0	-1.0986	0.0
9.5040	66.97200	13.53400	-1.46000	-0.86100	0.0	-0.86100	0.0
10.138	67.60560	13.53400	-1.46000	-0.62340	0.0	-0.62340	0.0
10.771	68.23920	13.53400	-1.46000	-0.38580	0.0	-0.38580	0.0
11.405	68.87280	13.53400	-1.46000	-0.14820	0.0	-0.14820	0.0
12.038	69.50640	13.53400	-1.46000	0.0	0.0	0.0	0.0
12.672	70.14000	13.53400	-1.46000	0.0	0.0	0.0	0.0

Specific Building Damage Results - Vertical Displacements

Structure: 40 Parkhill Rd | Sub-structure:

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	52.44000	13.53400	-1.80000	1.0176
0.64975	51.79025	13.53400	-1.80000	1.5530
1.2995	51.14050	13.53400	-1.80000	1.8284
1.9492	50.49075	13.53400	-1.80000	1.9030
2.5990	49.84100	13.53400	-1.80000	1.8299
3.2488	49.19125	13.53400	-1.80000	1.6556
3.8985	48.54150	13.53400	-1.80000	1.4202
4.5482	47.89175	13.53400	-1.80000	1.1577
5.1980	47.24200	13.53400	-1.80000	0.89550
5.8477	46.59225	13.53400	-1.80000	0.65472
6.4975	45.94250	13.53400	-1.80000	0.45010
7.1472	45.29275	13.53400	-1.80000	0.29002
7.7970	44.64300	13.53400	-1.80000	0.17651

Structure: 38 Parkhill Rd (adjacent) | Sub-structure:

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	57.46800	13.53400	-1.46000	1.1502
0.63360	58.10160	13.53400	-1.46000	1.6913
1.2672	58.73520	13.53400	-1.46000	2.0064
1.9008	59.36880	13.53400	-1.46000	2.1397
2.5344	60.00240	13.53400	-1.46000	2.1310
3.1680	60.63600	13.53400	-1.46000	2.0165
3.8016	61.26960	13.53400	-1.46000	1.8281
4.4352	61.90320	13.53400	-1.46000	1.5939
5.0688	62.53680	13.53400	-1.46000	1.3380
5.7024	63.17040	13.53400	-1.46000	1.0805
6.3360	63.80400	13.53400	-1.46000	0.83733
6.9696	64.43760	13.53400	-1.46000	0.62075
7.6032	65.07120	13.53400	-1.46000	0.43883

Fig UX1 - TAB

Dist.	Coordinates x	y	z	Displacements z
[m]	[m]	[m]	[m]	[mm]
8.2368	65.70480	13.53400	-1.46000	0.29572
8.8704	66.33840	13.53400	-1.46000	0.19155
9.5040	66.97200	13.53400	-1.46000	0.12250
10.138	67.60560	13.53400	-1.46000	0.080740
10.771	68.23920	13.53400	-1.46000	0.054461
11.405	68.87280	13.53400	-1.46000	0.027870
12.038	69.50640	13.53400	-1.46000	0.0
12.672	70.14000	13.53400	-1.46000	0.0

Structure: 38 Parkhill Rd (main) | Sub-structure:

Dist.	Coordinates x	y	z	Displacements z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	57.46800	13.53400	-1.46000	1.1502
0.63360	58.10160	13.53400	-1.46000	1.6913
1.2672	58.73520	13.53400	-1.46000	2.0064
1.9008	59.36880	13.53400	-1.46000	2.1397
2.5344	60.00240	13.53400	-1.46000	2.1310
3.1680	60.63600	13.53400	-1.46000	2.0165
3.8016	61.26960	13.53400	-1.46000	1.8281
4.4352	61.90320	13.53400	-1.46000	1.5939
5.0688	62.53680	13.53400	-1.46000	1.3380
5.7024	63.17040	13.53400	-1.46000	1.0805
6.3360	63.80400	13.53400	-1.46000	0.83733
6.9696	64.43760	13.53400	-1.46000	0.62075
7.6032	65.07120	13.53400	-1.46000	0.43883
8.2368	65.70480	13.53400	-1.46000	0.29572
8.8704	66.33840	13.53400	-1.46000	0.19155
9.5040	66.97200	13.53400	-1.46000	0.12250
10.138	67.60560	13.53400	-1.46000	0.080740
10.771	68.23920	13.53400	-1.46000	0.054461
11.405	68.87280	13.53400	-1.46000	0.027870
12.038	69.50640	13.53400	-1.46000	0.0
12.672	70.14000	13.53400	-1.46000	0.0

Specific Building Damage Results - All Segments

Structure: 40 Parkhill Rd | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	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	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	4.5877	Sagging	0.018137	0.037500	0.045951	-374.86E-6	-823.66E-6	1537.3	0 (Negligible)
	2	4.5877	3.2083	Hogging	0.0036476	0.037500	0.038107	-374.86E-6	403.39E-6	8968.5	0 (Negligible)

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

Structure: 38 Parkhill Rd (adjacent) | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	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	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	4.8130	Sagging	0.018148	0.037500	0.055485	-374.86E-6	-853.62E-6	1695.9	1 (Very Slight)

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

Structure: 38 Parkhill Rd (main) | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	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	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	0.25272	Sagging	0.0	0.037500	0.037500	-374.86E-6	403.74E-6	84185.	0 (Negligible)
	2	0.25272	4.4383	Hogging	0.0046042	0.037500	0.039052	-374.86E-6	406.35E-6	10588.	0 (Negligible)

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

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: 40 Parkhill Rd | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.018137	0.037500	-823.66E-6	1.9027	0.045951	-374.86E-6	-823.66E-6	8968.5	1537.3	0 (Negligible)

Structure: 38 Parkhill Rd (adjacent) | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.018148	0.037500	-853.62E-6	2.1391	0.055485	-374.86E-6	-853.62E-6	-	1695.9	1 (Very Slight)

Structure: 38 Parkhill Rd (main) | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0046042	0.037500	406.35E-6	1.4413	0.039052	-374.86E-6	406.35E-6	10588.	84185.	0 (Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
				[m]	[m]			[mm]	[%]	[m]	[m]	
40 Parkhill Rd	Max Slope	1	1	0.0	4.5877	Sagging	**823.66E-6**	1.9027	0.045951	-	1537.3	0 (Negligible)
	Max Settlement	1	1	0.0	4.5877	Sagging	823.66E-6	**1.9027**	0.045951	-	1537.3	0 (Negligible)
	Max Tensile Strain	1	1	0.0	4.5877	Sagging	823.66E-6	1.9027	**0.045951**	-	1537.3	0 (Negligible)

Fig UX1 - TAB

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
	Min Radius of Curvature (Hogging)		2	4.5877	7.7960	Hogging	403.39E-6	1.1418	0.038107	**8968.5**	-	0 (Negligible)
	Min Radius of Curvature (Sagging)		1	0.0	4.5877	Sagging	823.66E-6	1.9027	0.045951	-	**1537.3**	0 (Negligible)
38 Parkhill Rd (adjacent)	Max Slope		1	0.0	4.8130	Sagging	**853.62E-6**	2.1391	0.055485	-	1695.9	1 (Very Slight)
	Max Settlement		1	0.0	4.8130	Sagging	853.62E-6	**2.1391**	0.055485	-	1695.9	1 (Very Slight)
	Max Tensile Strain		1	0.0	4.8130	Sagging	853.62E-6	2.1391	**0.055485**	-	1695.9	1 (Very Slight)
	Min Radius of Curvature (Hogging)		-	-	-	-	-	-	-	-	-	-
	Min Radius of Curvature (Sagging)		1	0.0	4.8130	Sagging	853.62E-6	2.1391	0.055485	-	**1695.9**	1 (Very Slight)
38 Parkhill Rd (main)	Max Slope		2	0.25272	4.6910	Hogging	**406.35E-6**	1.3393	0.039052	10588.	-	0 (Negligible)
	Max Settlement		1	0.0	0.25272	Sagging	403.74E-6	**1.4413**	0.037500	-	84185.	0 (Negligible)
	Max Tensile Strain		2	0.25272	4.6910	Hogging	406.35E-6	1.3393	**0.039052**	10588.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)		2	0.25272	4.6910	Hogging	406.35E-6	1.3393	0.039052	**10588.**	-	0 (Negligible)
	Min Radius of Curvature (Sagging)		1	0.0	0.25272	Sagging	403.74E-6	1.4413	0.037500	-	**84185.**	0 (Negligible)

Fig UX1 - TAB

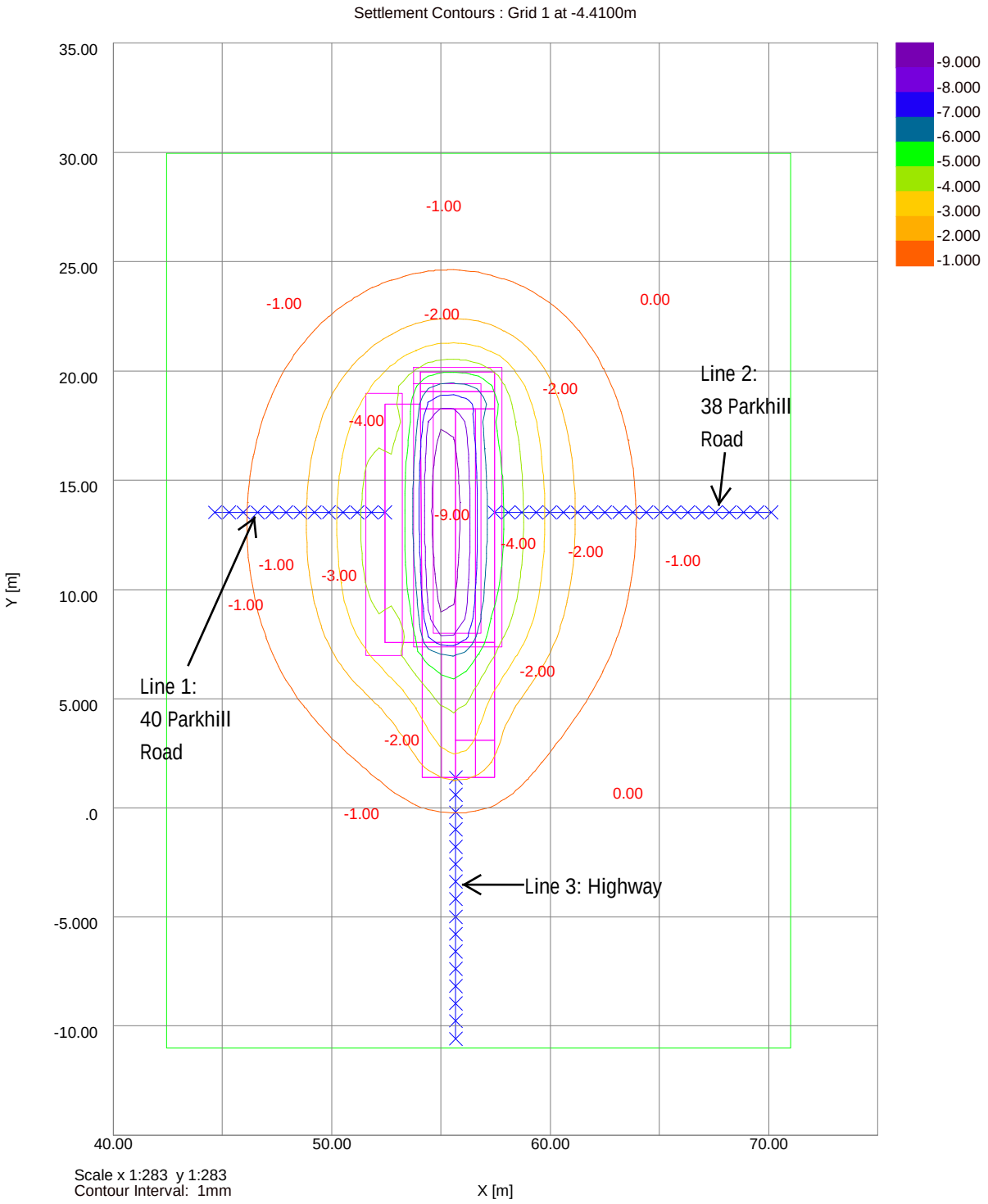


Fig V1:
Drained contour plot

Displacement for Line 1

Distance from (52.44,13.534) in m

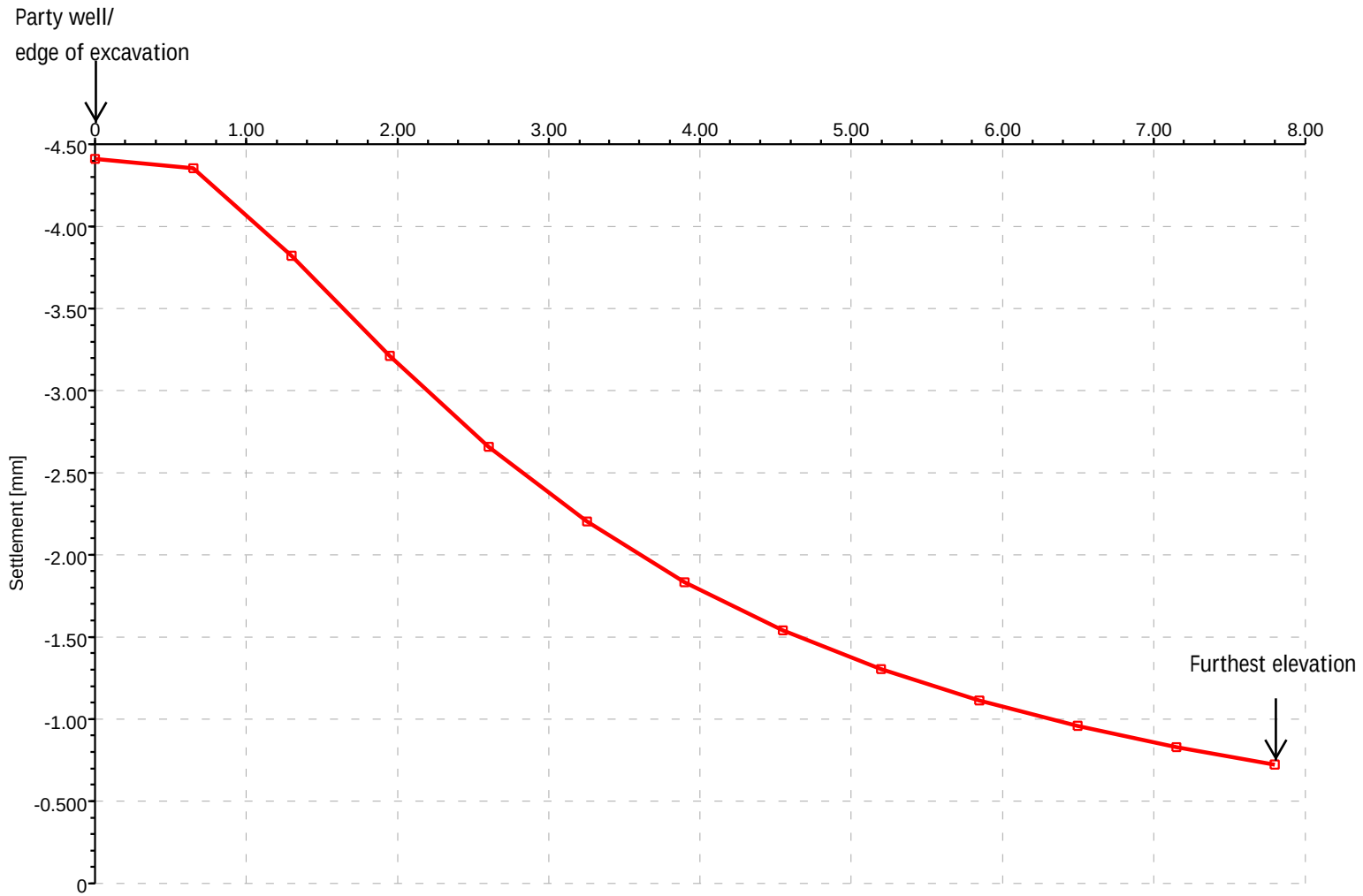


Fig V1-L1:
40 Parkhill Road

Displacement for Line 2

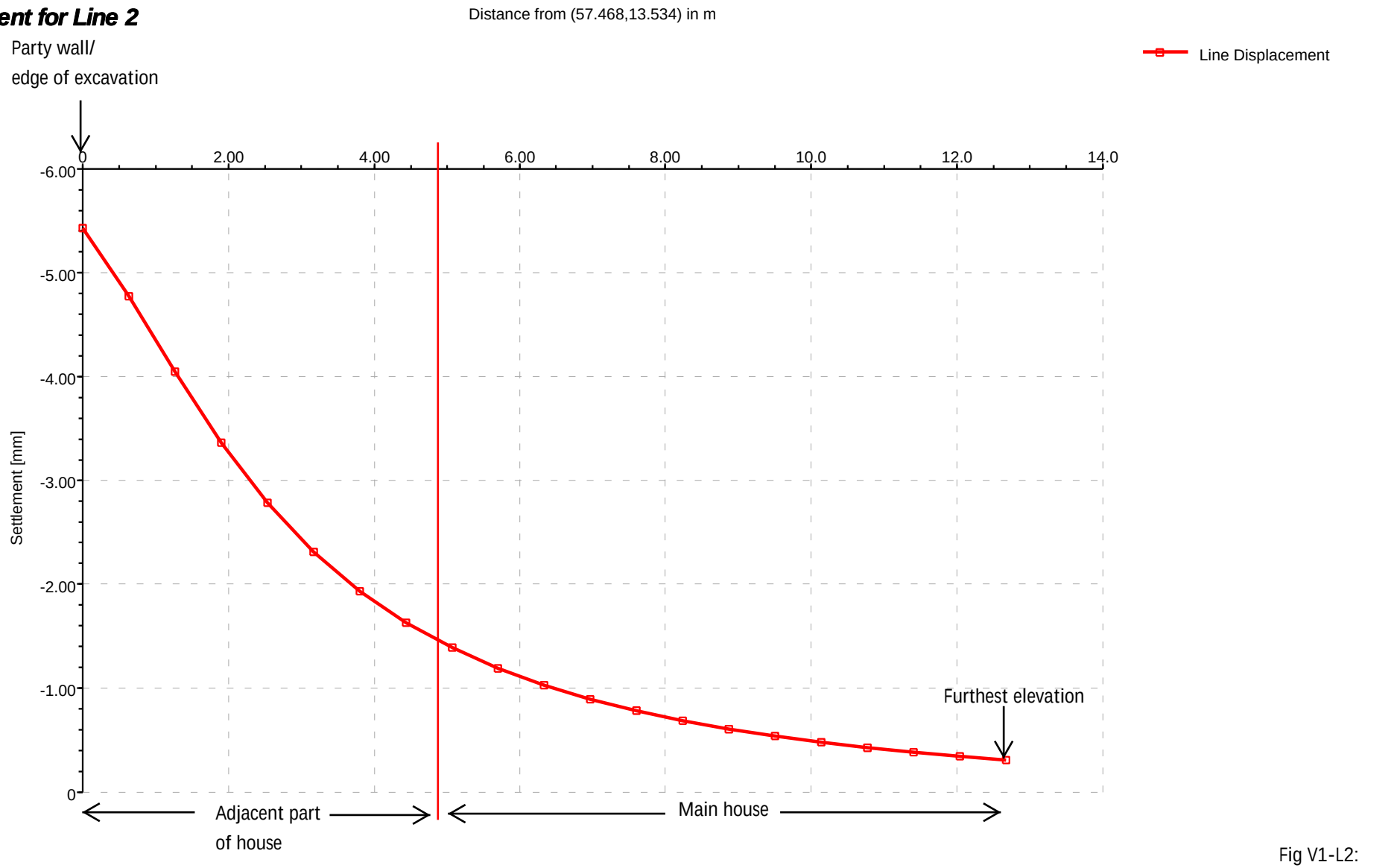


Fig V1-L2:
38 Parkhill Road

Displacement for Line 3

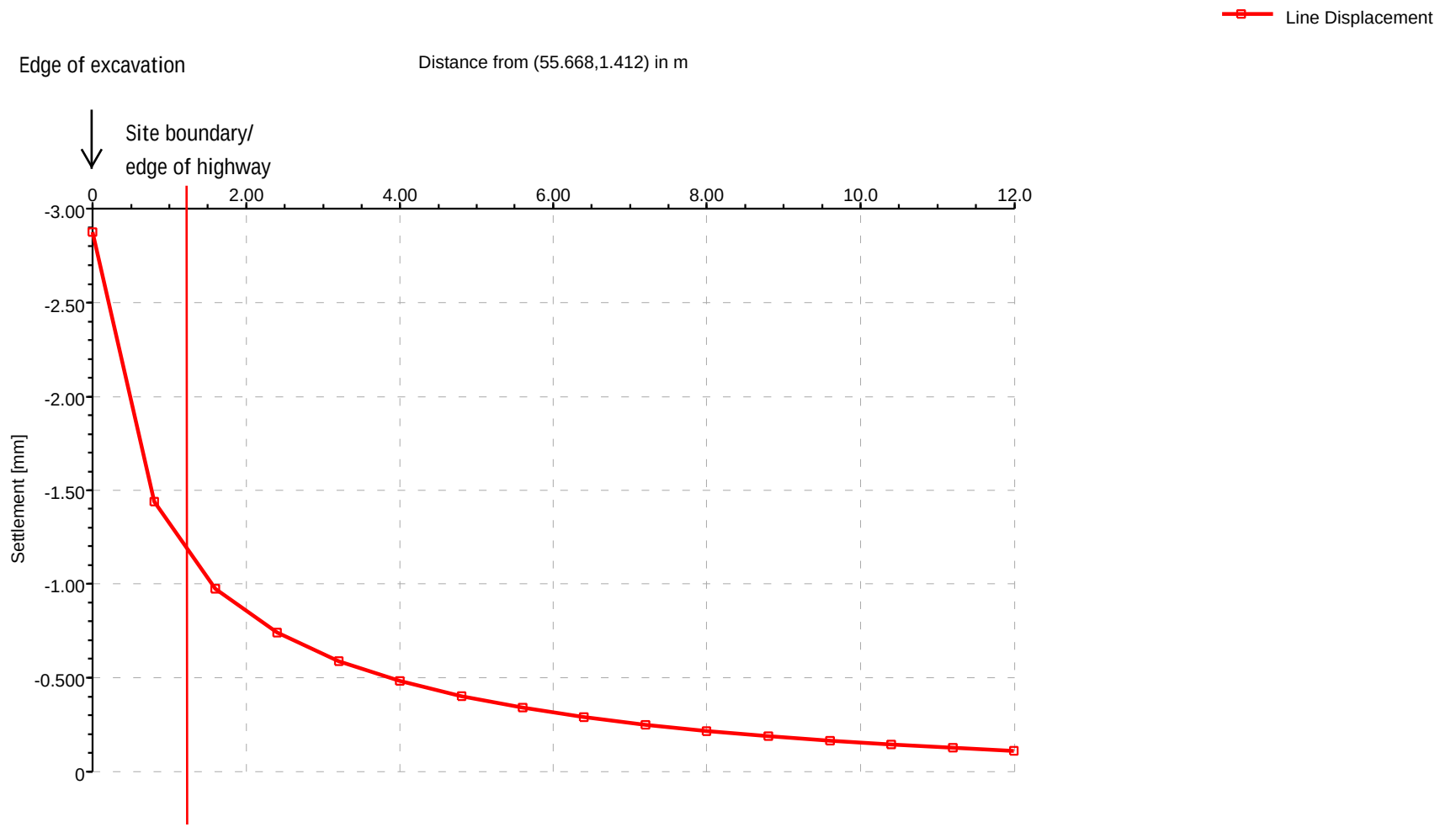


Fig V1-L3:
Highway

Line Displacements

Displacement Line 1: 40 Parkhill Rd

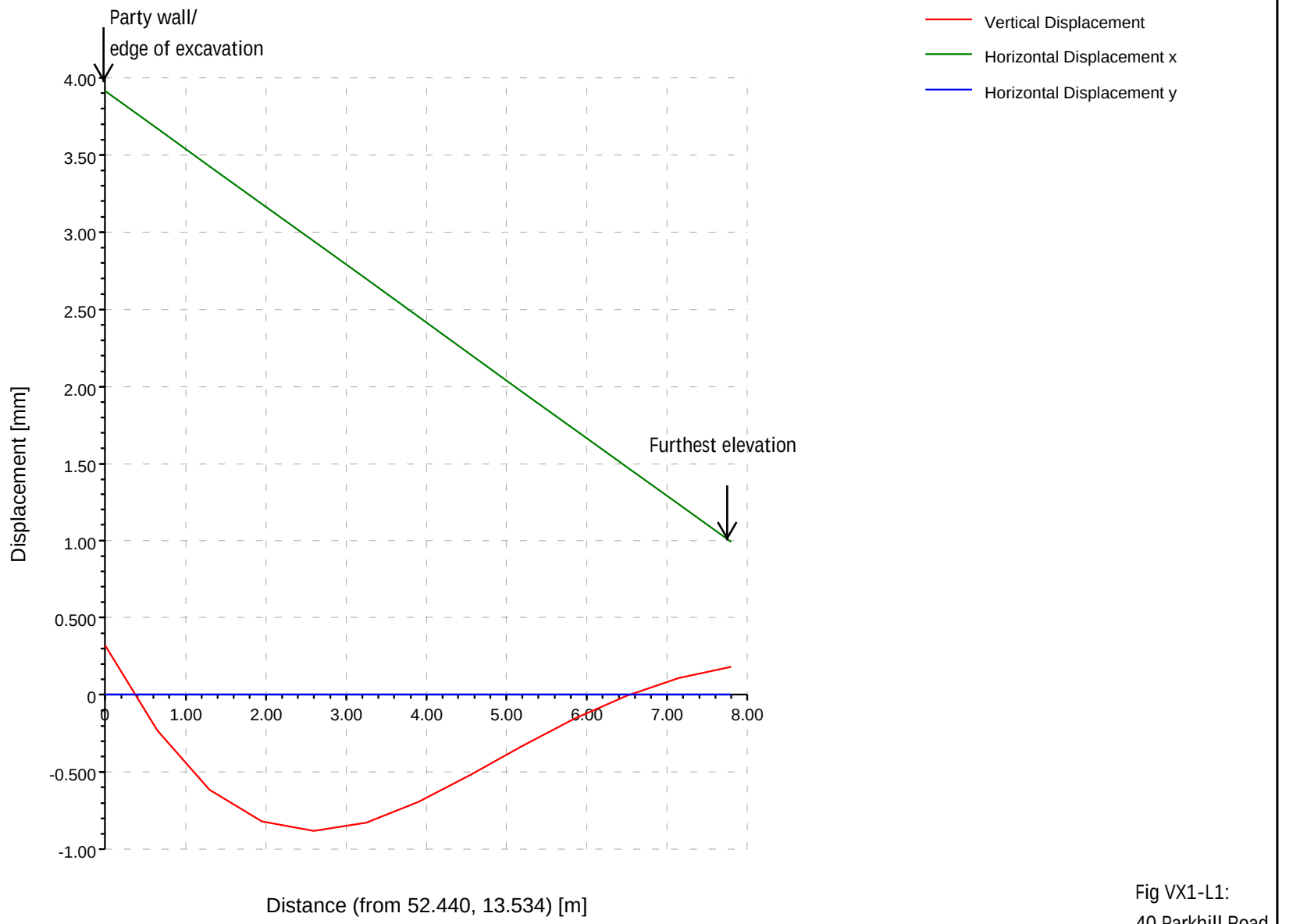


Fig VX1-L1:
40 Parkhill Road

Line Displacements

Displacement Line 2: 38 Parkhill Rd

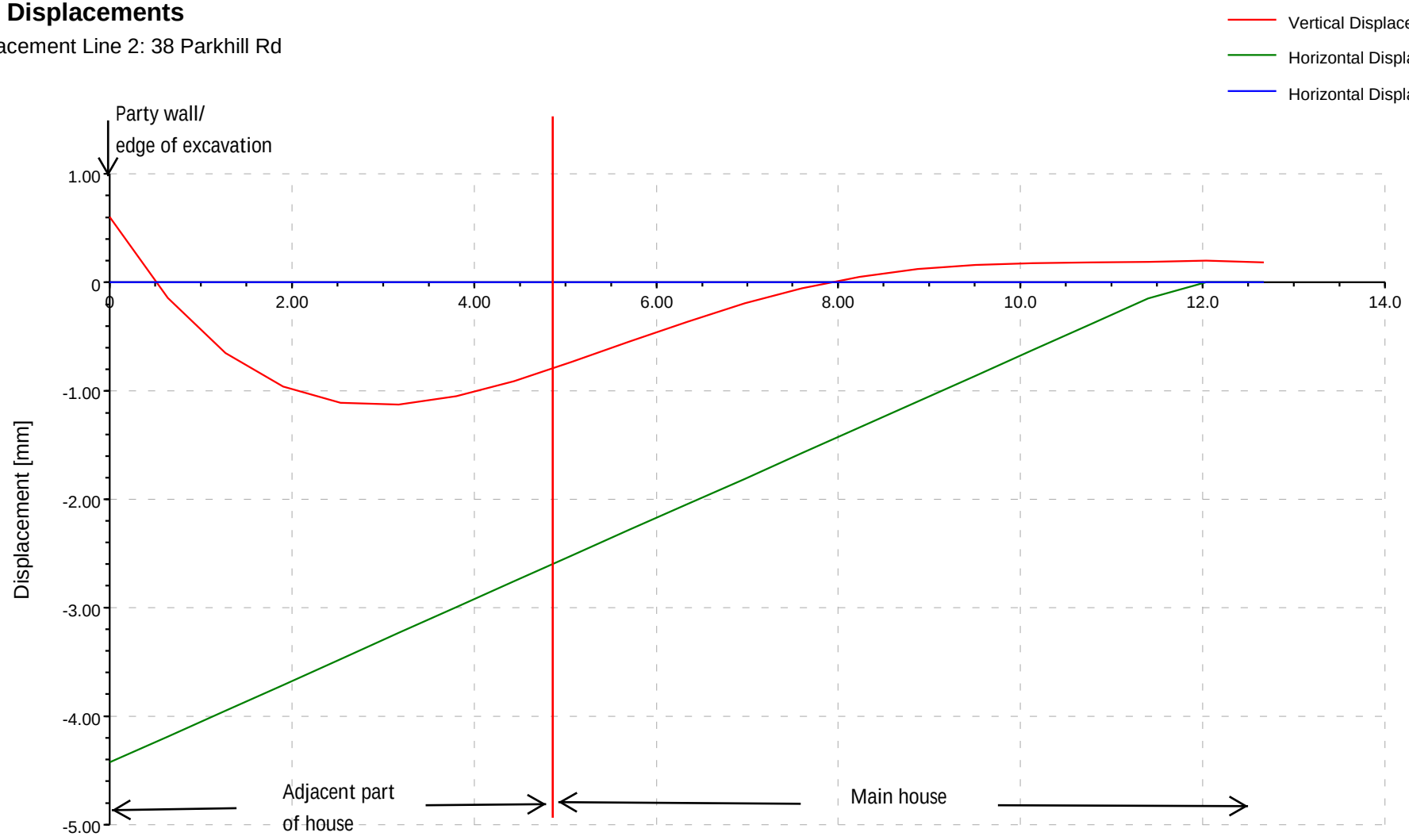


Fig VX1-L2:
38 Parkhill Road

Line Displacements

Displacement Line 3: Highway

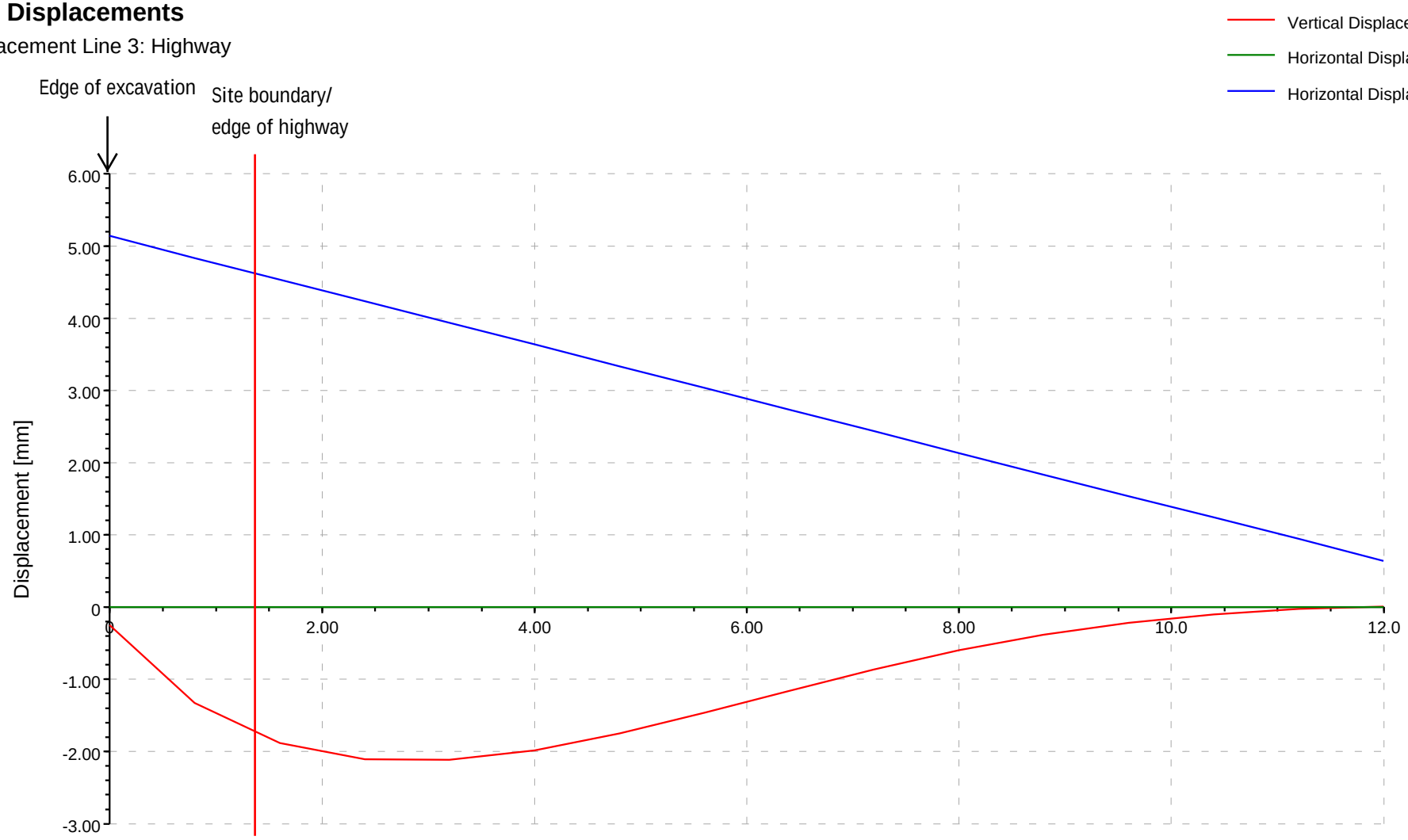


Fig VX1-L3:
38 Parkhill Road

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Specific Building Damage Results - Horizontal Displacements

Structure: 40 Parkhill Rd | Sub-structure:

Dist.	Coordinates			Displacements			
	x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	52.44000	13.53400	-1.80000	3.9150	0.0	-3.9150	0.0 d
0.64975	51.79025	13.53400	-1.80000	3.6713	0.0	-3.6713	0.0 d
1.2995	51.14050	13.53400	-1.80000	3.4277	0.0	-3.4277	0.0 d
1.9492	50.49075	13.53400	-1.80000	3.1840	0.0	-3.1840	0.0 d
2.5990	49.84100	13.53400	-1.80000	2.9404	0.0	-2.9404	0.0 d
3.2488	49.19125	13.53400	-1.80000	2.6967	0.0	-2.6967	0.0 d
3.8985	48.54150	13.53400	-1.80000	2.4531	0.0	-2.4531	0.0 d
4.5482	47.89175	13.53400	-1.80000	2.2094	0.0	-2.2094	0.0 d
5.1980	47.24200	13.53400	-1.80000	1.9658	0.0	-1.9658	0.0 d
5.8477	46.59225	13.53400	-1.80000	1.7221	0.0	-1.7221	0.0 d
6.4975	45.94250	13.53400	-1.80000	1.4784	0.0	-1.4784	0.0 d
7.1472	45.29275	13.53400	-1.80000	1.2348	0.0	-1.2348	0.0 d
7.7970	44.64300	13.53400	-1.80000	0.99113	0.0	-0.99113	0.0 d

d - Displacements include imported displacements.

Structure: 38 Parkhill Rd (adjacent) | Sub-structure:

Dist.	Coordinates			Displacements			
	x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	57.46800	13.53400	-1.46000	-4.4250	0.0	-4.4250	0.0 d
0.63360	58.10160	13.53400	-1.46000	-4.1874	0.0	-4.1874	0.0 d
1.2672	58.73520	13.53400	-1.46000	-3.9498	0.0	-3.9498	0.0 d
1.9008	59.36880	13.53400	-1.46000	-3.7122	0.0	-3.7122	0.0 d
2.5344	60.00240	13.53400	-1.46000	-3.4746	0.0	-3.4746	0.0 d
3.1680	60.63600	13.53400	-1.46000	-3.2370	0.0	-3.2370	0.0 d
3.8016	61.26960	13.53400	-1.46000	-2.9994	0.0	-2.9994	0.0 d
4.4352	61.90320	13.53400	-1.46000	-2.7618	0.0	-2.7618	0.0 d
5.0688	62.53680	13.53400	-1.46000	-2.5242	0.0	-2.5242	0.0 d
5.7024	63.17040	13.53400	-1.46000	-2.2866	0.0	-2.2866	0.0 d
6.3360	63.80400	13.53400	-1.46000	-2.0490	0.0	-2.0490	0.0 d
6.9696	64.43760	13.53400	-1.46000	-1.8114	0.0	-1.8114	0.0 d
7.6032	65.07120	13.53400	-1.46000	-1.5738	0.0	-1.5738	0.0 d
8.2368	65.70480	13.53400	-1.46000	-1.3362	0.0	-1.3362	0.0 d
8.8704	66.33840	13.53400	-1.46000	-1.0986	0.0	-1.0986	0.0 d
9.5040	66.97200	13.53400	-1.46000	-0.86100	0.0	-0.86100	0.0 d
10.138	67.60560	13.53400	-1.46000	-0.62340	0.0	-0.62340	0.0 d
10.771	68.23920	13.53400	-1.46000	-0.38580	0.0	-0.38580	0.0 d
11.405	68.87280	13.53400	-1.46000	-0.14820	0.0	-0.14820	0.0 d
12.038	69.50640	13.53400	-1.46000	0.0	0.0	0.0	0.0 d
12.672	70.14000	13.53400	-1.46000	0.0	0.0	0.0	0.0 d

d - Displacements include imported displacements.

Structure: 38 Parkhill Rd (main) | Sub-structure:

Dist.	Coordinates			Displacements			
	x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	57.46800	13.53400	-1.46000	-4.4250	0.0	-4.4250	0.0 d
0.63360	58.10160	13.53400	-1.46000	-4.1874	0.0	-4.1874	0.0 d
1.2672	58.73520	13.53400	-1.46000	-3.9498	0.0	-3.9498	0.0 d
1.9008	59.36880	13.53400	-1.46000	-3.7122	0.0	-3.7122	0.0 d
2.5344	60.00240	13.53400	-1.46000	-3.4746	0.0	-3.4746	0.0 d
3.1680	60.63600	13.53400	-1.46000	-3.2370	0.0	-3.2370	0.0 d
3.8016	61.26960	13.53400	-1.46000	-2.9994	0.0	-2.9994	0.0 d
4.4352	61.90320	13.53400	-1.46000	-2.7618	0.0	-2.7618	0.0 d
5.0688	62.53680	13.53400	-1.46000	-2.5242	0.0	-2.5242	0.0 d
5.7024	63.17040	13.53400	-1.46000	-2.2866	0.0	-2.2866	0.0 d
6.3360	63.80400	13.53400	-1.46000	-2.0490	0.0	-2.0490	0.0 d
6.9696	64.43760	13.53400	-1.46000	-1.8114	0.0	-1.8114	0.0 d
7.6032	65.07120	13.53400	-1.46000	-1.5738	0.0	-1.5738	0.0 d
8.2368	65.70480	13.53400	-1.46000	-1.3362	0.0	-1.3362	0.0 d
8.8704	66.33840	13.53400	-1.46000	-1.0986	0.0	-1.0986	0.0 d
9.5040	66.97200	13.53400	-1.46000	-0.86100	0.0	-0.86100	0.0 d
10.138	67.60560	13.53400	-1.46000	-0.62340	0.0	-0.62340	0.0 d
10.771	68.23920	13.53400	-1.46000	-0.38580	0.0	-0.38580	0.0 d
11.405	68.87280	13.53400	-1.46000	-0.14820	0.0	-0.14820	0.0 d
12.038	69.50640	13.53400	-1.46000	0.0	0.0	0.0	0.0 d
12.672	70.14000	13.53400	-1.46000	0.0	0.0	0.0	0.0 d

d - Displacements include imported displacements.

Specific Building Damage Results - Vertical Displacements

Structure: 40 Parkhill Rd | Sub-structure:

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	52.44000	13.53400	-1.80000	-0.32195 d
0.64975	51.79025	13.53400	-1.80000	0.23242 d
1.2995	51.14050	13.53400	-1.80000	0.61259 d
1.9492	50.49075	13.53400	-1.80000	0.82161 d
2.5990	49.84100	13.53400	-1.80000	0.88091 d
3.2488	49.19125	13.53400	-1.80000	0.82591 d
3.8985	48.54150	13.53400	-1.80000	0.69401 d
4.5482	47.89175	13.53400	-1.80000	0.51976 d
5.1980	47.24200	13.53400	-1.80000	0.33252 d
5.8477	46.59225	13.53400	-1.80000	0.15546 d
6.4975	45.94250	13.53400	-1.80000	0.0052178 d
7.1472	45.29275	13.53400	-1.80000	-0.10823 d
7.7970	44.64300	13.53400	-1.80000	-0.18156 d

d - Displacements include imported displacements.

Structure: 38 Parkhill Rd (adjacent) | Sub-structure:

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	57.46800	13.53400	-1.46000	-0.60448 d
0.63360	58.10160	13.53400	-1.46000	0.14234 d
1.2672	58.73520	13.53400	-1.46000	0.64899 d
1.9008	59.36880	13.53400	-1.46000	0.95904 d
2.5344	60.00240	13.53400	-1.46000	1.1061 d
3.1680	60.63600	13.53400	-1.46000	1.1249 d
3.8016	61.26960	13.53400	-1.46000	1.0492 d
4.4352	61.90320	13.53400	-1.46000	0.91008 d
5.0688	62.53680	13.53400	-1.46000	0.73441 d

Fig VX1 - TAB

Dist.	Coordinates x	y	z	Displacements z
[m]	[m]	[m]	[m]	[mm]
5.7024	63.17040	13.53400	-1.46000	0.54491 d
6.3360	63.80400	13.53400	-1.46000	0.35981 d
6.9696	64.43760	13.53400	-1.46000	0.19299 d
7.6032	65.07120	13.53400	-1.46000	0.053985 d
8.2368	65.70480	13.53400	-1.46000	-0.051911 d
8.8704	66.33840	13.53400	-1.46000	-0.12362 d
9.5040	66.97200	13.53400	-1.46000	-0.16424 d
10.138	67.60560	13.53400	-1.46000	-0.18100 d
10.771	68.23920	13.53400	-1.46000	-0.18500 d
11.405	68.87280	13.53400	-1.46000	-0.19200 d
12.038	69.50640	13.53400	-1.46000	-0.20236 d
12.672	70.14000	13.53400	-1.46000	-0.18667 d

d - Displacements include imported displacements.

Structure: 38 Parkhill Rd (main) | Sub-structure:

Dist.	Coordinates x	y	z	Displacements z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	57.46800	13.53400	-1.46000	-0.60448 d
0.63360	58.10160	13.53400	-1.46000	0.14234 d
1.2672	58.73520	13.53400	-1.46000	0.64899 d
1.9008	59.36880	13.53400	-1.46000	0.95904 d
2.5344	60.00240	13.53400	-1.46000	1.1061 d
3.1680	60.63600	13.53400	-1.46000	1.1249 d
3.8016	61.26960	13.53400	-1.46000	1.0492 d
4.4352	61.90320	13.53400	-1.46000	0.91008 d
5.0688	62.53680	13.53400	-1.46000	0.73441 d
5.7024	63.17040	13.53400	-1.46000	0.54491 d
6.3360	63.80400	13.53400	-1.46000	0.35981 d
6.9696	64.43760	13.53400	-1.46000	0.19299 d
7.6032	65.07120	13.53400	-1.46000	0.053985 d
8.2368	65.70480	13.53400	-1.46000	-0.051911 d
8.8704	66.33840	13.53400	-1.46000	-0.12362 d
9.5040	66.97200	13.53400	-1.46000	-0.16424 d
10.138	67.60560	13.53400	-1.46000	-0.18100 d
10.771	68.23920	13.53400	-1.46000	-0.18500 d
11.405	68.87280	13.53400	-1.46000	-0.19200 d
12.038	69.50640	13.53400	-1.46000	-0.20236 d
12.672	70.14000	13.53400	-1.46000	-0.18667 d

d - Displacements include imported displacements.

Specific Building Damage Results - All Segments

Structure: 40 Parkhill Rd | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	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	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	4.9574	Sagging	0.017316	0.037500	0.046184	-374.86E-6	-852.89E-6	2414.7	0 (Negligible)
	2	4.9574	2.8386	Hogging	0.0028139	0.037500	0.037915	-374.86E-6	288.07E-6	10306.	0 (Negligible)

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

Structure: 38 Parkhill Rd (adjacent) | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	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	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	4.8130	Sagging	0.020890	0.037500	0.058203	-374.86E-6	-0.0011782	1600.3	1 (Very Slight)

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

Structure: 38 Parkhill Rd (main) | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	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	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	0.82494	Sagging	465.26E-6	0.037500	0.037559	-374.86E-6	298.98E-6	17318.	0 (Negligible)
	2	0.82494	7.0331	Hogging	0.0048676	0.032856	0.035408	-374.86E-6	298.98E-6	12016.	0 (Negligible)

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

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: 40 Parkhill Rd | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.017316	0.037500	-852.89E-6	0.88049	0.046184	-374.86E-6	-852.89E-6	10306.	2414.7	0 (Negligible)

Structure: 38 Parkhill Rd (adjacent) | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.020890	0.037500	-0.0011782	1.1246	0.058203	-374.86E-6	-0.0011782	-	1600.3	1 (Very Slight)

Structure: 38 Parkhill Rd (main) | Sub-structure:

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0048676	0.037500	298.98E-6	0.80533	0.037559	-374.86E-6	298.98E-6	12016.	17318.	0 (Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature	Min Radius of Curvature	Damage Category

Fig VX1 - TAB

			[m]	[m]			[mm]	[%]	(Hogging) [m]	(Sagging) [m]	
40 Parkhill Rd	Max Slope	1	0.0	4.9574	Sagging	**852.89E-6**	0.88049	0.046184	-	2414.7	0 (Negligible)
	Max Settlement	1	0.0	4.9574	Sagging	852.89E-6	**0.88049**	0.046184	-	2414.7	0 (Negligible)
	Max Tensile Strain	1	0.0	4.9574	Sagging	852.89E-6	0.88049	**0.046184**	-	2414.7	0 (Negligible)
	Min Radius of Curvature (Hogging)	2	4.9574	7.7960	Hogging	288.07E-6	0.40185	0.037915	**10306.**	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	1	0.0	4.9574	Sagging	852.89E-6	0.88049	0.046184	-	**2414.7**	0 (Negligible)
38 Parkhill Rd (adjacent)	Max Slope	1	0.0	4.8130	Sagging	**0.0011782**	1.1246	0.058203	-	1600.3	1 (Very Slight)
	Max Settlement	1	0.0	4.8130	Sagging	0.0011782	**1.1246**	0.058203	-	1600.3	1 (Very Slight)
	Max Tensile Strain	1	0.0	4.8130	Sagging	0.0011782	1.1246	**0.058203**	-	1600.3	1 (Very Slight)
	Min Radius of Curvature (Hogging)	-	-	-	-	-	-	-	-	-	-
	Min Radius of Curvature (Sagging)	1	0.0	4.8130	Sagging	0.0011782	1.1246	0.058203	-	**1600.3**	1 (Very Slight)
38 Parkhill Rd (main)	Max Slope	1	0.0	0.82494	Sagging	**298.98E-6**	0.80533	0.037559	-	17318.	0 (Negligible)
	Max Settlement	1	0.0	0.82494	Sagging	298.98E-6	**0.80533**	0.037559	-	17318.	0 (Negligible)
	Max Tensile Strain	1	0.0	0.82494	Sagging	298.98E-6	0.80533	**0.037559**	-	17318.	0 (Negligible)
	Min Radius of Curvature (Hogging)	2	0.82494	7.8580	Hogging	298.98E-6	0.56419	0.035408	**12016.**	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	1	0.0	0.82494	Sagging	298.98E-6	0.80533	0.037559	-	**17318.**	0 (Negligible)

Fig VX1 - TAB