CROSSRAIL TUNNEL IMPACT ASSESSMENT

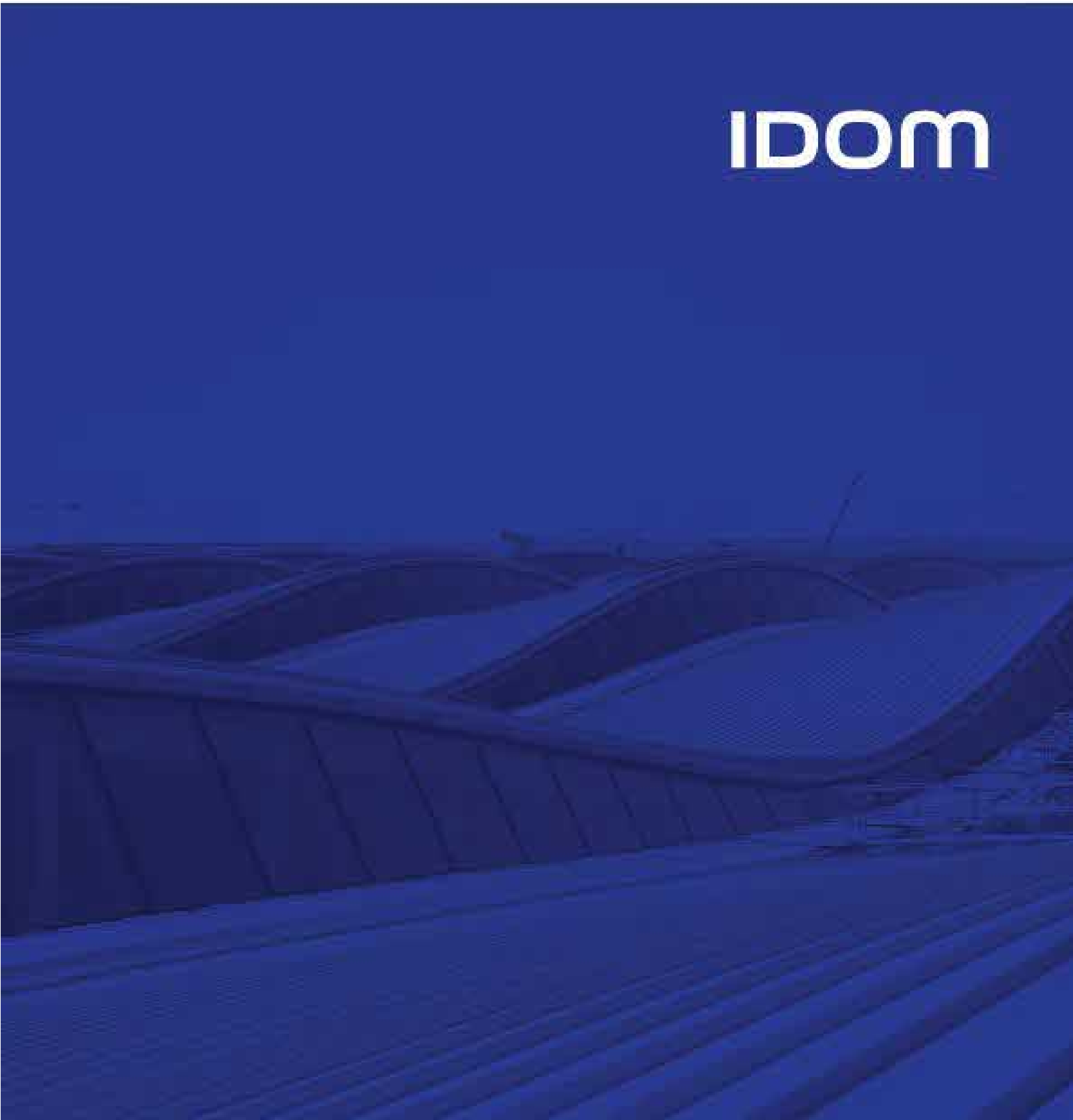
81-88 BERESFORD STREET

WOOLWICH

B WOOLWICH LTD

GMA-22277-23-402 REVISION 2

NOVEMBER 2023



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0	KM	SAH	31/10/2023	
1	KM	SAH	03/11/2023	Update Figure 3
2	KM	SAH	06/11/2023	Update Appendix 1

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SECTION 1 INTRODUCTION

1.1 B Woolwich Ltd proposes to redevelop an area of land located adjacent to Beresford Street, Woolwich currently occupied by a disused Catholic Club. The proposed redevelopment of the site comprises a 14-storey student accommodation tower block. The proposed development also includes:

i. Underground basement,

ii. Outdoor roof terrace atop the south-eastern half of the building

1.2 A section of Crossrail asset, the Elizabeth underground line, comprising two tunnels running in an east to west direction lies approximately 22 m below ground level and 15.4 m away from the proposed building. Crossrail requires a tunnel impact assessment due to the proposed development.

1.3 IDOM Merebrook (IDOM) has been appointed by B Woolwich Ltd to carry out a Ground Movement Assessment (GMA) to assess the impact of the proposed development on the Elizabeth underground line assets, and to check this against ground movement criteria set by London Underground to prevent disruption of its operations.

1.4 This report presents the findings of the Tunnel Impact Assessment which has been carried out in accordance with the guidelines set out in the relevant London Underground (LU) standards and manuals.

1.5 This report has been prepared for B Woolwich Ltd for the sole purpose described above and no extended duty of care to any third party is implied or offered. Third parties making reference to the report should consult B Woolwich Ltd and IDOM as to the extent to which the findings may be appropriate for their use.

SECTION 2 DEVELOPMENT PROPOSALS

2.1 The site is located approximately 13.7 km east of London City centre to the northeast of Beresford Street, Woolwich. The National Grid Reference (NGR) for the approximate centre of the site is 543678 179059.

2.2 The site occupies an area of approximately 0.10 hectares. The south-eastern boundary and part of the north-eastern boundary is formed by a wooden fence. The south-western and north-western boundaries are formed by the existing building that covers most of the site. The remaining part of the north-eastern boundary is formed by recently erected Heras fencing.

2.3 Beresford street is located immediately southwest of the site whilst the surrounding areas comprise recently constructed residential tower blocks, particularly to the north, and areas of public open space with some commercial buildings.

2.4 The site is almost completely occupied by an existing building that was formerly used as a Catholic Club. As the subject site lies within the footprint of a pre-existing building, the site topography is flat. The existing site building is not adjoined to any other structures.

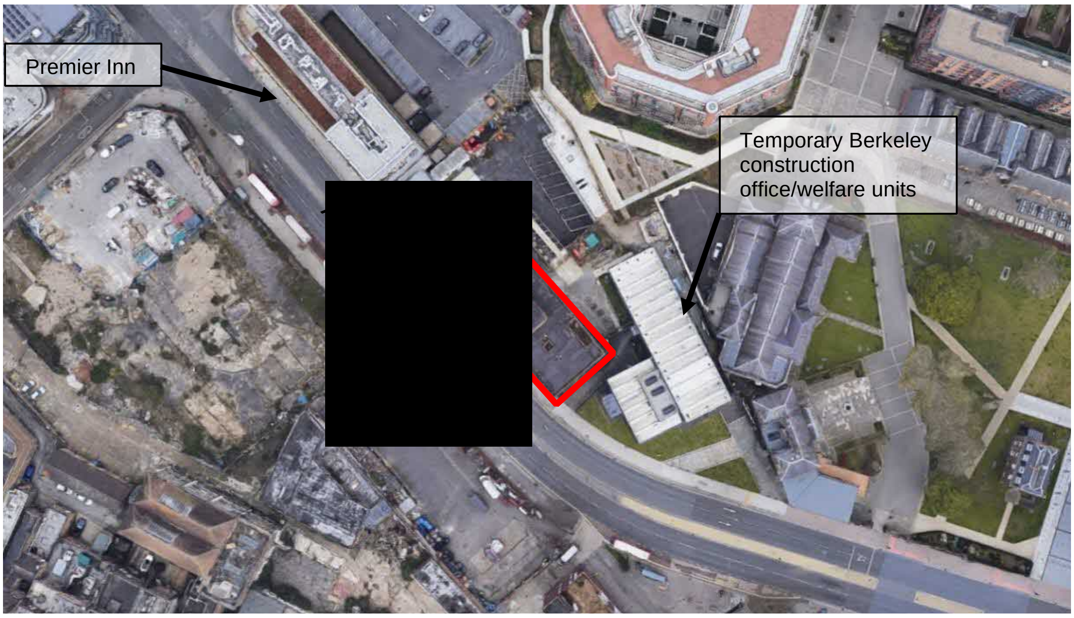


Figure 1: Recent satellite imagery of site (red boundary) and surrounding land.

2.5 The proposed development comprises a 14-storey high rise building with a basement. A raft foundation is proposed, with small clusters of piles in more heavily loaded areas to control settlement.

2.6 A contiguous pile wall will be installed along the north-east corner of the building to be used for gravity and lateral loads.

SECTION 3 CROSSRAIL ASSET

3.1 A portion of the Elizabeth Line Crossrail asset comprising two tunnels running in an east to west direction lies approximately 15.4 m to the northwest of the proposed building, as indicated in Figure 2, which is an extract from a drawing in Appendix 1. The west bound line is closer to the new building and the invert level is 22 m below ground level at +1.89 m AOD. Layout plan showing the point of the building closest to the tunnels is given in Figure 3.

3.2 Details of the tunnels are given on drawings in Appendix 2. Only the westbound tunnel was assessed.

3.3 The design load of the existing building has been provided by the structural engineer (Form Structural Design) as 90 kN/m^2. The cross section drawing showing the assumed load spread from the existing building onto the west bound tunnel is indicated in Figure 2.

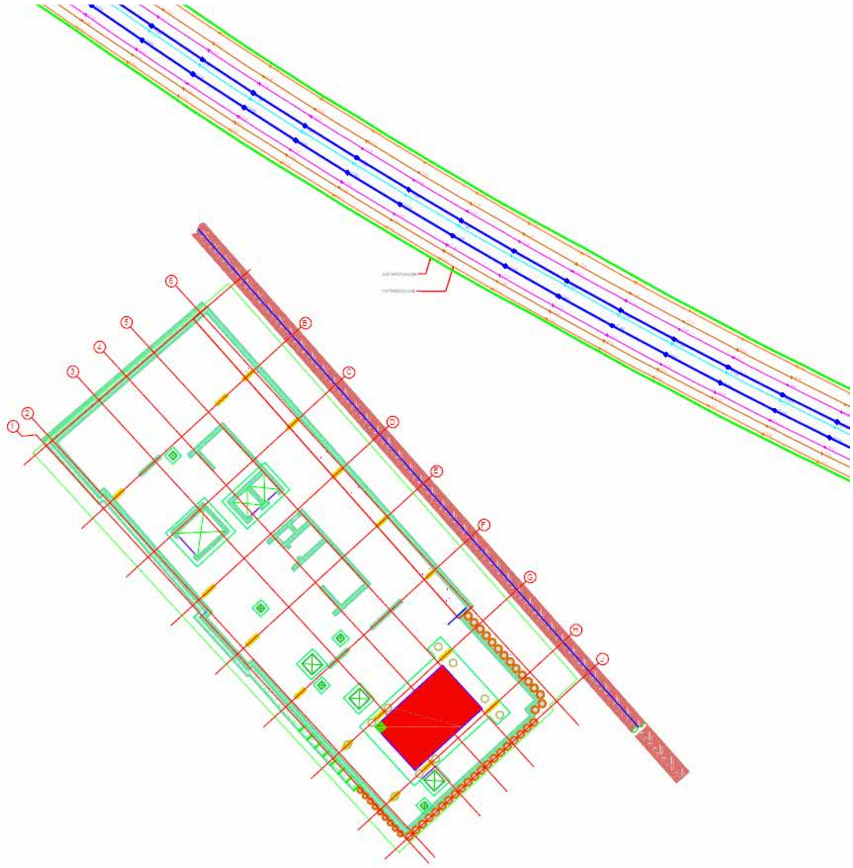


Figure 2: Crossrail Asset overview layout plan relative to proposed development

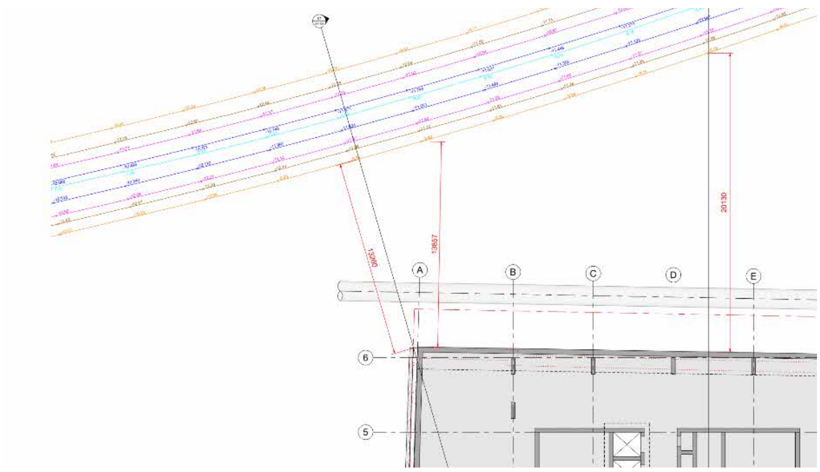


Figure 3: Crossrail asset relative to closest point to the proposed development

SECTION 4 RELEVANT LU STANDARDS AD MANUALS

4.1 The relevant LU Standards and manuals are given in Table 1.

Table 1: LU Standards and Manuals

Document Reference	Title	Version
S 1023	Infrastructure protection	A5
S 1050	Civil Engineering – Common Requirements	A9
S 1055	Civil Engineering – Deep Tube Tunnels and Shafts	A5
S 1158	Track – Inspection and Maintenance	A10
S 1159	Track – Dimensions and Tolerances	A4
G 0050	Civil Engineering – Common Requirements	A4

4.2 ASSESSMENT OF LU TUNNELS

4.2.1 The summary of assessment of the running tunnels was carried out in accordance with recommendations set out in LU Standard S1055. The following assessments are required:

i. Longitudinal assessment: minimum radius or curvature along the tunnel.

ii. Radial assessment: bending moments and hoop forces induce radial deformation, i.e., ovalisation.

iii. Track and clearance assessment: Track geometry and tunnel clearance changes due to induced ground movements

iv. Leakage at joints

4.3 TRACK CATEGORY

4.3.1 The running tracks are categorised to ensure that the requirements of inspection and maintenance activities can be determined based on the track category. The track category is defined in LU Standards S 1158 and each track section is allocated a track category A, B, C, and depending on the Loading Factor, to ensure the requirements of maintenance activities.

4.4 MAINTENANCE REQUIREMENTS

4.4.1 The maintenance requirements are given in LU Standards S 1159. On maintenance requirements, Track Category A and Category B values are more onerous and were therefore used for the assessment of the running and crossover tunnels. The values are summarised in Table 2.

Table 2: Geometric standards – manual measurements

Parameter	Safety Standard -SS	Maintenance Limit - ML	Maintenance Target - MT
Vertical profile - long undulations at 5m intervals (mm)	10	7	5
Vertical profile - short undulations at 1m intervals (mm)	-	3	2
Cross Level (cant) - Maximum permitted deviation from marked cant averaged over 5 sleepers (mm)	-40 / +30	-20 / +15	-15 / +10
Twist 2 metre base - cross level variation (mm)	25	20	12
Twist 10 metre base - cross level variation (mm)	40 1:250)	37 (1:270)	35 (1:286)

SECTION 5 GEOTECHNICAL INPUT PARAMETERS

5.1 EXISTING GROUND INVESTIGATION INFORMATION

5.1.1 IDOM carried out a preliminary intrusive ground investigation at the site in July 2023. The investigation comprised one cable percussion borehole (MBH01) and Standard Penetration Tests (SPTs) at approximate 1.0 metre intervals, to a depth of 40 metres below ground level (m bgl). The findings of the investigation are presented in IDOM report reference GEA-22277-23-283.

5.2 SURFACE LEVELS

5.2.1 According to the borehole levels reported in the geo-environmental report, current ground level at which the borehole was progressed from is +10.55 m AOD.

5.3 STRATIGRAPHY AND SOIL PARAMETERS

5.3.1 The stratigraphy and soil parameters at the site were estimated from site-specific ground investigation carried out by IDOM in 2023.

5.3.2 Table 3 summarises the ground profile developed from the respective borehole log.

Table 3: Ground profile

Strata	Depth to Top of Range (m AOD)	Thickness Range (m)
Made Ground	10.55	2.20
Superficial – Head deposits	8.45	1.50
Solid – Thanet Sand Formation	6.98	14.10
Solid – Undifferentiated Chalk	-7.15	22.20

5.3.3 Figure 4 is a representation of the variation of SPT results with depth from the investigation and historic data from nearby sites that was reviewed. The following are the recommended SPT values adopted for correlation to obtain the geotechnical parameters.

i. Made ground N = 3

ii. Heads Deposits N = 20

iii. Thanet Sand Formation N = 80

iv. Undifferentiated chalk N = 30

5.3.4 The SPT values for Thanet Sand formation and undifferentiated Chalk are too low to directly correlate with soil stiffness. As such, reference was made to published literature and experience with the material types as discussed below.

5.3.5 Table 4 gives a summary of the stratigraphy and the relevant soil parameters used in the calculations.

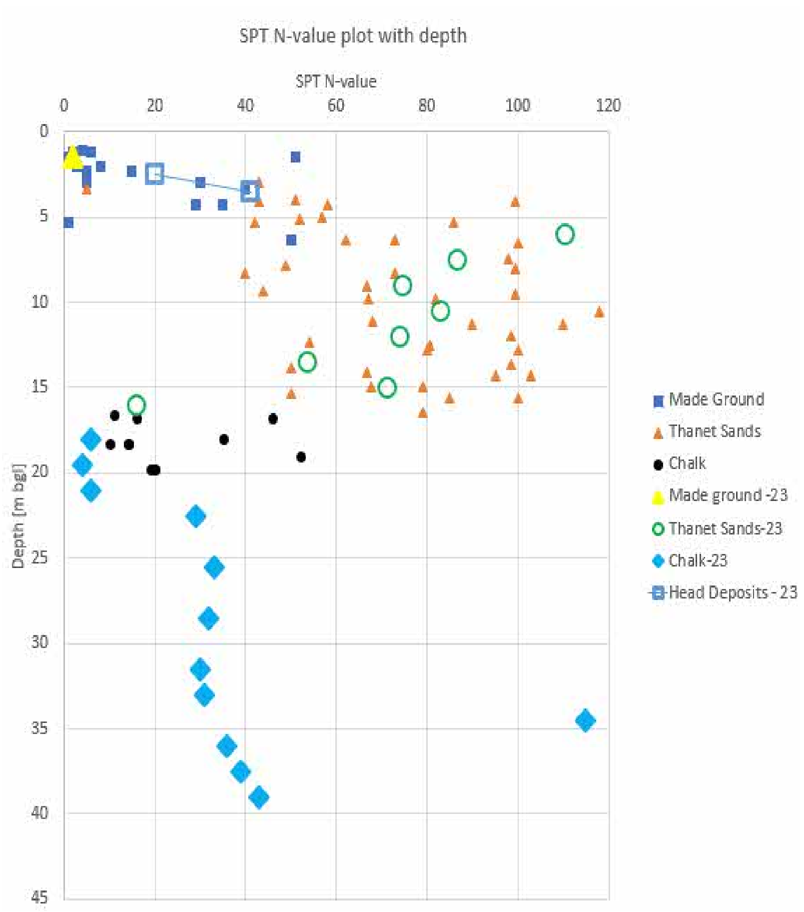


Figure 4 – SPT N-value vs depth including historic data.

Table 4: Soil parameters for ground movement analysis

Stratum	Depth (m bgl)	Level of top of stratum (mOD)	Thickness (m)	Bulk unit weight (kN/m3)	Cu (kN/m2)	ϕ' (°)	Poisson's ratio	Eu (kPa)		E' (kPa)	
								Top*	Bottom*	Top	Bottom
Made Ground	0.1	10.55	2.10	18	23	23	0.25	7000[1]		7000	
Head Deposits	2.2	8.45	1.50	20	-	32	0.25	30000[1]		30000	
Thanet Sands	3.7	6.95	14.10	21	-	38	0.25	160000[2]		160000[2]	
Chalk	17.8	-7.15	Not proven	22	-	38	0.25	1000000[3]		1000000[3]	

[1] Values were doubled to account for the higher soil stiffness during stress unloading
[2] E' (sand) = 2 x N (ref. Bowles - Table 2.8 (5th adition), Ciria 143 (page 81))
[3] E' (Chalk) = 1GPa (ref. Ciria guide C574)

5.4 GROUND WATER

5.4.1 No groundwater was encountered to a depth of 40 m below ground level.

SECTION 6 LOAD INPUT PARAMETERS

6.1 PERMANENT RAFT LOADS

6.1.1 A raft foundation is proposed, with small clusters of piles in more heavily loaded areas to control settlements. The load distribution across the basement foundation footprint was determined iteratively following change in soil's spring stiffness (modulus of subgrade reaction) to keep the predicted settlement below 25 mm. Settlement piles are used where the predicted settlement is more than 25 mm. Figure 5 shows the raft load distribution contours and Figure 6 shows the idealized load zones A to F used in the model.

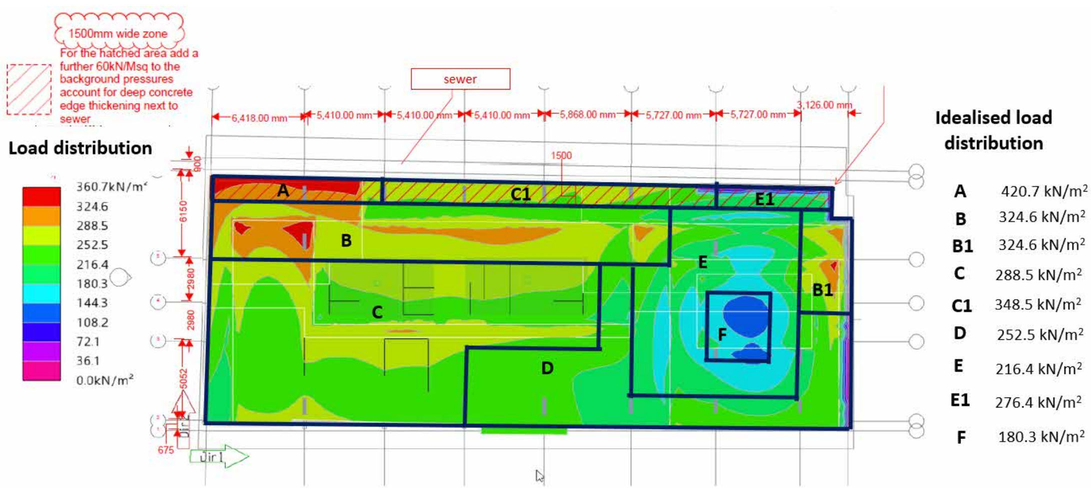


Figure 5: Raft foundation load distribution at the basement (+5.48 m OD)

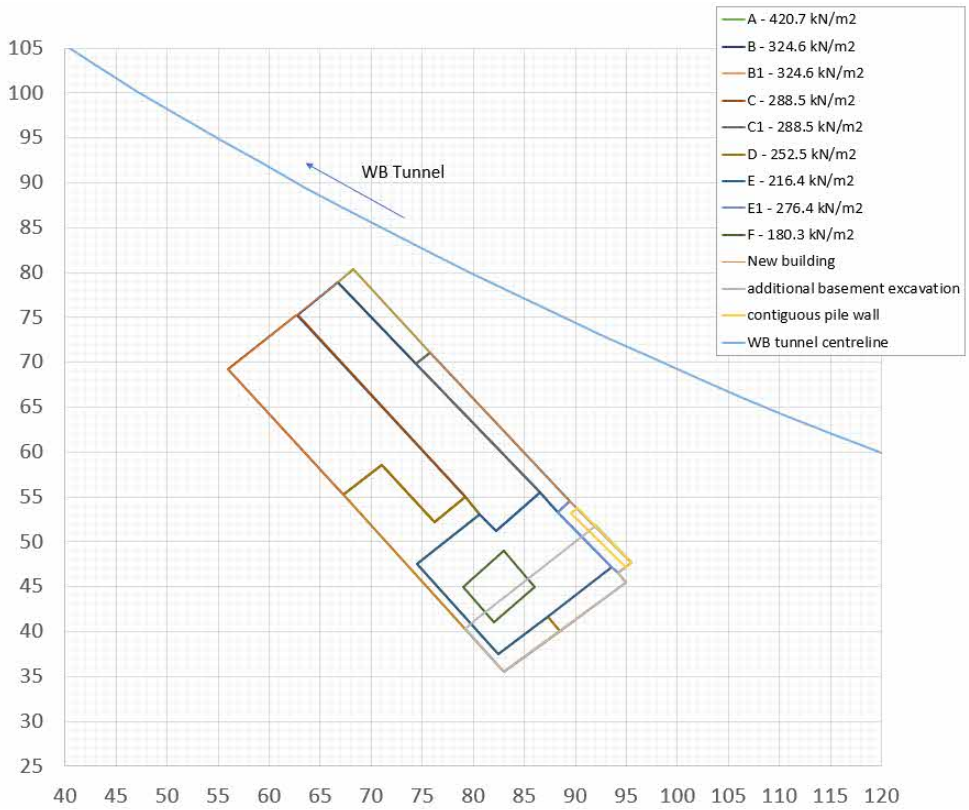


Figure 6: Indicative raft load arrangement at basement level (+5.48 m OD)

6.1.2 The estimated equivalent loads for each zone are summarised in Table 5.

Table 5: Dead load due to raft and superstructure

Zone	Dead Load (kN/m2)	Invert level (mOD)	Comment
A	420.7	4.20	Raft deepened such that the tunnel above (outside) the 45-degree “zone of influence” load from the building
B	324.6	5.48	Basement level
B1	324.6	5.48	Basement level
C	288.5	5.48	Basement level
C1	348.5	4.20	Raft deepened such that the tunnel above (outside) the 45-degree “zone of influence” load from the building
D	252.5	5.48	Basement level

Zone	Dead Load (kN/m2)	Invert level (mOD)	Comment
E	216.4	5.48	Basement level
E1	276.4	4.20	Raft deepened such that the tunnel above (outside) the 45-degree “zone of influence” load from the building
F	180.3	5.48	Basement level

6.2 DEMOLITION LOADS

6.2.1 The existing superstructure on site is to be demolished to make way for the new development. The demolition loads were determined in the context of the following proposed construction sequence:

i. Demolish existing building superstructure own to grid floor level. This will partially reduce load on existing tunnel as the existing structure does surcharge the tunnel .

ii. Demolish existing ground floor slab and in sequence, backfill to existing basement retaining walls to give the required passive resistance and lateral support.

iii. Level the backfill to give suitable piling mat for sheet piling to rear section and suit cut off level for settlement control piles. Break out voids in existing slab as required beforehand to suit pile arrangement.

iv. Install contiguous pile wall and any settlement control piles from lower-level piling mat. (No bored piles to be within 3.0 m of any tunnel zone.)

v. Excavate to basement formation the section to the east beyond the existing building. The contiguous pile wall installed along the north-east section the new building will be used for gravity and lateral loads.

vi. Install lateral propping system between sheet piling and existing basement wall to front and flank. Excavation is now top supported laterally.

vii. To rear area firstly, demolish and excavate down to formation level, breaking out existing reinforced concrete wall and existing basement slab to an agreed extent. Batter back to maintain lateral support to existing basement retaining wall to front elevation, to maintain support. Existing tunnel is now unloaded from existing building.

6.2.2 From the second point on the construction sequence, the basement will be backfilled and therefore, there is a reduction in the stress unloading associated with demolition of the superstructure.

6.2.3 The net stress unloading accounting for the backfilling of the basement was calculated as follows:

i. Existing ground level = 10.55 mOD

ii. Existing basement level = 7.53 mOD

iii. Density of platform material = 22 KN/m^3

iv. Load due to backfill = (10.55 - 7.53) x 22 = 66.44 kN/m^2

v. Load due to existing building = 90 kN/m^2

vi. Therefore, net stressing unloading = -90 +66.44 = **-23.56** kN/m^2

6.2.4 The new building extends beyond the footprint of the existing building towards the east by approximately 10 m. This footprint of the new building will be excavated by 5.05 m to 10.5 mOAD. Assuming soil density of 19 kN/m^3, the net stress unloading = -5.05 x 19 kN/m^3 = **-95.95 kN/m^2.**

6.3 PILING PLATFORM

6.3.1 The piling platform will comprise backfill to existing basement retaining wall level, designed to also provide the required passive resistance and lateral support. Therefore, there is no additional load due to piling platform.

6.4 PILING PLANT

6.4.1 The piling rig for the installation of the contiguous pile wall and any settlement piles will be positioned within the building footprint and far away from the 3.0 m Crossrail boundary zone. Therefore, no further consideration of the piling plant is necessary.

6.5 MODELLING LANDSCAPE

6.5.1 The existing ground level is at approximately +10.55 mOD and mostly paved. Therefore, there is no net loading arising from landscaping.

SECTION 7 ASSESSMENT METHODOLOGY

7.1 ASSESSMENT TOOL

7.1.1 The assessment of the ground movements and impact of the redevelopment on the site was carried out using Oasys PDISP software. PDISP is a pressure induced displacement analysis and is a program which can calculate the displacements (and stresses if required) within a linear elastic or non-linear soil mass, arising from uniform normal or tangential pressure, applied to rectangular and circular loaded planes.

7.1.2 The stages of the redevelopment that were modelled are demolition and hence installation of the piling platform and excavation for basement extension, construction of the new building, and long-term conditions.

7.1.3 The OASYS software program PDISP was used to set up models reflecting each stage of construction to estimate the ground movement during the development of the site.

7.1.4 The size of the tunnel is such that the vertical and lateral movements of soil at the crown and invert of the tunnel were computed using PDISP. In the software analyses, the Boussinesq method is used to predict the movements of the ground.

7.2 MODEL GEOMETRY

7.2.1 The west bound tunnel is closer to the new building and was therefore modelled and analysed. The tunnel is circular with the following dimensions.

i. Outer diameter = 6.8 m

ii. Internal diameter = 6.2 m

7.2.2 The tunnel displacements have been calculated at approximately 1.0 m intervals along the line of the running tunnel and to at least 50 m outside the portion that is closest to the new building, see Figure 7.

7.2.3 Ground movements have been calculated at 4 locations at the running tunnel forming a square in which the tunnel sists, as illustrated in Figure 7.

7.2.4 The crown and invert levels of the tunnel at portion closest to the new building are as follows:

i. Crown level -6.847 mOD

ii. Invert level -13.647 mOD

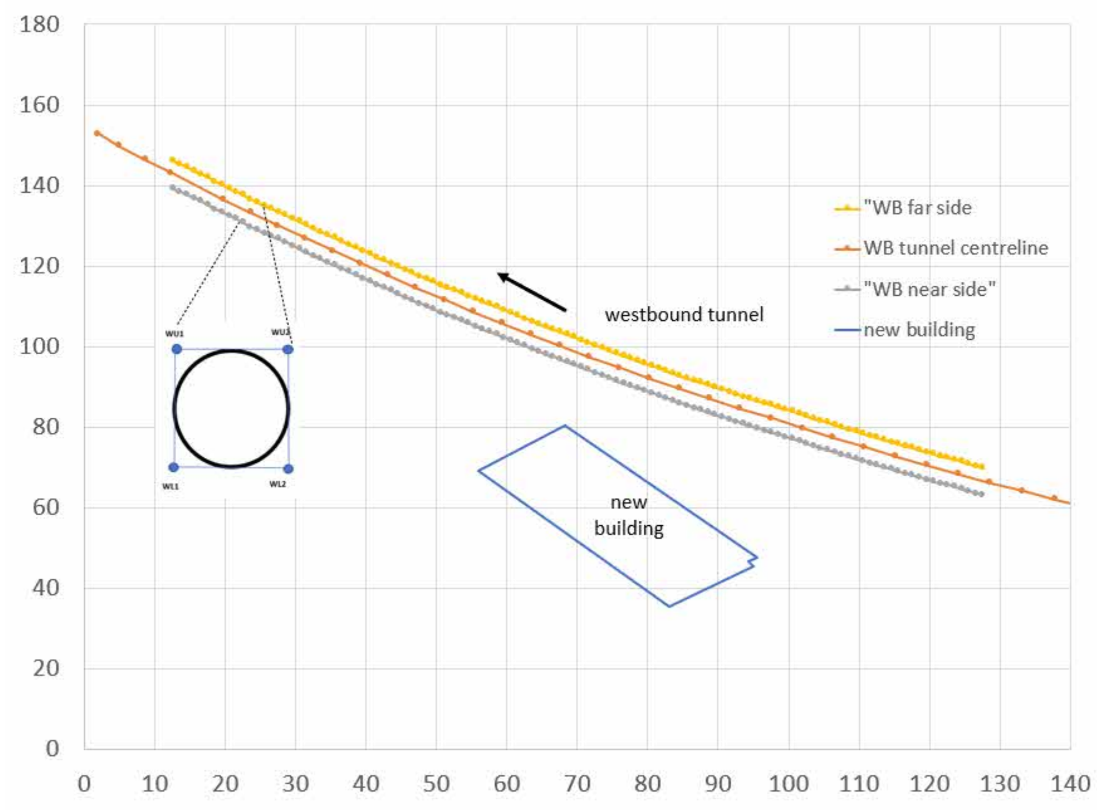


Figure 7: Model geometry

7.2.5 The PDISP programme uses Bousinesq stress distribution and elastic soil parameters. It is therefore possible to carry out analyses for different loading cases and sum the displacements.

7.2.6 Throughout this report, heave (upwards movement) is denoted as a negative value and settlement (downwards movement) is denoted as a positive value. PDISP uses the same sign convention. Figure 8 is a model geometry of points of displacements along the tunnel. Displacements at each of the 464 points were measured during the analyses.

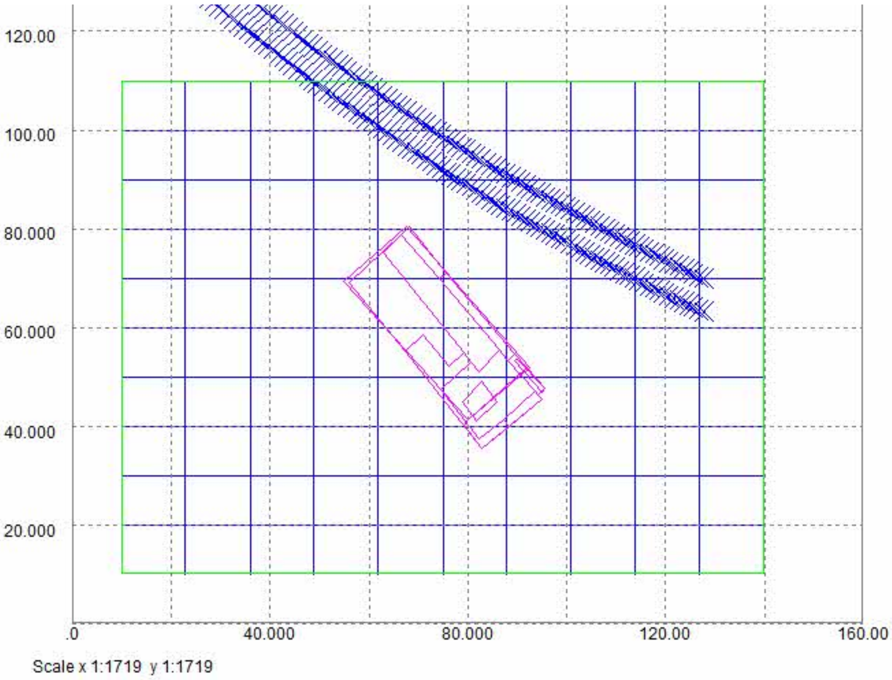


Figure 8: Modelling of settlement points along the running tunnels

7.3 CONSTRUCTION SEQUENCE

7.3.1 Modelling the construction sequence has been modelled in PDISP as a series of loading cases given below. The cases provide the load conditions likely to give the maximum heave or settlement movements at the tunnels during and after the construction phase.

7.3.1.1 Case 1 Existing Loading

i. Application of 90 kN/m^2 surcharge to simulate existing building on site.

7.3.1.2 Case 2 Demolition and construction of piling platform - undrained condition

i. Application of -23.56 kN/m^2 surcharge to simulate demolition and construction of pile platform.

ii. Application of -95.95 kN/m^2 surcharge to simulate excavation for basement extension to the east.

7.3.1.3 Case 3 Construction stage - undrained condition

i. Application of -23.56 kN/m^2 surcharge to simulate demolition and construction of pile platform.

ii. Application of -95.95 kN/m^2 surcharge to simulate excavation for basement extension to the east.

iii. Construction of the new building (application of raft design loads)

7.3.1.4 Case 4 Long-term - drained condition (drained parameters)

i. Application of -23.56 kN/m^2 surcharge to simulate demolition and construction of pile platform.

ii. Application of -95.95 kN/m^2 surcharge to simulate excavation for basement extension to the east.

iii. Construction of the new building (application of raft design loads)

7.3.2 Results from PDISP analyses for the three stages analysed are presented in this section. Both the loading regime and the resultant displacements are provided. The displacements are presented in shaded format around the site to visually show the extent of the displacement beyond the site.

SECTION 8 ASSESSMENT APPROACH

8.1 The effect of the induced ground movements on the existing tunnel structures was assessed by considering the following at the three stages of construction:

i. Calculation of the change in tunnel radius of curvature.

ii. Calculation of ovalling (or squatting) induced.

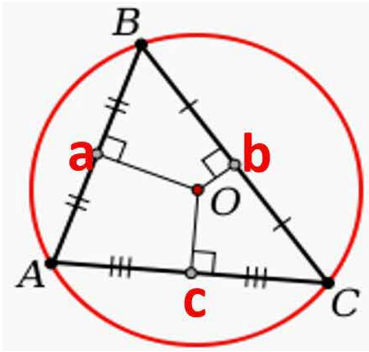
8.2 RADIUS OF CURVATURE

8.2.1 The following formula has been used to calculate the imposed radius of tunnel curvature based on the ground movements calculated in the PDISP ground movement model:

i. The diameter of the circumcircle can be computed as the length of any side of the triangle, divided by the sine of the opposite angle. (As a consequence of the law of sines, it does not matter which side is taken: the results will be the same.)

ii. The triangle's nine-point circle has half the diameter of the circumcircle. The diameter of the circumcircle of the triangle ∆ABC is given below.

$$\begin{aligned}\text{diameter} &= \frac{abc}{2\cdot\text{area}} = \frac{|AB||BC||CA|}{2|\Delta ABC|}\\ &= \frac{abc}{2\sqrt{s(s-a)(s-b)(s-c)}}\\ &= \frac{2abc}{\sqrt{(a+b+c)(-a+b+c)(a-b+c)(a+b-c)}}\end{aligned}$$



Where a, b, c = the lengths of the side of the triangle

s = (a + b + c)/2 is the semi-perimeter

8.3 **OVALLING (OR SQUATTING)**

8.3.1 Calculation of ovalling (or squatting) induced in the tunnel is the difference between the movement of the crown (top) of tunnel and invert (bottom) of the tunnel.

8.3.2 In this analysis positions EU1, EU2 (eastbound) and WU1, WU2 (westbound) are at crown level and positions EL1, EL2 (eastbound) and WL1, WL2 (westbound) are at invert level.

SECTION 9 PDISP RESULTS – VERTICAL DISPLACEMENTS

9.1 **GENERAL**

9.1.1 Results of PDSIP analyses are presented below according to the construction stages modelled. PDISP input data is presented in Appendix 3.

9.1.2 The load cases considered are as follows:

i. Existing loading (Case 1-Drained)

ii. Demolition of existing building (Case 2 – Undrained)

iii. Redevelopment (Case 3-undrained)

iv. Long term (Case 4-Drained)

9.2 **EXISTING LOADING (CASE1-DRAINED)**

9.2.1 The existing building load is 90 kN/m^2 and is applied at the raft level of +5.3 m OD.

9.2.2 The vertical displacements at the top of the running tunnel are given in figure 8. The displacements range from 0 mm to +2 mm.

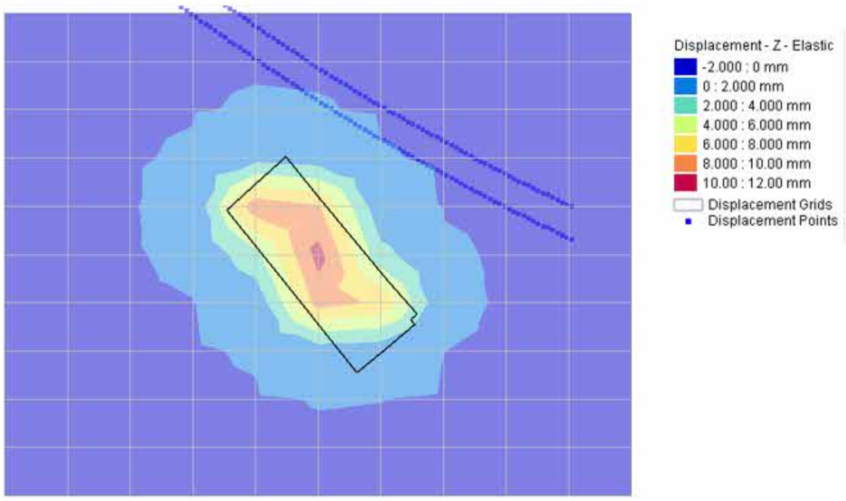


Figure 8 Existing building – vertical displacements along the running tunnel

9.2.3 Vertical displacements of the crown and invert of the running tunnel are given in figure 9.

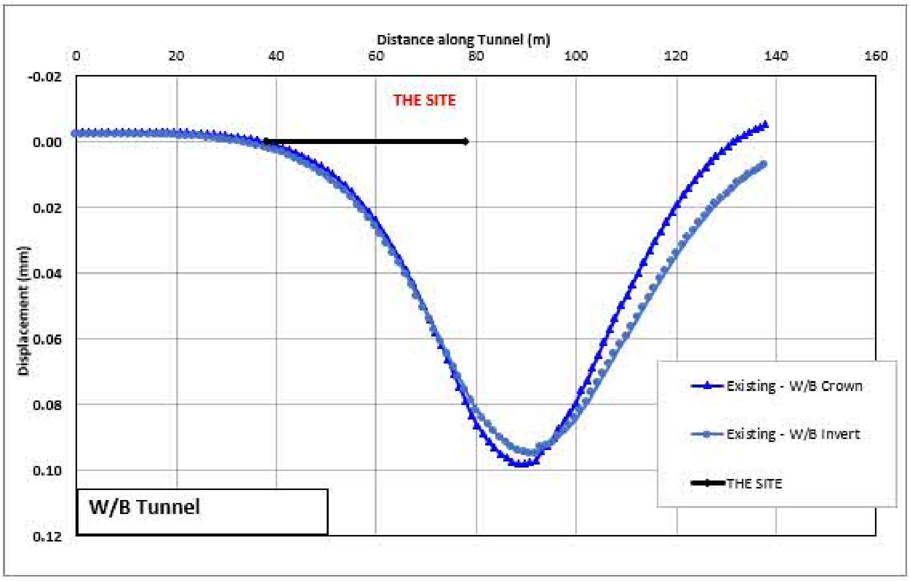


Figure 9 Existing loading – Crown and invert vertical displacements of running tunnel

9.3 DEMOLITION OF EXISTING BUILDING (CASE 2 – UNDRAINED)

9.3.1 Demolition of the existing building will result in stress unloading. The loads applied in this case are as follows:

i. Load due to demolition of existing building is -23.56 kN/m^2

ii. Load due to basement extension is -95.95 kN/m^2

9.3.2 The incremental vertical displacements at the top of the running tunnel are given in figure 10. The displacements range from -0.4 mm to 2 mm.

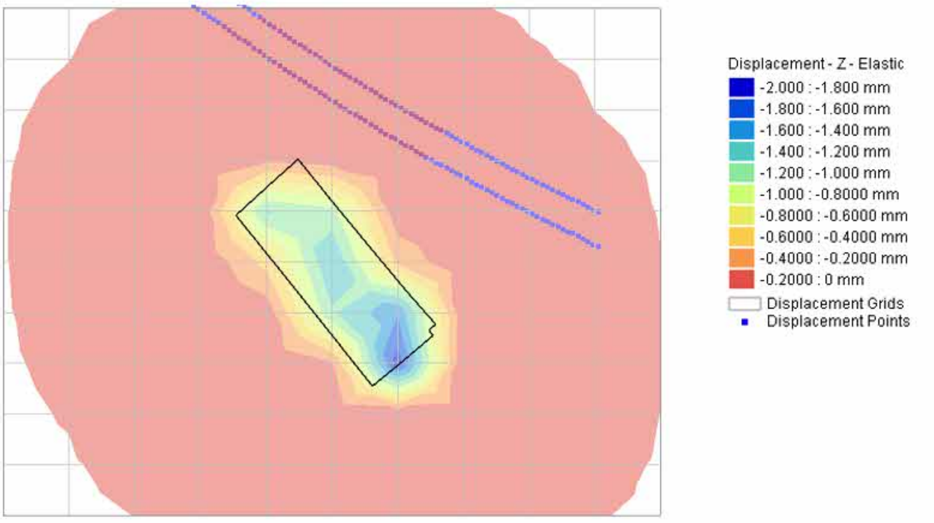


Figure 10 Demolition of existing building and basement exaction – vertical displacements along running tunnel

9.3.3 Vertical displacements of the crown and invert of the running tunnel are given in figure 11.

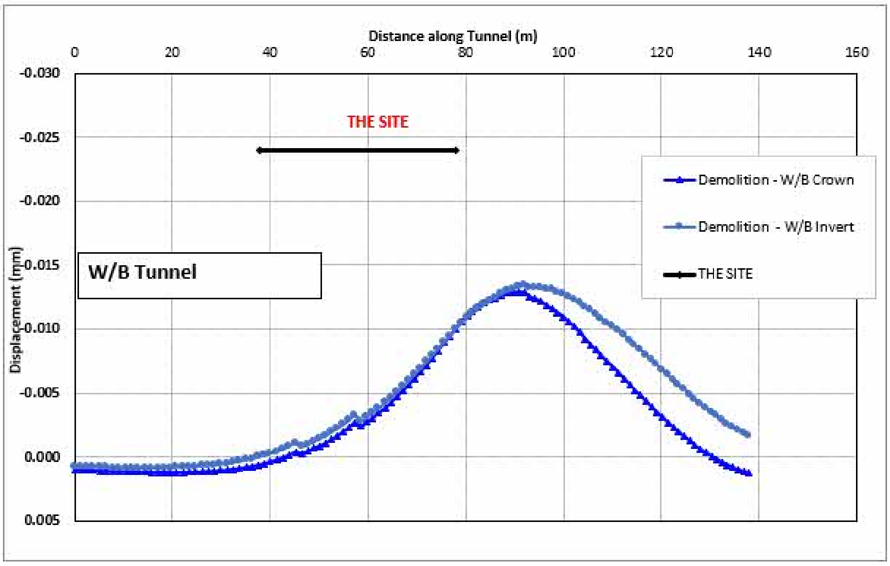


Figure 11 Demolition of existing building and basement exaction – cumulative vertical displacements of running tunnel

9.4 REDEVELOPMENT (CASE 3 – UNDRAINED)

9.4.1 The loads applied due to construction of the new building are given in Figure 5.

9.4.2 The incremental vertical displacements at the top of the running tunnel are given in Figure 12. The displacements range from 0 mm to +5 mm.

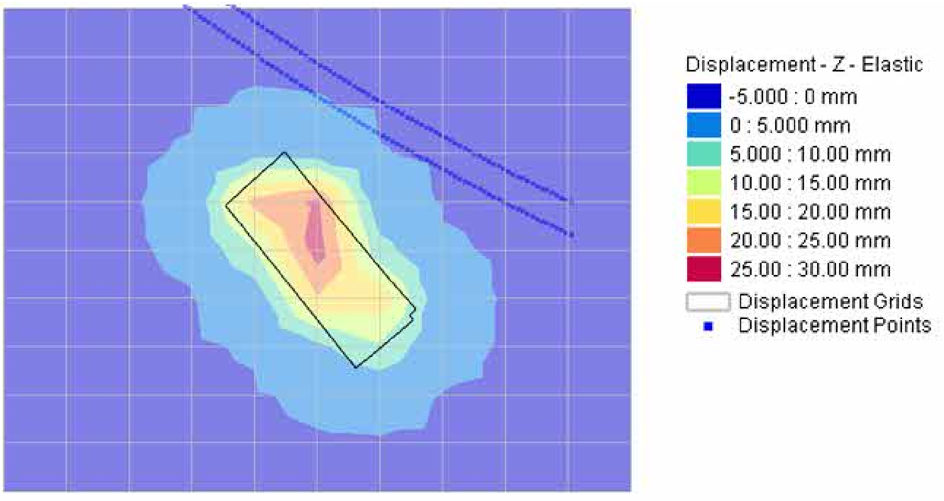


Figure 12 Redevelopment – incremental vertical displacements along running tunnel

9.4.3 The cumulative vertical displacements (case 2 + case 3) of the crown and invert of the running tunnel are given in Figure 13.

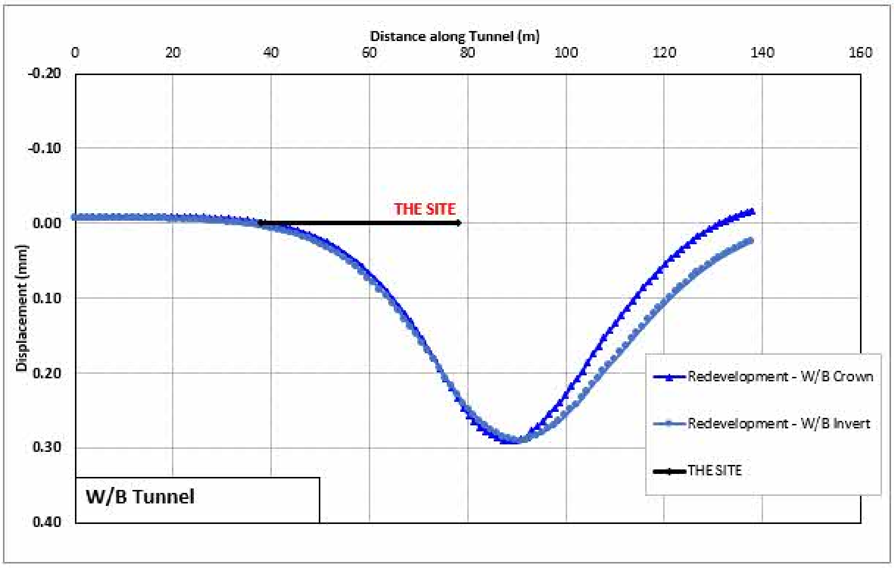


Figure 13 Redevelopment – cumulative vertical displacements of running tunnel

9.5 LONG TERM (CASE 4 – DRAINED)

9.5.1 In case 4 the vertical loads are the same as in case 3 but with drained parameters for cohesive soils.

9.5.2 The incremental vertical displacements at the top of the running tunnel are given in Figure 14. The displacements range from 0 mm to +5.0 mm.

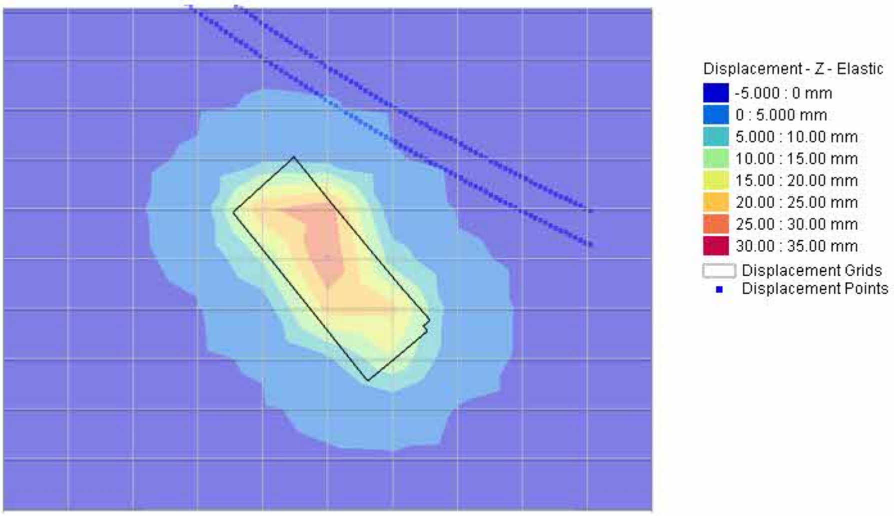


Figure 14 Redevelopment – incremental vertical displacements

9.5.3 The cumulative vertical displacements of the crown and invert of the running tunnel are given in Figure 15.

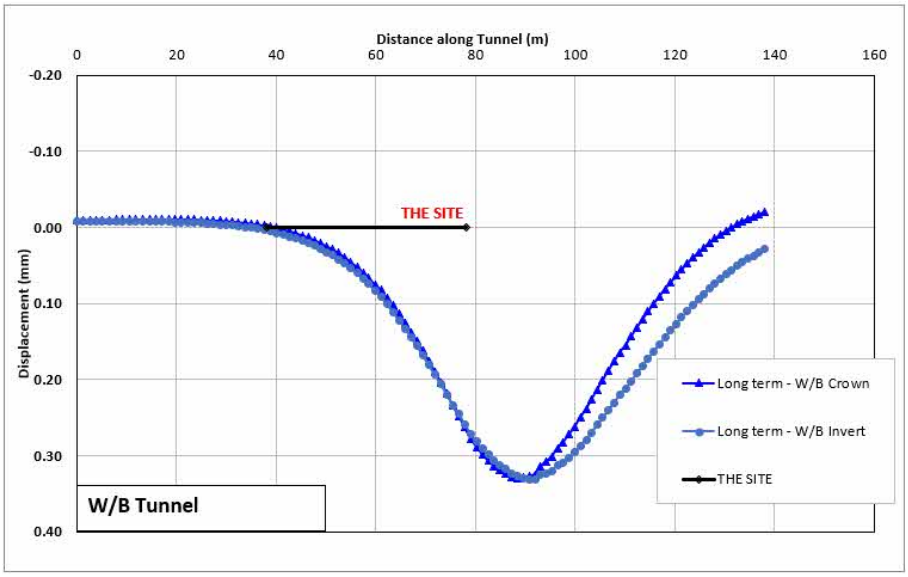


Figure 15 Redevelopment – cumulative vertical displacements of running tunnel

9.6 SUMMARY OF TUNNEL DISPLACEMENTS

9.6.1 A summary of the calculated vertical displacements is given in Table 6.

Table 6: Maximum cumulative vertical displacement

Stage details	Maximum settlement of Westbound tunnel (mm)	
	Crown	Invert
Current Loading (Drained)	0.10	0.10
Demolition – minimum unloading (Undrained)	0	0
Loading – Maximum building load (Undrained)	0.29	0.29
Loading – Maximum building load (Drained)	0.33	0.33

9.6.2 The maximum displacement is 0.33 mm during long term and the maximum slope is about 1:102000 also at long-term condition.

SECTION 10 TUNNEL ASSESSMENT

10.1 LONGITUDINAL SESSEMENT – RADIUS OF CURVATURE

10.1.1 Radius of curvature represents the deformation of the tunnel since it was constructed. The higher the calculated radius of curvature is, the lower the impact of the tunnel.

10.1.2 The allowable (limiting) radius (R'_{lim}) of longitudinal bending of the tunnel in compression was calculated from the following two equations:

i. $R'_{lim} = E \times I / M$ and $M = \sigma \times I / y$

ii. Hence $R'_{lim} = E \times y / \sigma$

Where E = Young's modulus of steel = 100 GN/m^2

I = moment of inertia

M = moment

σ = permissible compressive strength

y = lever arm (radius of tunnel) = 3.1 m

10.1.2 According to LU Standard S 1055 A5, Deep Tube Tunnels and Shafts:

i. Permissible compressive strength (σ) = 150 N/mm^2 – Grade 10 cast iron lining

ii. Young's modulus of steel (E) = 100 GPa

10.1.2 Therefore, the limiting or allowable radius of curvature, **R'_{lim} = 2.1 km**

10.1.3 The calculated radius of curvature of the crown for the running tunnel are given in Figure 16.

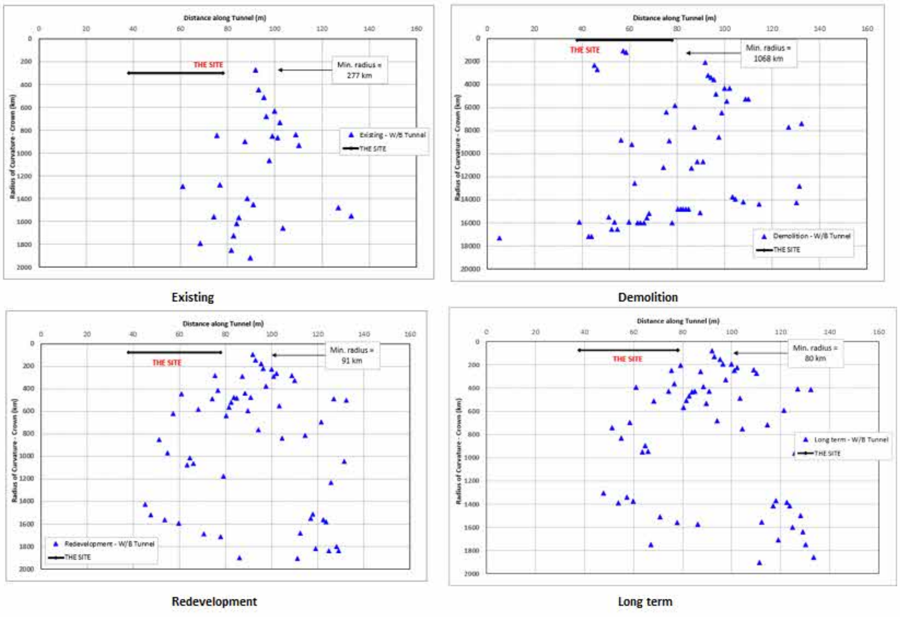


Figure 16 Radius of curvature

10.1.4 The minimum radius of curvature is 80 km (long term), and is greater that the assessed allowable value of 2.1 km.

10.1.5 Therefore, the bending of the tunnel resulting from the proposed development is acceptable for the westbound Elizabeth lining running tunnel.

10.2 RADIAL ASSESSMENT – SQUAT / OVALISATION

10.2.1 Squat or ovalisation of the change in shape of the tunnel measures in terms of the difference in vertical movement between the crown and the invert of the tunnel.

10.2.2 The calculated squat/ovalisation of the running tunnels is shown in figure 17.

10.2.3 The maximum squat is 0.1 mm and maximum ovalisation of -0.45 mm for the westbound tunnel.

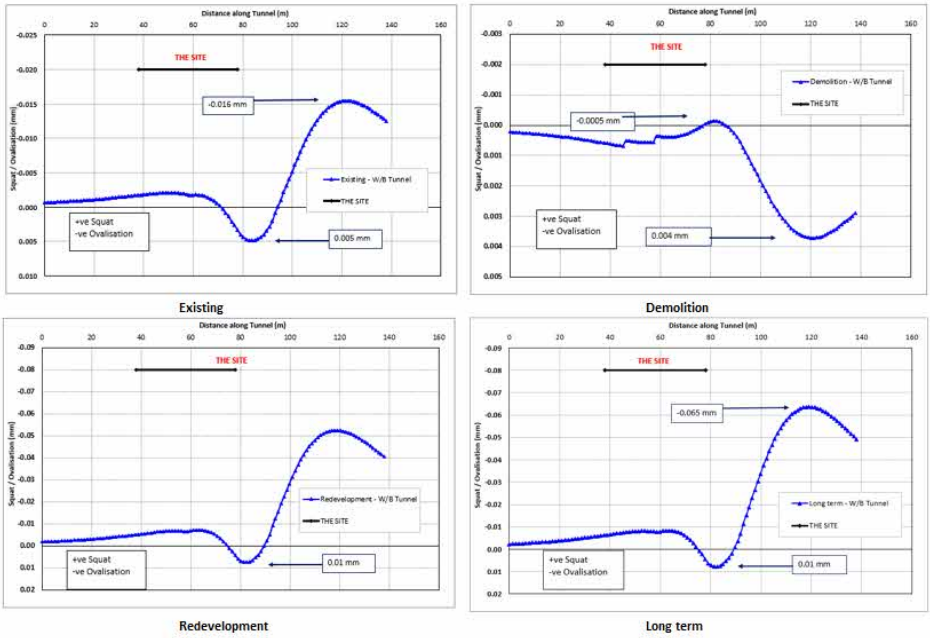


Figure 17 Squat / ovalisation of the running tunnels

10.2.4 The additional squat / ovalisation due to the proposed redevelopment is less than 0.001 % of the tunnel diameter. Therefore, the proposed redevelopment will have minimal effect on the Elizabeth line running tunnels.

10.3 TRACK ASSESSMENT

10.3.1 General

10.3.1.1 The deformation of the tunnels should not adversely affect the safety of passengers, vehicles, or the track itself.

10.3.1.2 According to the LU Engineering Standard S1159, the following are the key parameters of concern:

i. Vertical profile (long undulations – 5m intervals): Maximum deviation measured at 5m intervals.

ii. Vertical profile (short undulation – 1 m straightedge): Maximum permitted vertical error in the rail suing 2 m long straightedge.

iii. Cross Level (cant): Maximum permitted deviation from marked cant averaged over 5 slippers.

iv. Twist 2 metre base (cross level variation): The maximum values of twist on a 2 m base.

v. Twist 10 metre twist (cross level variation), concrete track: The maximum values of the twist on a 10 m base.

10.3.1.3 The maintenance requirements for Track Category A and Category B values are more onerous, and these are given in Table 2 in Section 4.3.

10.3.2 Vertical profile

10.3.2.1 Vertical profile - long undulation

i. The vertical profiles of the track at 5 m intervals (long undulation) are given in figure 18. The values are within the Maintenance Target (MT) value of 5 mm.

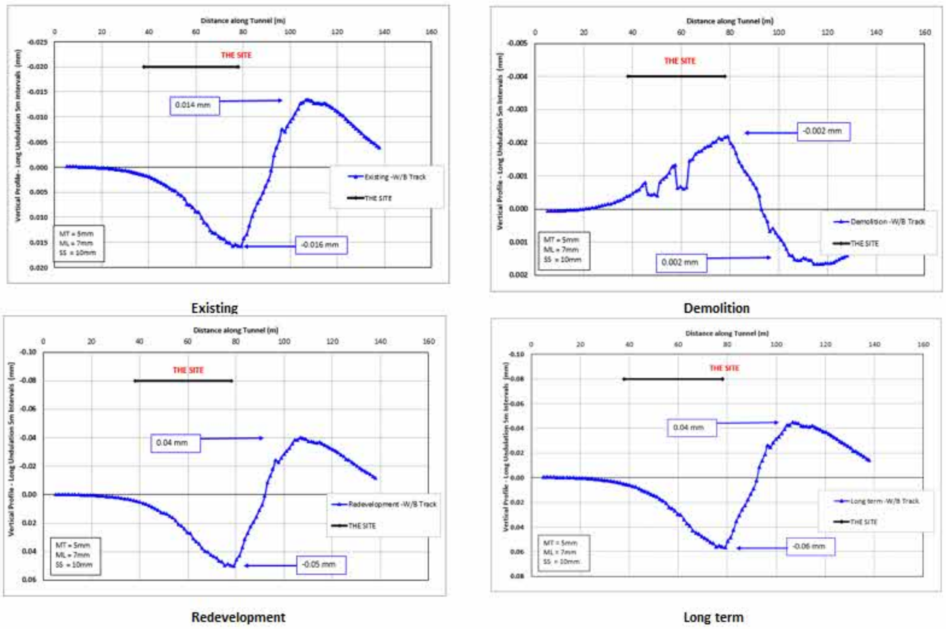


Figure 18 Vertical profile – Long undulation 5 m intervals

10.3.2.2 Vertical profile - 1 m straight edge

i. The vertical profiles of the track at 1 m straight edge (short undulation) are given in figure 19. The values are within the Maintenance Target (MT) value of 2 mm.

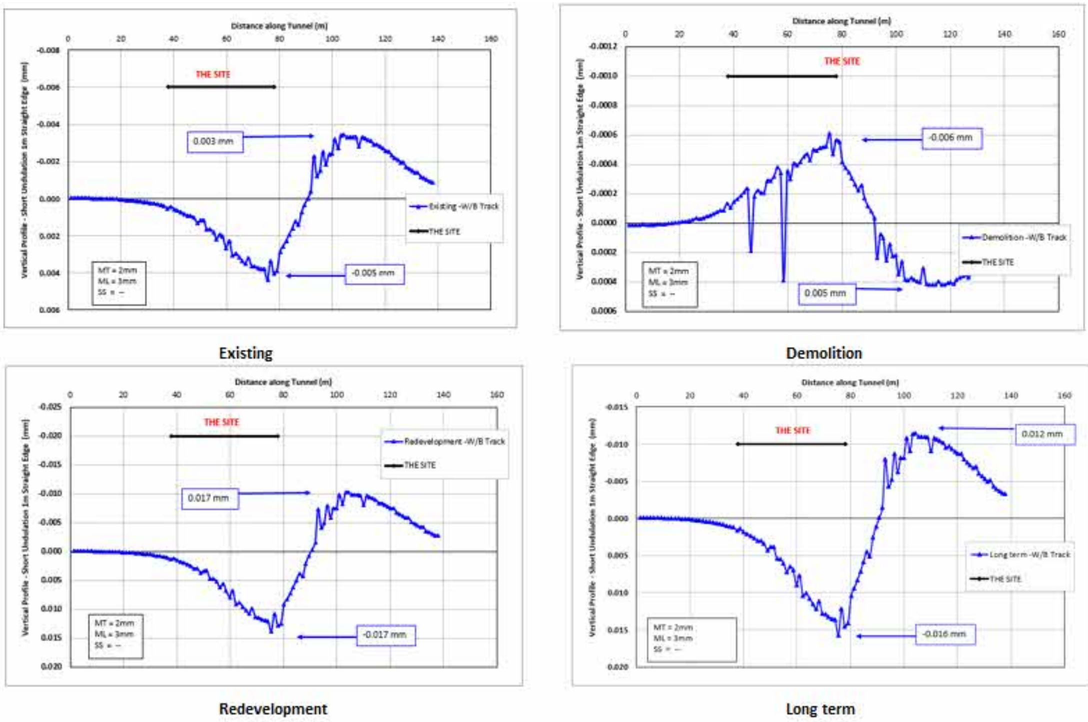


Figure 19 Vertical profile – Short undulation (1 m straight edge)

10.3.3 Cross Level (Cant)

10.3.3.1 The cross level (cant) averaged over 5 sleepers is given in Figure 20. The values are within the Maintenance Target (MT) value of -15/+10 mm.

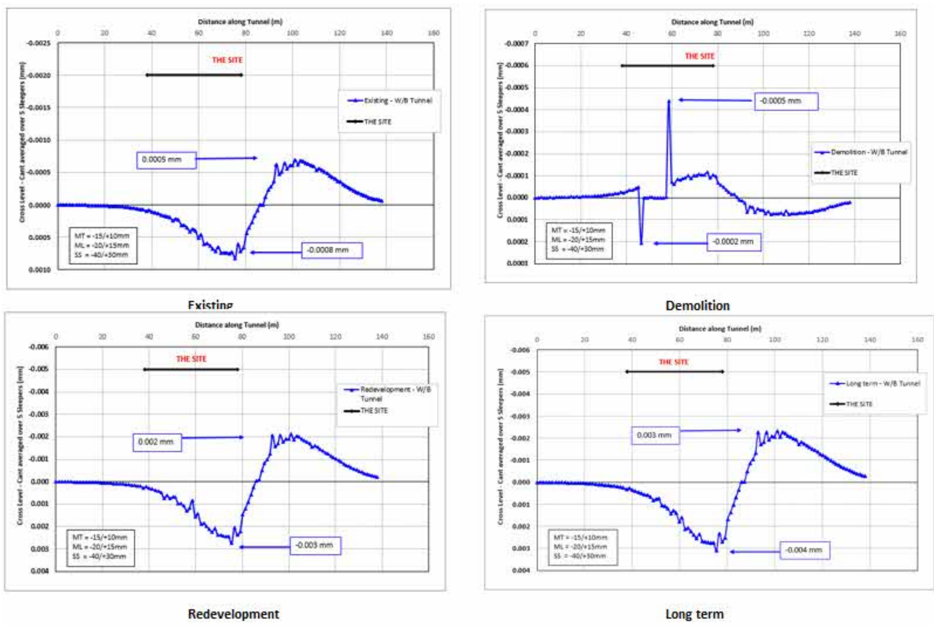


Figure 20 cross level (cant) averaged over 5 sleepers

10.3.4 Twist

10.3.4.1 Twist 2 metre base cross level variation (mm) *i.* The Twist 2 metre base is given in figure 21. The values are within the Maintenance Target (MT) value of 12 mm.

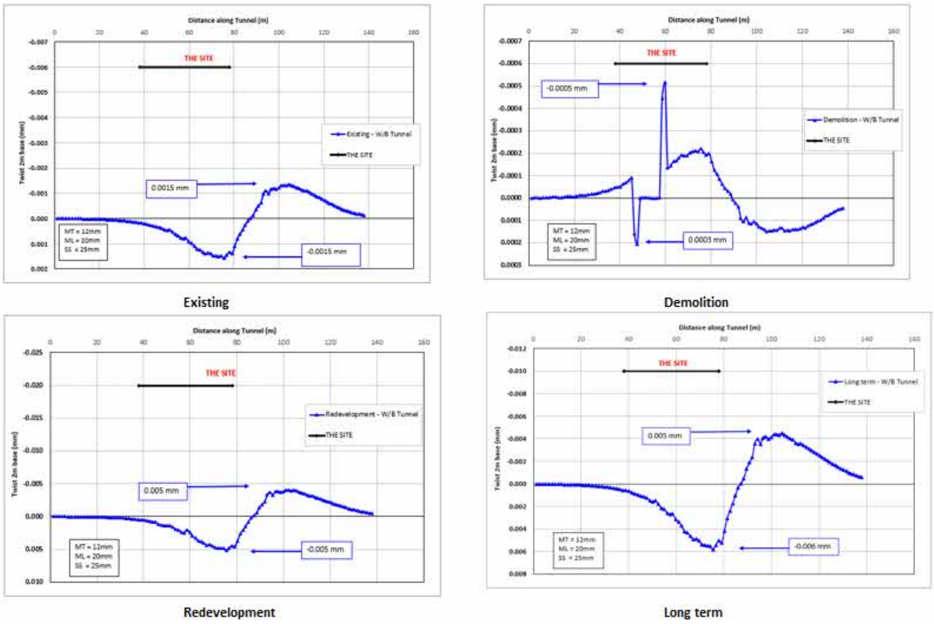


Figure 21 Twist 2 metre base cross level variation (mm)

10.3.4.2 Twist 10 metre concrete track base – cross level

i. The Twist 10 metre concrete track base is given in Figure 22. These are within the Maintenance Target (MT) value of 35 mm.

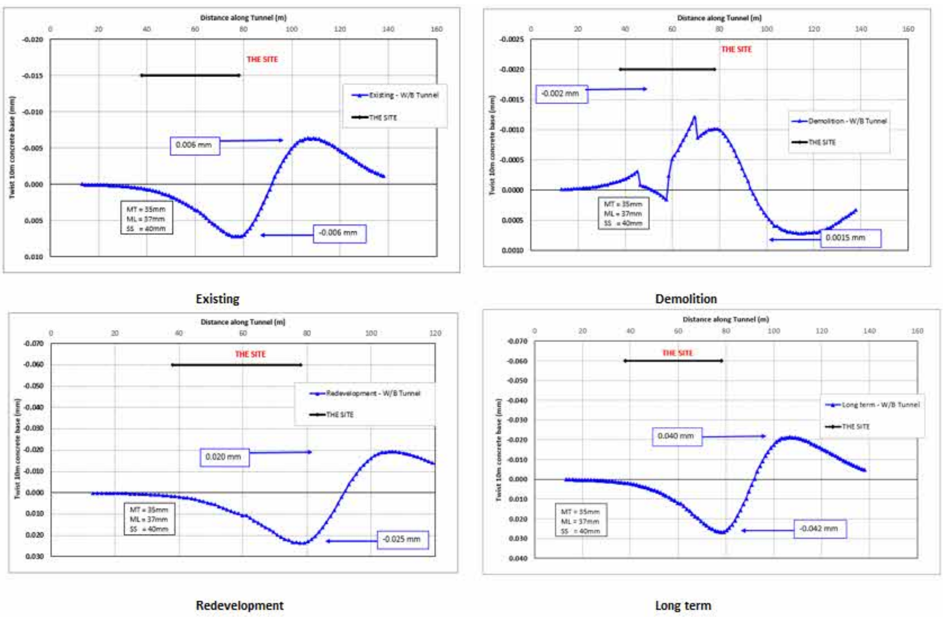


Figure 22 Twist 10 metre concrete track base – cross level

10.4 SUMMARY OF TUNNEL ASSESSMENT

10.4.1 A summary of the tunnel assessment results is given in Table 7.

Table 7: Summary of the Tunnel Assessment

Parameter		Limit/Target	Value	Stage
Longitudinal assessment – radius of curvature (km)		2.1[1]	81	Long term
Radial assessment – squat / ovalisation (%)		-	0.001	Long term
Track assessment	Vertical profile – long undulation at 5 m intervals (mm)	5[2]	0.04	Redevelopment
	Vertical profile - short undulations at 1m intervals (mm)	2[2]	0.017	Long term
	Cross level (cant) – Maximum permitted deviation from marked cant averaged over 5 m sleepers (mm)	-15/+10[2]	0.004	Long term & Redevelopment
	Twist 2 metre base - cross lever variation (mm)	12[2]	0.005	Long term
	Twist 10 metre base - cross level variation (mm)	35[2]	0.020	Long term
	Note [1] Calculated allowable [2] Maintenance Target [MT] adopted as most onerous			

10.4.2 As shown from sections 10.3.2 to section 10.3.4 and summarised in Table 7, the calculated deformations of the tunnels are not likely to adversely affect the safety of the passengers, vehicles, or the track itself.

10.4 **TUNNEL LEAKAGE DUE TO LONGITIDUAL BENDING**

10.4.1 The permissible stresses for gey cast iron and wrought bolts given in LU Standard S 1055 are summarised in Table 7.

Table 7: Material properties – grey cast iron linings and wrought iron

Property	Value – Grade 10 Cast Iron
Cast iron permissible bending tensile strength (N/mm^2)	38
Cast iron permissible compressive strength (N/mm^2)	150
Cast iron permissible shear strength (N/mm^2)	44
Cast iron Young's modulus (N/mm^2)	100000
Cast iron Poisson's ratio	0.26
Wrought iron bolt ultimate tensile strength (N/mm^2)	342
Wrought iron bolt ultimate shear strength (N/mm^2)	137
Wrought iron bolt permissible tensile strength (N/mm^2)	114
Wrought iron bolt permissible shear strength (N/mm^2)	46

10.4.2 To review the structural impact of the redevelopment on the tunnels, the leakage potential cause by the longitudinal bending was considered. For the 101 km minimum radius of curvature, the theoretical width of the crack was calculated as follows:

i. Small crack width, $\delta = L \times D / R$

Where

L = segment length = 0.508 m

D = tunnel diameter = 3.2 m

R = radius of curvature = 80 km

10.4.2.2 The estimated crack width (opening of compressed segment joint) is 0.020 mm.

10.4.3 Therefore, leakage at joints is not expected to increase.

SECTION 11 FUTURE WORKS

11.1 CONDITION SURVEYS

11.1.1 A pre- and post-condition survey is recommended to record the condition of the tunnels prior to demolition and to record any change of the condition following the demotion and construction works.

11.1.2 The survey will confirm the condition of the tunnels and allow comparison to be made with the LU Principal Inspection records.

11.1.3 Either a conventional condition survey or a 360-degree camera is proposed to be undertaken to note defects per ring number in accordance with LU Standards S 1055

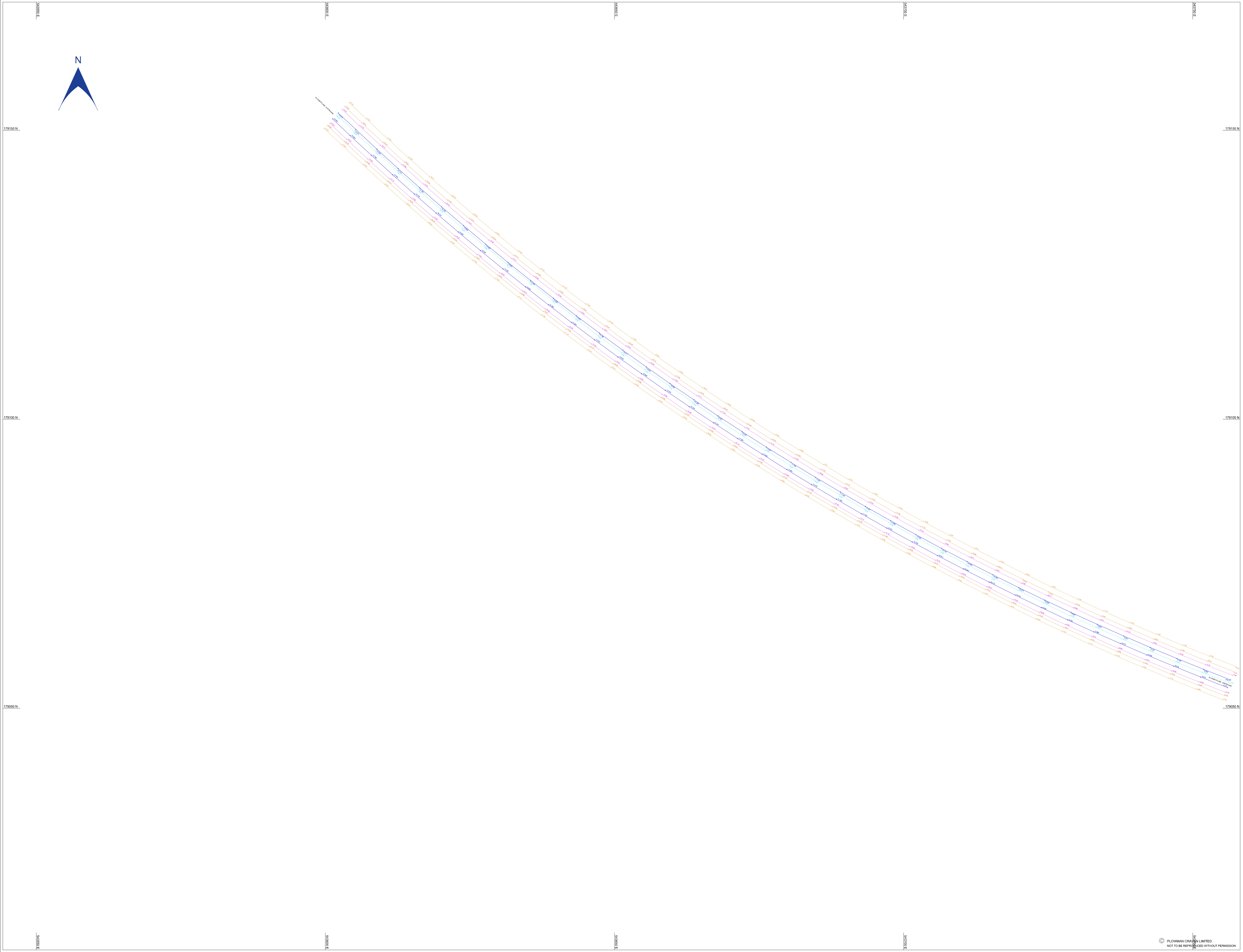
11.2 MONITORING

11.2.1 The magnitude of the estimated displacements has minimal risk to LU assets. Therefore, it is not recommended to undertake movement or vibration monitoring along the tunnels during the demolition or construction of the Beresford development.

APPENDIX 1 Project Drawings

IDOM Cromford Mills, Mill Lane, Matlock, Derbyshire DE4 3RQ
t: +44(0)1773 829 988 e: info.derbyshire@idom.com

Client/Project	Map Title	Job no.	Drawing No.	Revision
81 - 88 Beresford Street Hurlington Capital Ltd	Site Locaon Plan	22277	2277-001-001	-
		Scale	Date 17/07/2023	Frame dimensions A3
		Drawn CMM	Checked SE	Approved SE



STANDARD ABBREVIATIONS

A/C	Air Conditioner	LB	Litter Bin
ATM	Automated Telling Machine	LP	Lamp Post
B	Bollard	Max	Maximum
BB	Belisha Beacon	Mb	Multibole
Bh	Borehole	MH	Manhole
Br	Brick	Min	Minimum
BrS	Brick Setts	Mkr	Marker
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BS	Bus Stop	NP	Name Plate
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CBF	Close Boarded Fence	P	Post
CCTV	Closed Circuit Television	PB	Pillar Box
CIF	Corrugated Iron Fence	PGM	Permanent Ground Marker
CL	Cover Level	PLt	Pavement Light
CLF	Chain Link Fence	TM	Parking Meter
Col	Column	PRF	Post and Rail Fence
Conc	Concrete	PS	Paving Stones
CoW	Cable on Wall	PWF	Post and Wire Fence
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DrC	Drainage Channel	SB	Sign Board
EIC	Electrical Inspection Cover	SBM	Site Bench Mark
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FL	Floor Level	SV	Stop Valve
Flt	Floodlight	T	Telephone
g	girth	Tac	Tactile Paving
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GM	Gas Meter	TCP	Traffic Control Post
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IRF	Iron Railing Fence	Typ	Typical
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JB	Junction Box	VP	Vent Pipe
KO	Kerb Outlet	W	Window
L	Light	WM	Water Meter
		WV	Water Valve

LEGEND

22.70	Ceiling level
F22.70	False ceiling level
	Stair/step arrows point up
	Sloping ceiling arrows point up
	Roof arrows point down
	Assumed detail

The identification of service covers has been made by a surface inspection only - critical identifications should be verified by the lifting of covers or a full utilities survey

Due to the inherent instability of paper materials, drawings plotted on paper may be stretched and distorted - dimensions scaled from paper plots should therefore be treated with caution

SHEET LAYOUT

01

STATUS CODE & REVISIONS

Stat	Rev	Details	Checked 1st	Checked 2nd	Date
S3	P01	First Issue - QA approval required	CT	GC	23/10/23

This survey is commensurate with band E accuracy, as outlined in the RICS survey detail accuracy banding table

All levels are in metres and are above Ordnance Survey Newlyn Datum derived by multiple network RTK GPS observations

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Unless otherwise stated, levels have been taken to finished floor surface

All quoted dimensions are in metres

Drawing units are metres

CLIENT

B Woolwich Limited

c/o Hurlington Capital
33 Foley Street
London
W1W

PROJECT TITLE

Beresford Street

Woolwich

3D Correlation Survey

PRESENTATION SCALE 1:200 @ A0

DATE OF ORIGINAL SURVEY October 2023

PC PROJECT No. 48537

DRAWING No.

48537-PCL-TO-ZZ-M3-Y-00001-S3-P01-01

Plowman Craven

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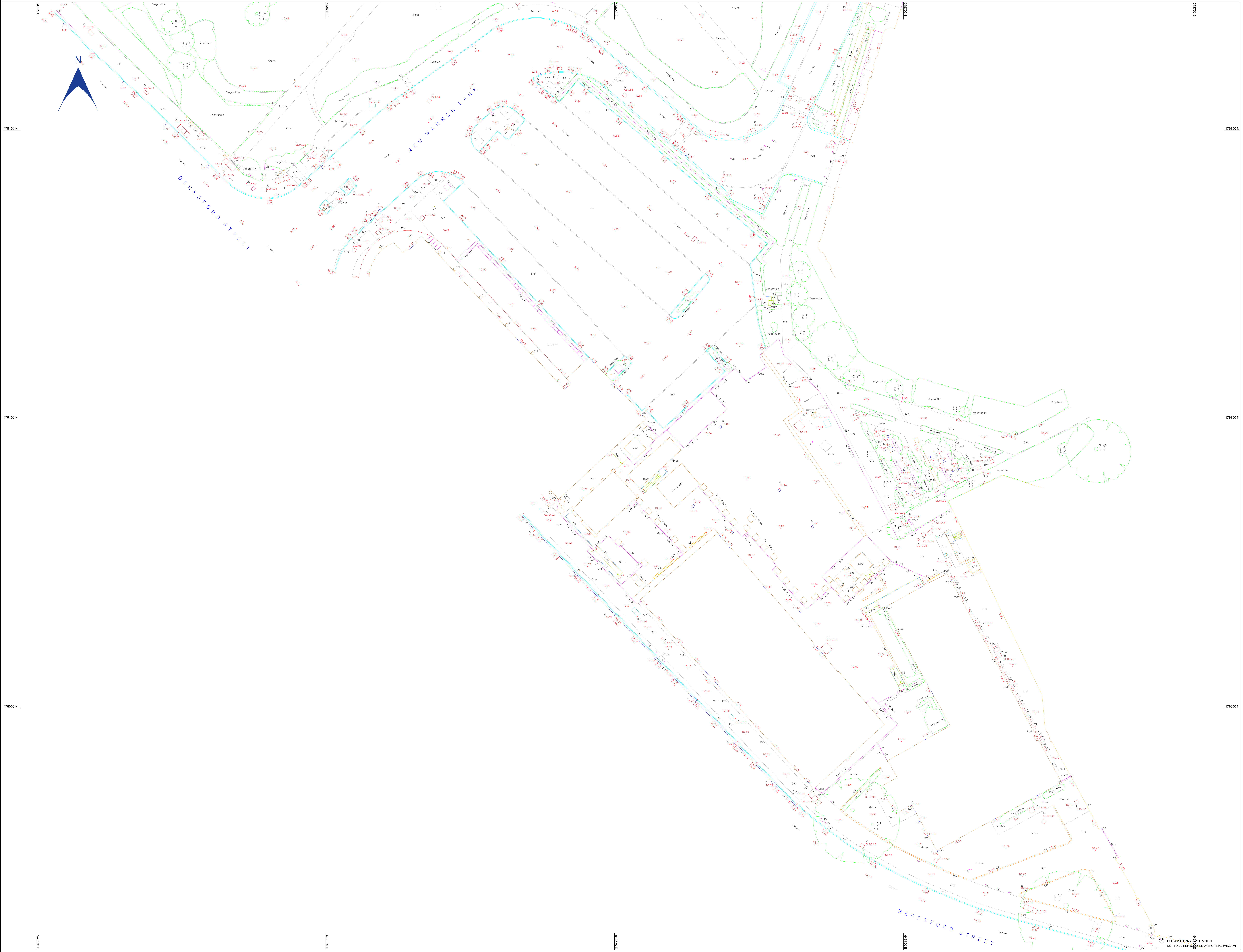

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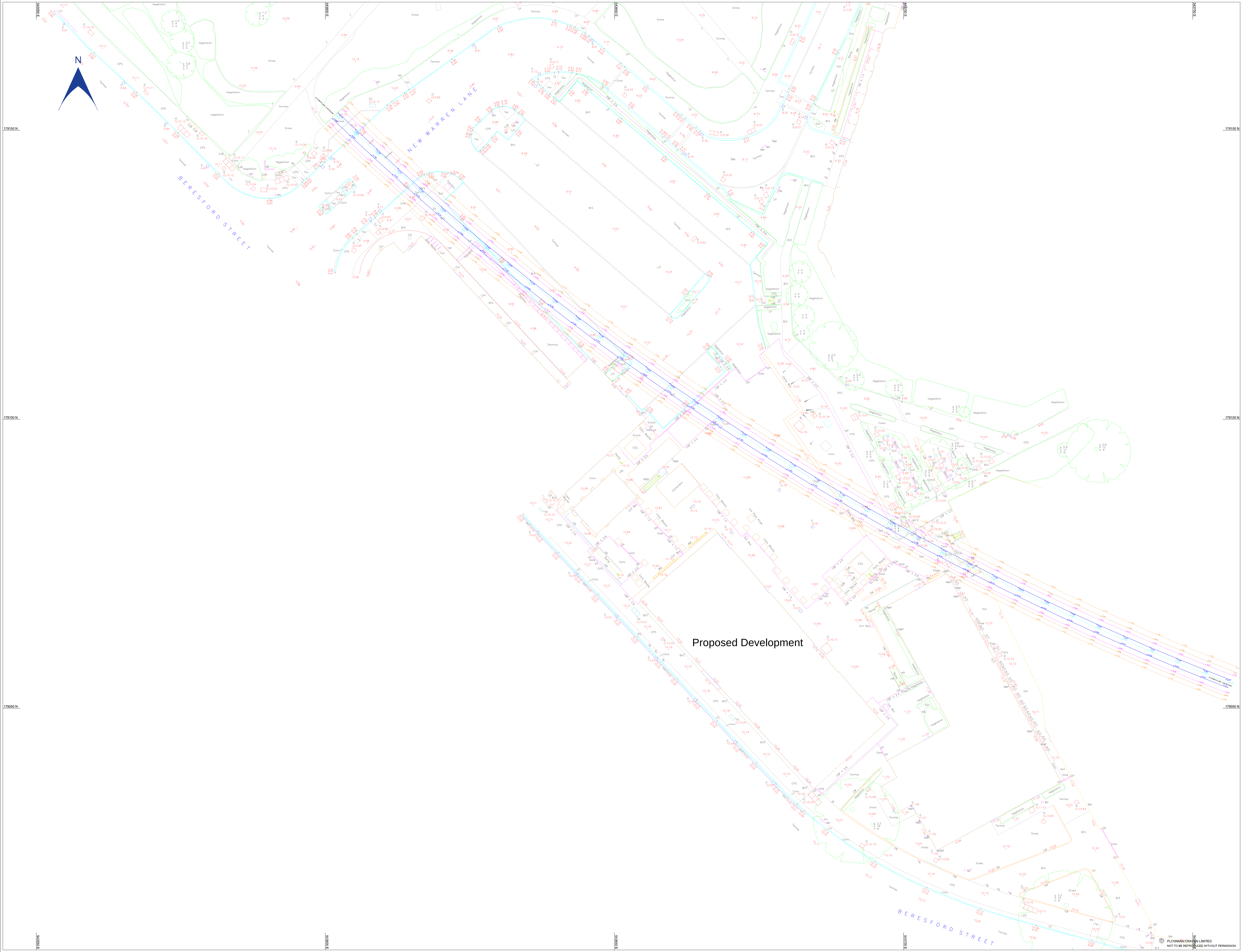

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This drawing has been produced for the purpose of the original commissioning agent. Plowman Craven Limited will accept no responsibility for details that are subsequently found to be the consequence of undisclosed facts or that were obscured from view at the time of survey or that have been altered since the survey.

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Woolwich

3D Topographical Survey

PRESENTATION SCALE: 1:200 @ A0

DATE OF ORIGINAL SURVEY: October 2023

PC PROJECT No. 48537

DRAWING No.

48537-PCL-TO-ZZ-M3-Y-00001-S3-P01-01

Plowman Craven

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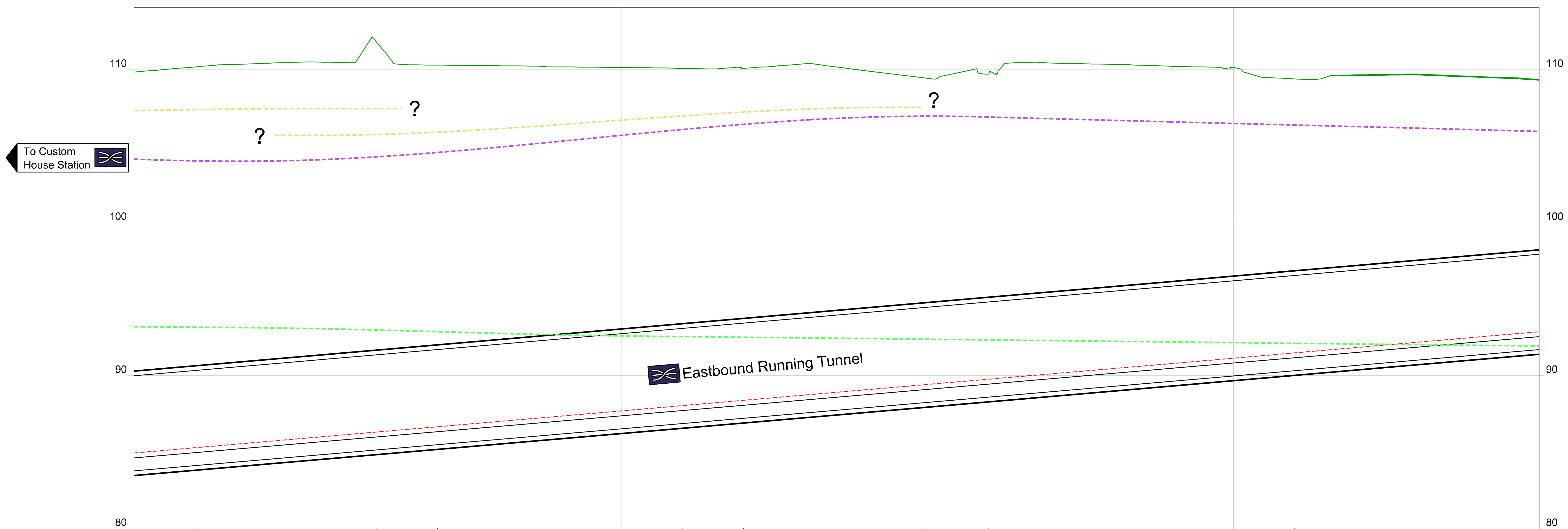
Tel: +44 (0)1582 765566
Tel: +44 (0)207 490 7700
Email: post@plowmancraven.co.uk
Web: www.plowmancraven.co.uk

APPENDIX 2 Crossrail Tunnel Details



Track Centreline Chainage(m)	SE 20730	SE 20740	SE 20750	SE 20760	SE 20770	SE 20780	SE 20790	SE 20800	SE 20810	SE 20820	SE 20830	SE 20840
Track Level (mATD)	85.239	85.585	85.931	86.276	86.622	86.968	87.313	87.659	88.004	88.350	88.696	89.041
Existing Ground Level (mATD)	110.131	110.356	110.464	111.792	110.264	110.223	110.148	110.109	110.049	110.036	110.349	109.892

Track Centreline Chainage(m)	SE 20850	SE 20860	SE 20870	SE 20880	SE 20890	SE 20900	SE 20910	SE 20920	SE 20930	SE 20940	[illegible]
Track Level (mATD)	89.387	89.733	90.078	90.424	90.769	91.115	91.461	91.806	92.152	92.498	[illegible]
Existing Ground Level (mATD)	109.405	109.666	110.396	110.316	110.187	110.107	109.368	109.596	109.651	109.493	[illegible]

Rev.	Date	Description	By	Chkd	App	Auth
P02	18/05/2010	Issued for Tender Purposes	JN	AC	RM	
P03	09/06/2010	---	AH	AC	RM	
P04	10/06/2010	---	AH	AC	PC	
P05	01/07/2010	Issued for RIBA E	GP	AC	RM	
P06	02/07/2010	Issued For RIBA E	AH	AC	RM	
P07	14/03/2011	Issued for OCI Submission	AH	AC	RM	
P08	21/09/2011	Issued for RIBA F	GP	JR	RM	
C01	07/10/2011	Issued as Fit for construction	GP	JR	RM	IT
P09	24/10/2012	Updated for Alignment U	SD	JR	RM	-
C02	26/10/2012	Issued as Fit for construction	SD	JR	RM	MA
P10	23/04/2020	Issued as ready for As-built	CD	MC	IA	-
C03	25/04/2020	Issued as As Built	CD	MC	IA	DC

Note

1. For Keyplan, Plan and Profile Legend,Obstruction Legend, Drawing sheet location and Notes refer to dgn: C122-OVE-C4-DDA-CR001_Z-21300.dgn

Safety Health and Environmental Information:

1. Notes below are additional to hazards and risks normally associated with this type of work:
Ci; Mixed face tunnelling between ~Ref Ch 90500 to 90800 and 90040 to 90240. Potential inability to maintain face pressure leading to excessive ground movement and in the worst case “sinkhole”and consequential injury/death to persons in situ. CDM Risk Register: C122-OVE-N3-LRG-CRG01-00002 DVH-LOC-007a.
2. See Designers CDM Risk Register Ref: Doc. No: C122-OVE-N3-LRG-CRG01-00002 for full hazard, risk and mitigation details for Tunnel Drive H.
3. These notes are based on experienced and competent contractors carrying out the works using an approved safe method of working.
4. For General Notes/General SHE Notes refer to drawing: C122-OVE-C4-DDJ-CR001_Z-22100.

Scale V =1:200
4m 0 4m 8m 12m 16m 20m
Scale H= 1:500
10m 0 10m 20m 30m 40m 50m

Crossrail Limited
5 Endeavour Square
Stratford
London
E20 1JN

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Contract : Bored Tunnels (Alignment and Track)

Originator : Ove Arup & Partners Limited

Location : Crossrail General

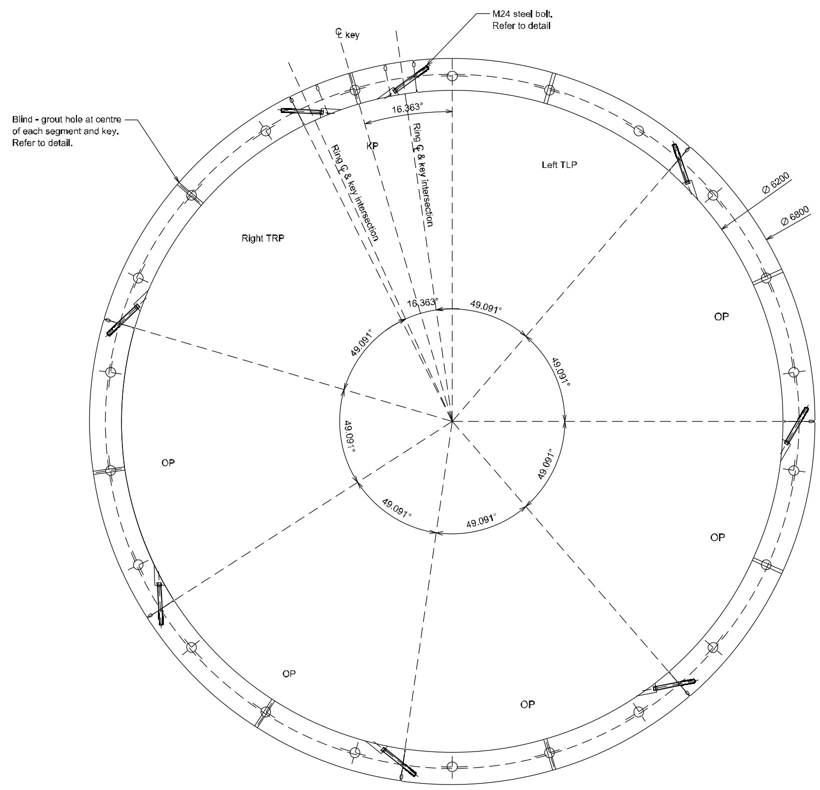
Title : Route Plan and Profile Eastbound Sheet 62 of 88 C310

By : C.DRIVER1
Chk : M.COLEMAN
App : I.AUSTIN
Auth : D.COUGHLAN

Scale : Various@ A1
Drawing and CAD file No : C122-OVE-C4-DDA-CR001_Z-21162
Rev : C03
Suitability : AB

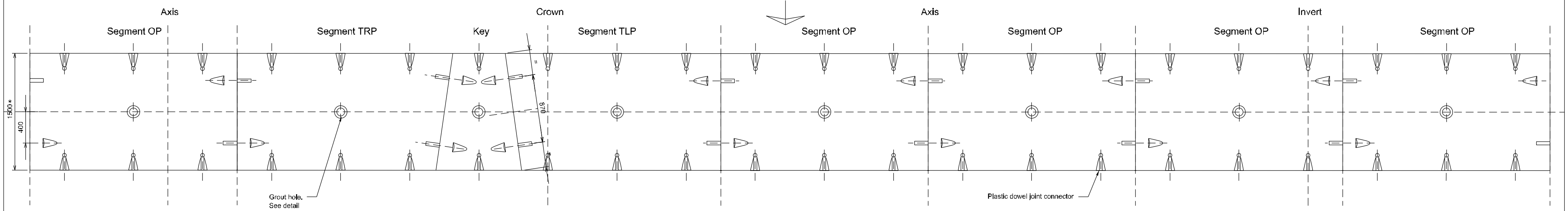
As Built

RESTRICTED



Typical parallel ring elevation on leading edge

Scale 1:25



Developed view on ring intrados

Scale 1:25

(* Nominal Length)

Rev.	Date	Description	By	Chkd	App	Auth
P01	10/09/2009	First Issue	DB	SD	PC	
P02	02/11/2009	Issued for Tender Purposes	DB	HM	PC	
P03	20/11/2009	Issued for Tender Purposes	DB	SD	RM	
P04	04/12/2009	Issued for Tender Purposes	DB	AS	PC	
P05	15/03/2010	Reissued for Tender Purposes	NL	AS	RM	
P06	28/04/2010	Reissued for Tender Addendum Purposes	NL	AS	RM	
P07	18/05/2010	Reissued for Tender Addendum Purposes	JC	SD	PC	

Notes

1. Parallel ring segments are used in conjunction with SGI opening set elements.
2. Three number segments type 'O' are replaced by SGI elements at interventions and cross passages.
3. Three number segments type 'O' are replaced by SGI elements at ventilation openings.
4. Circumferential joint plastic dowel connectors are replaced by cast in sockets to receive M24 bolt adjacent to SGI segments.
5. For SHE information relevant to all C300 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001-Z-20100.
6. For SHE information relevant to all C305 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001-Z-20200.
7. Other than the SHE content of the General Notes drawings cited, there are considered to be no specific significant health and safety hazards and issues are currently identified for construction works associated with this drawing other than those which a competent contractor will be readily aware.
8. For SHE information relevant to all C310 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001_Z-22100.

P07

Crossrail

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Canary Wharf
London
E14 5LQ

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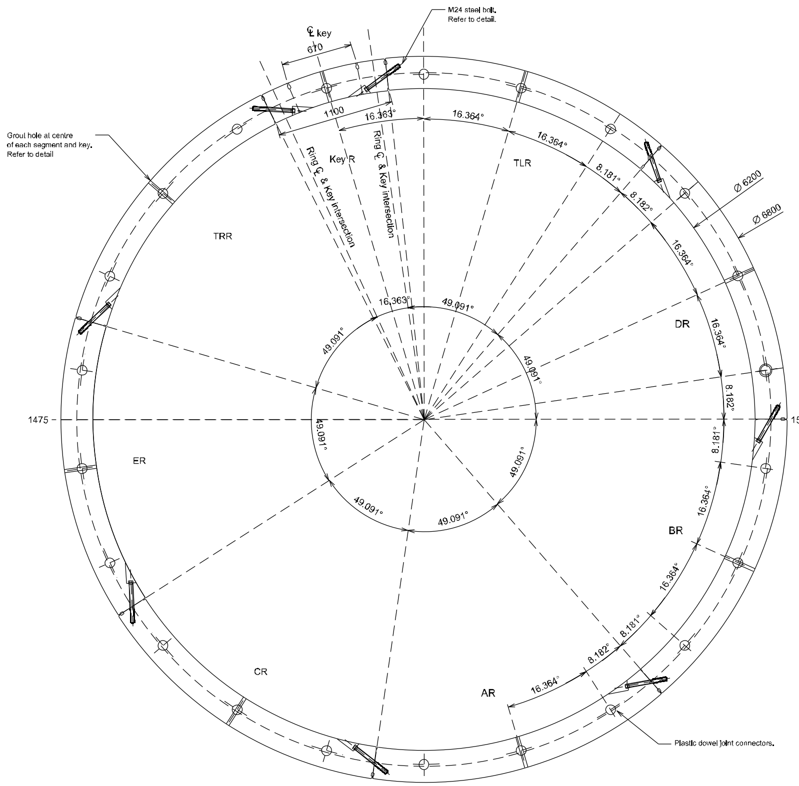
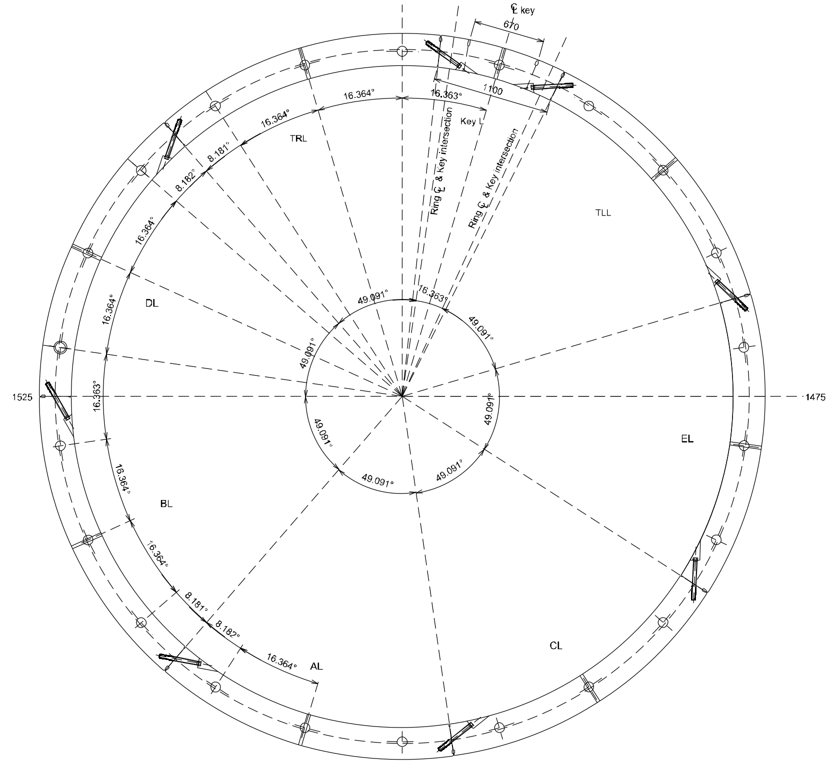
Contract :	Bored Tunnels (Alignment and Track)
Originator :	Ove Arup & Partners Limited
Location :	Crossrail General
Title :	6.2mID Parallel Precast Concrete Segment Segmental Lining. General arrangement C300, C305, C310
By :	J.CHAPMAN
Chk :	
App :	S.DORAN
Auth :	P.CHAMLEY
Scale :	1:25@ A1
Drawing and CAD file No :	C122-OVE-C4-DDB-CR001_Z-22001
Rev :	P07
Suitability :	S4



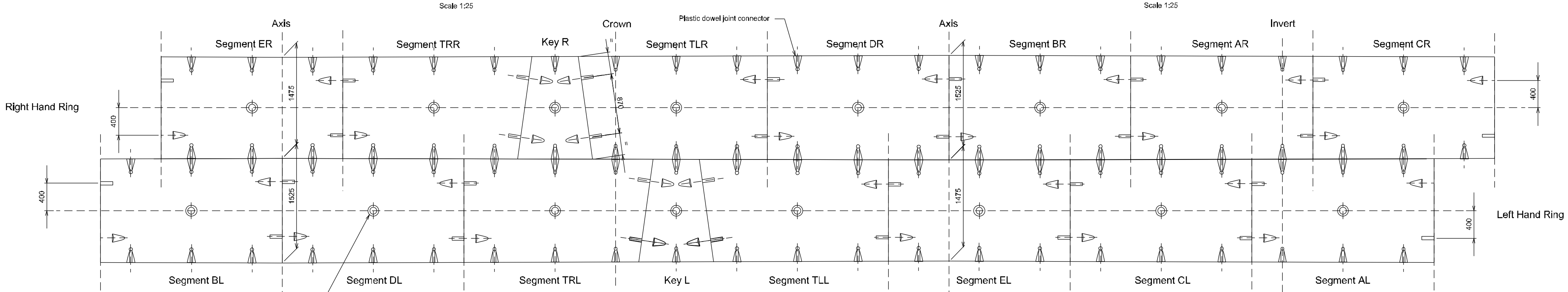
Typical right hand ring elevation on leading edge

Scale 1:25



Typical left hand ring elevation on leading edge

Scale 1:25



Developed View on Ring Intrados

NTS

Notes

1. For SHE information relevant to all C300 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001-Z-20100.
2. For SHE information relevant to all C305 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001-Z-20200.
3. Other than the SHE content of the General Notes drawings cited, there are considered to be no specific significant health and safety hazards and issues are currently identified for construction works associated with this drawing other than those which a competent contractor will be readily aware.
4. For SHE information relevant to all C310 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001_Z-20200.

P06

Rev.	Date	Description	By	Chkd	App	Auth
P01	05/11/2009	Issued for Tender Purposes	DB	AS	RM	
P02	20/11/2009	Issued for Tender Purposes	DB	SD	RM	
P03	03/12/2009	—	DB	AS	PC	
P04	15/03/2010	Reissued for Tender Purposes	NL	AS	RM	
P05	28/04/2010	Reissued for Tender Addendum Purposes	NL	AS	RM	
P06	18/05/2010	Reissued for Tender Addendum Purposes	JC	SD	PC	

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Canary Wharf
London
E14 5LQ

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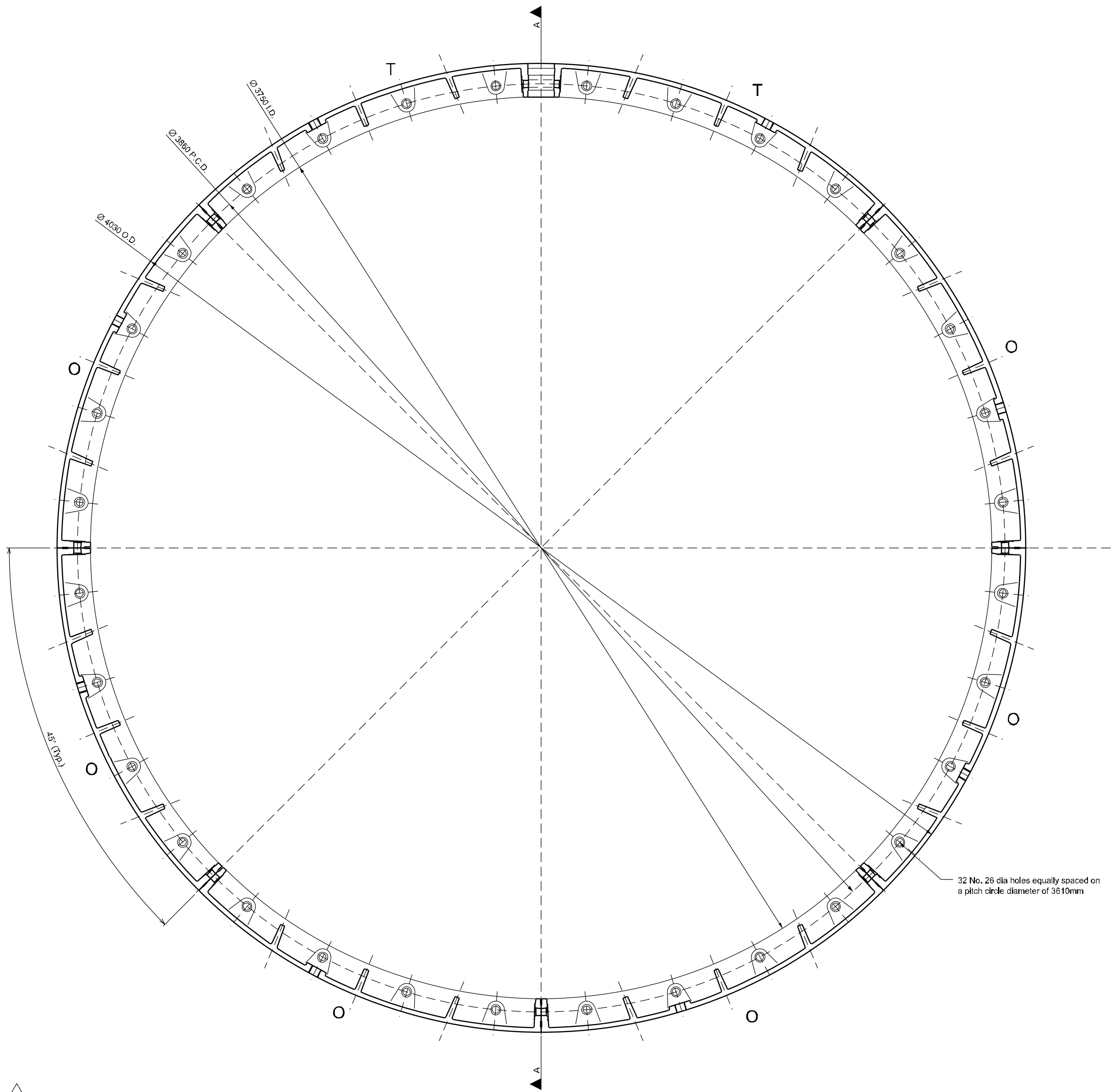
Contract: Bored Tunnels (Alignment and Track)
Originator: Ove Arup & Partners Limited
Location: Crossrail General
Title: 6.2m I.D. Standard Precast Concrete Segmental Lining (tapered ring) General Arrangement C300, C305, C310

By:	J.CHAPMAN
Chk:	
App:	S.DORAN
Auth:	P.CHAMLEY

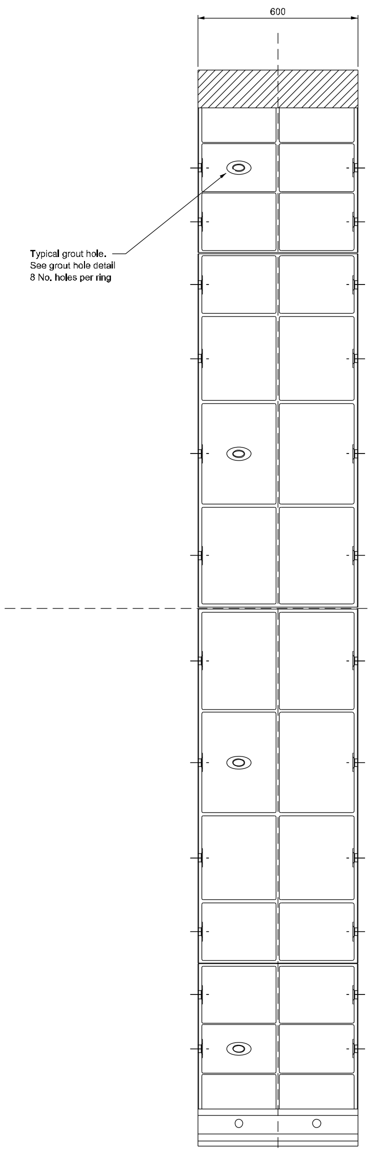
Scale:	Drawing and CAD file No:	Rev:	Suitability:
Various@ A1	C122-OVE-C4-DDB-CR001_Z-22002	P06	S4

RESTRICTED

Fit for authorisation



Section Showing Elevation of Ring
(Ribs omitted for clarity)



Section A-A

Rev.	Date	Description	By	Chkd	App	Auth
P01	03/11/2009	Issued for Tender Purposes	DB	AS	PC	
P02	15/03/2010	Reissued for Tender Purposes	NL	AS	RM	
P03	20/05/2010	Reissued for Tender Addendum Purposes	NL	AC	PC	

Notes
1. For SHE information relevant to all C300 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001-Z-20100.
2. For SHE information relevant to all C305 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001-Z-20200.
3. Other than the SHE content of the General Notes drawings cited, there are considered to be no specific significant health and safety hazards and issues are currently identified for construction works associated with this drawing other than those which a competent contractor will be readily aware.
4. For SHE information relevant to all C310 tunnel drawings, see the SHE content of General Notes Drawing No. C122-OVE-C4-DDJ-CR001_Z-22100.

P03

Scale 1:10
200mm 0 200mm 400mm 600mm 800mm 1000mm

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25 Canada Square
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Contract: Bored Tunnels (Alignment and Track)
Originator: Ove Arup & Partners Limited
Location: Crossrail General
Title: 3.75m I.D.Spheroidal Graphite Iron Lining General Arrangement
C305, C310
By: N.LEIGHTON
Chk:
App: A.CHODOROWSKI
Auth: P.CHAMLEY
Scale: 1:10@ A1
Drawing and CAD file No: C122-OVE-C4-DDB-CR001_Z-22004
Rev: P03
Suitability: S4

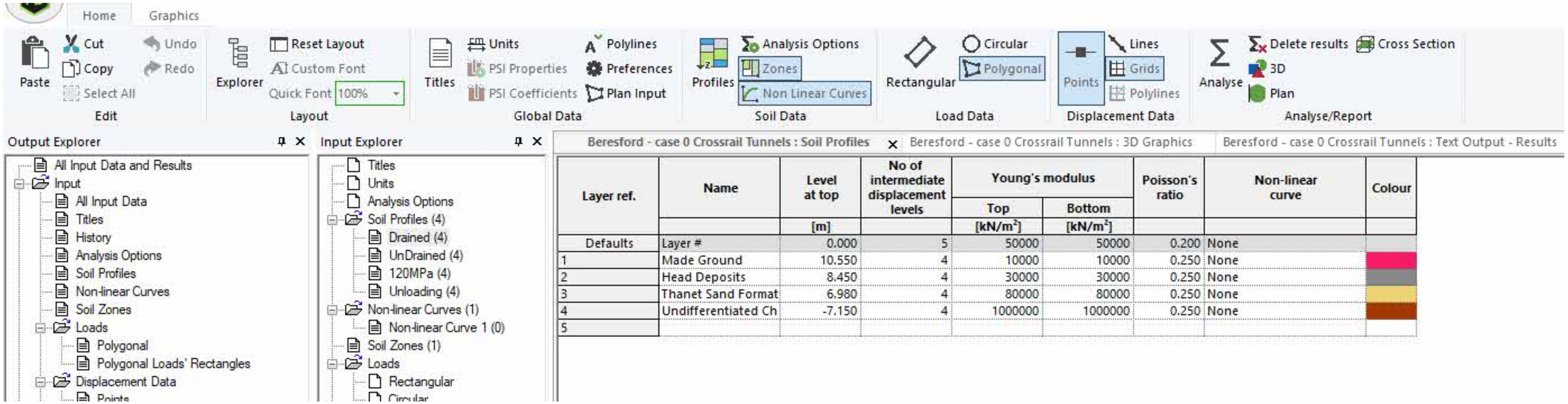
RESTRICTED

Fit for authorisation

APPENDIX 3 OASYS PDisp input data

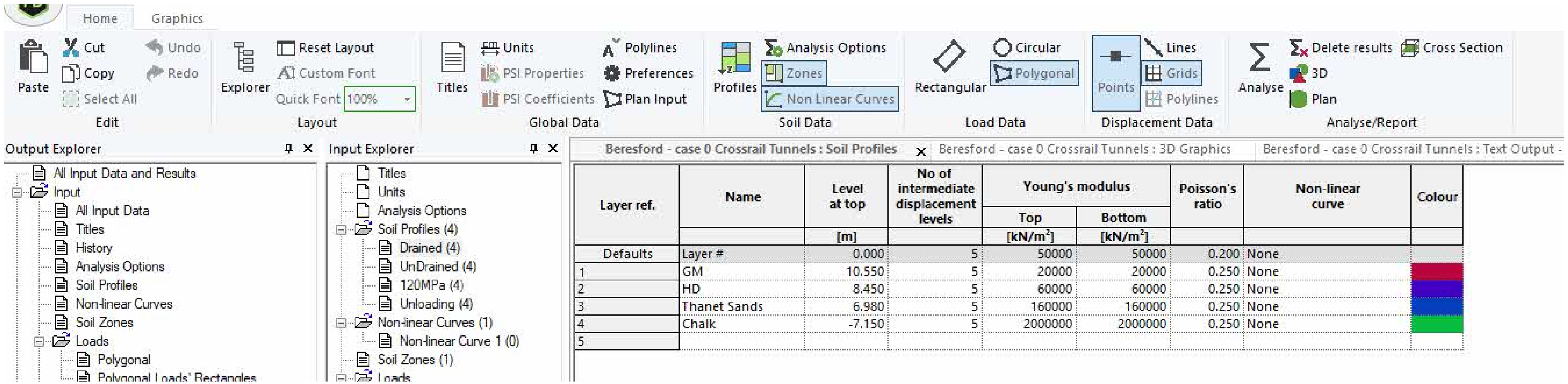
1 Soil profiles

1.1 Undrained (exiting building)



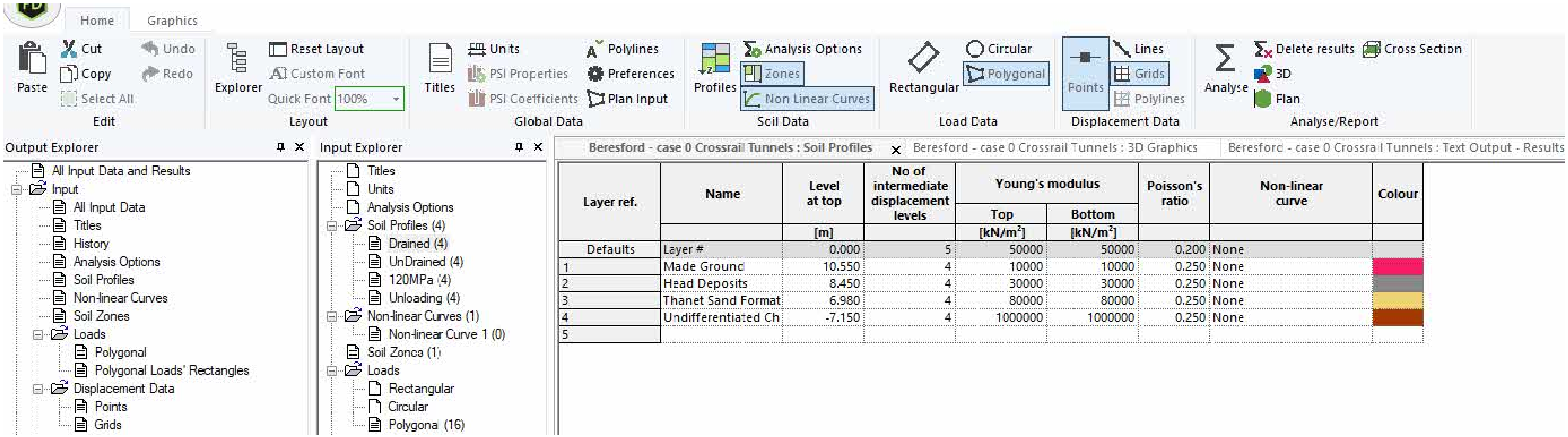
Layer ref.	Name	Level at top [m]	No of intermediate displacement levels	Young's modulus Top [kN/m²]	Young's modulus Bottom [kN/m²]	Poisson's ratio	Non-linear curve	Colour
Defaults	Layer #	0.000	5	50000	50000	0.200	None	
1	Made Ground	10.550	4	10000	10000	0.250	None	
2	Head Deposits	8.450	4	30000	30000	0.250	None	
3	Thanet Sand Format	6.980	4	80000	80000	0.250	None	
4	Undifferentiated Ch	-7.150	4	1000000	1000000	0.250	None	
5								

1.2 Undrained (demolition and excavation of basement)



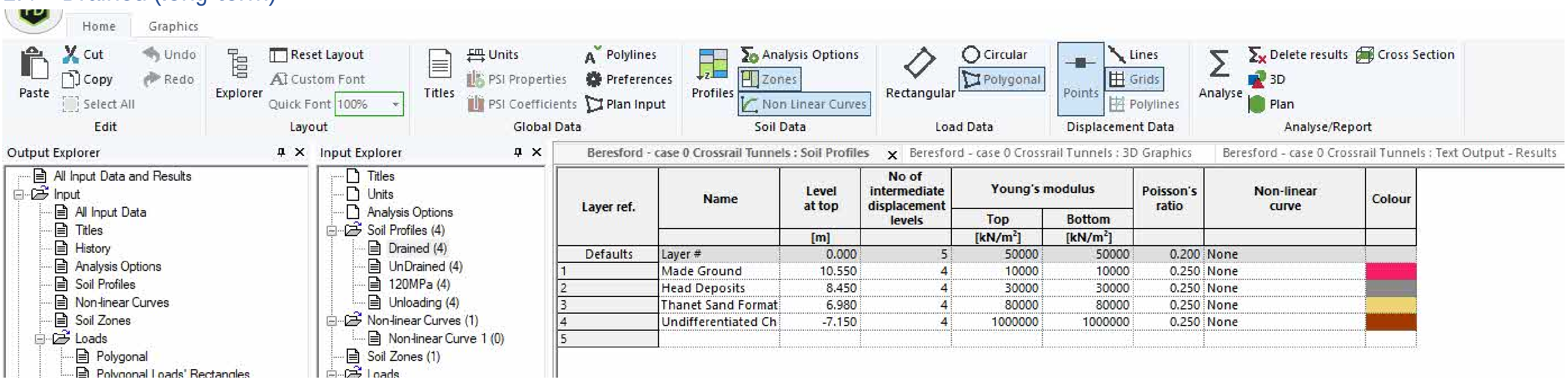
Layer ref.	Name	Level at top [m]	No of intermediate displacement levels	Young's modulus Top [kN/m²]	Young's modulus Bottom [kN/m²]	Poisson's ratio	Non-linear curve	Colour
Defaults	Layer #	0.000	5	50000	50000	0.200	None	
1	GM	10.550	5	20000	20000	0.250	None	
2	HD	8.450	5	60000	60000	0.250	None	
3	Thanet Sands	6.980	5	160000	160000	0.250	None	
4	Chalk	-7.150	5	2000000	2000000	0.250	None	
5								

1.3 Undrained (Redevelopment stage)



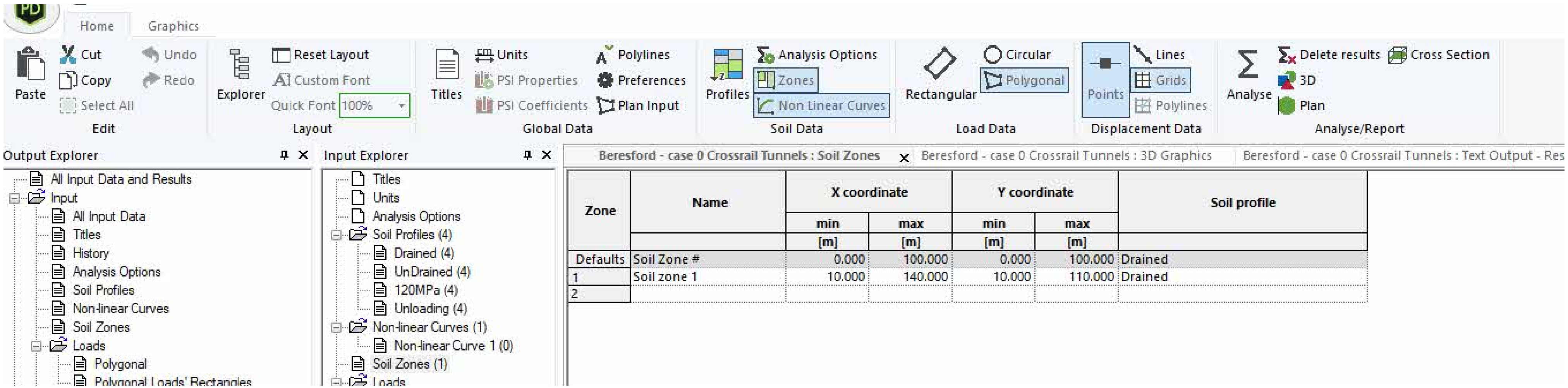
Layer ref.	Name	Level at top [m]	No of intermediate displacement levels	Young's modulus Top [kN/m²]	Young's modulus Bottom [kN/m²]	Poisson's ratio	Non-linear curve	Colour
Defaults	Layer #	0.000	5	50000	50000	0.200	None	
1	Made Ground	10.550	4	10000	10000	0.250	None	
2	Head Deposits	8.450	4	30000	30000	0.250	None	
3	Thanet Sand Format	6.980	4	80000	80000	0.250	None	
4	Undifferentiated Ch	-7.150	4	1000000	1000000	0.250	None	
5								

1.4 Drained (long-term)



Layer ref.	Name	Level at top [m]	No of intermediate displacement levels	Young's modulus Top [kN/m²]	Young's modulus Bottom [kN/m²]	Poisson's ratio	Non-linear curve	Colour
Defaults	Layer #	0.000	5	50000	50000	0.200	None	
1	Made Ground	10.550	4	10000	10000	0.250	None	
2	Head Deposits	8.450	4	30000	30000	0.250	None	
3	Thanet Sand Format	6.980	4	80000	80000	0.250	None	
4	Undifferentiated Ch	-7.150	4	1000000	1000000	0.250	None	
5								

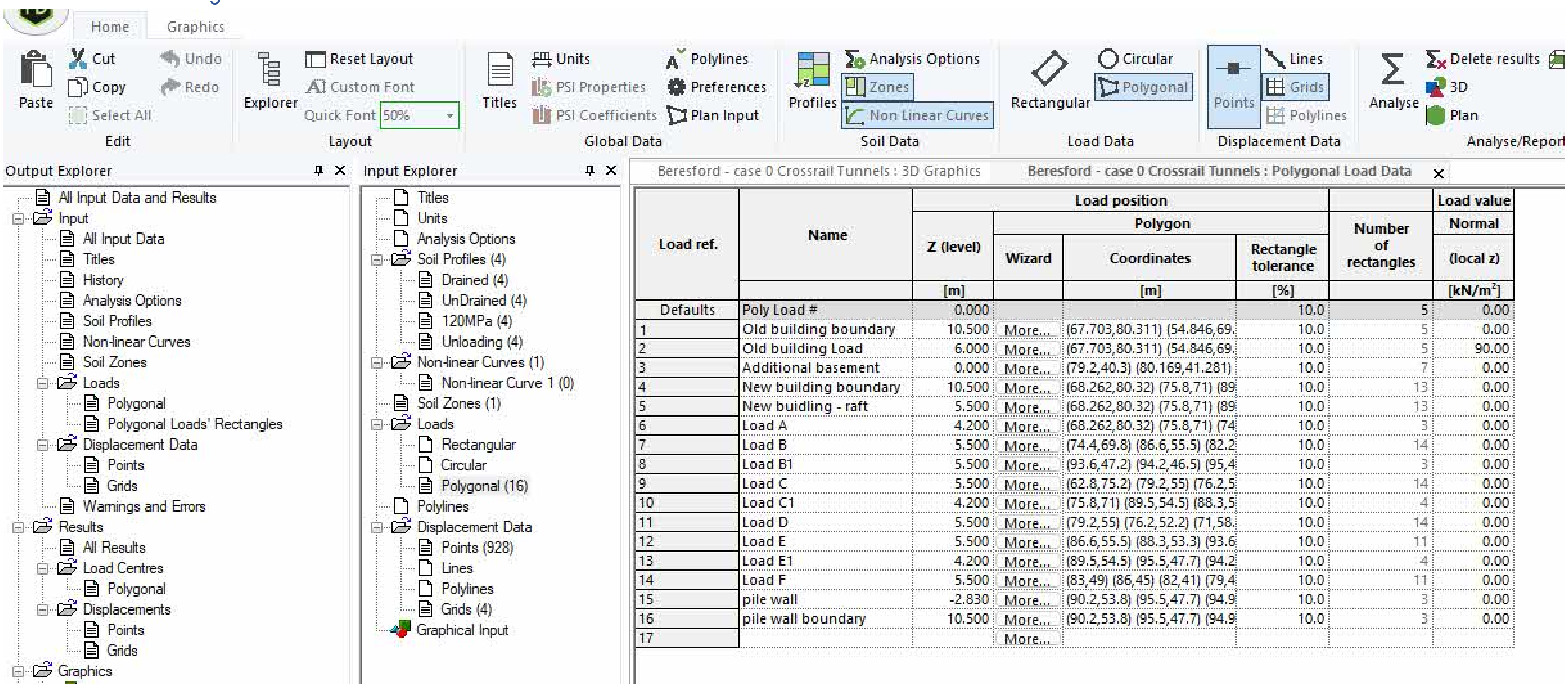
2 Soil zones



Home
Graphics
Paste
Cut
Copy
Select All
Undo
Redo
Edit
Explorer
Reset Layout
Custom Font
Quick Font 100%
Layout
Titles
Units
PSI Properties
PSI Coefficients
Polylines
Preferences
Plan Input
Global Data
Profiles
Analysis Options
Zones
Non Linear Curves
Soil Data
Rectangular
Circular
Polygonal
Load Data
Points
Lines
Grids
Polylines
Displacement Data
Analyse
Delete results
3D
Plan
Cross Section
Analyse/Report
Output Explorer
All Input Data and Results
Input
All Input Data
Titles
History
Analysis Options
Soil Profiles
Non-linear Curves
Soil Zones
Loads
Polygonal
Input Explorer
Titles
Units
Analysis Options
Soil Profiles (4)
Drained (4)
UnDrained (4)
120MPa (4)
Unloading (4)
Non-linear Curves (1)
Non-linear Curve 1 (0)
Soil Zones (1)
Loads
Beresford - case 0 Crossrail Tunnels : Soil Zones
Beresford - case 0 Crossrail Tunnels : 3D Graphics
Beresford - case 0 Crossrail Tunnels : Text Output - Res
Zone
Name
X coordinate
Y coordinate
min
max
[m]
Soil profile
Defaults | Soil Zone # | 0.000 | 100.000 | 0.000 | 100.000 | Drained
1 | Soil zone 1 | 10.000 | 140.000 | 10.000 | 110.000 | Drained
2

3 Loads

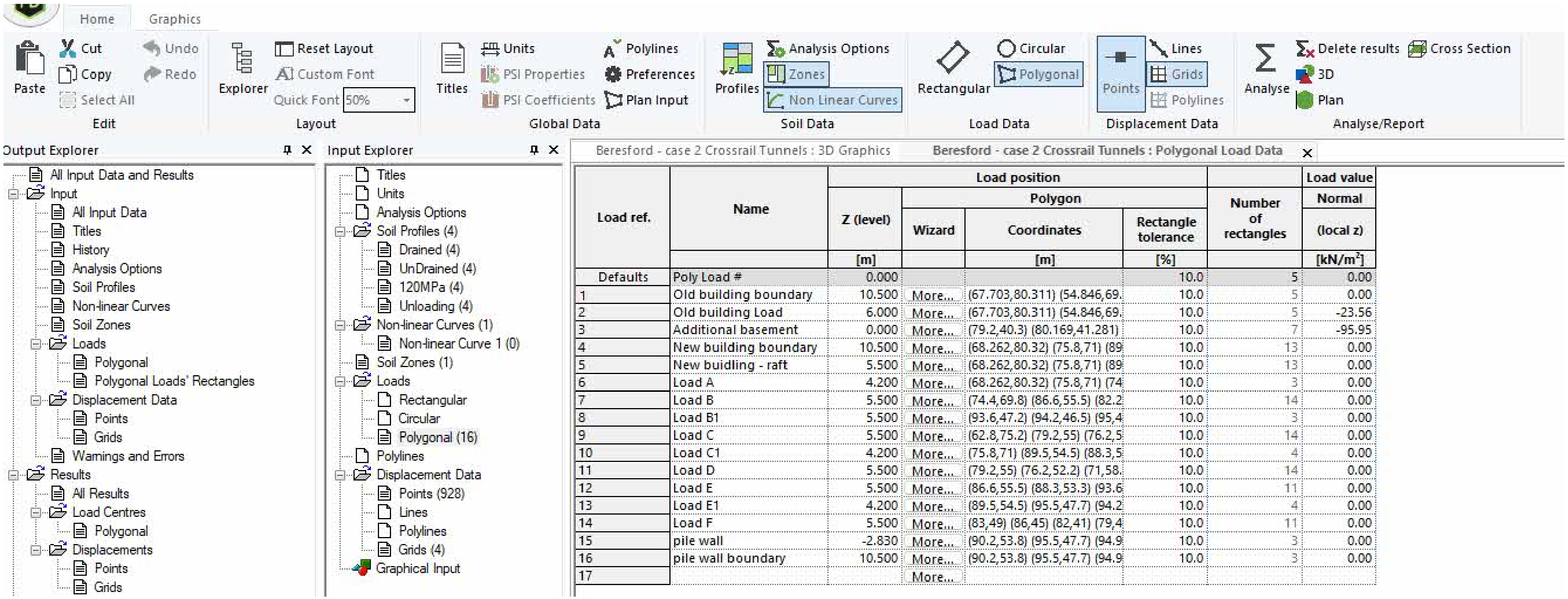
3.1 Case 1 Existing



Beresford - case 0 Crossrail Tunnels : Polygonal Load Data

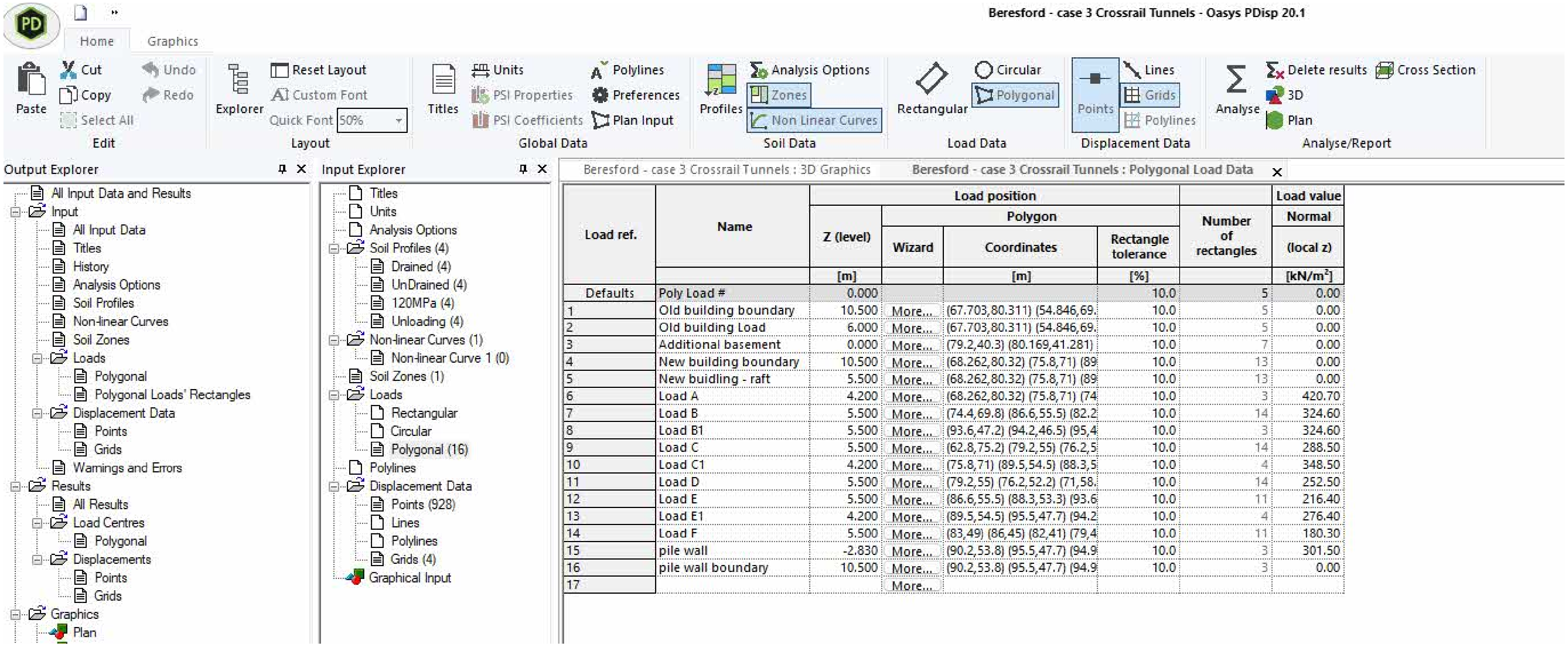
Load ref.	Name	Load position				Number of rectangles	Load value
		Z (level)	Polygon				Normal
			Wizard	Coordinates	Rectangle tolerance		(local z)
		[m]		[m]	[%]		[kN/m²]
Defaults	Poly Load #	0.000			10.0	5	0.00
1	Old building boundary	10.500	More...	(67.703,80.311) (54.846,69.	10.0	5	0.00
2	Old building Load	6.000	More...	(67.703,80.311) (54.846,69.	10.0	5	90.00
3	Additional basement	0.000	More...	(79.2,40.3) (80.169,41.281)	10.0	7	0.00
4	New building boundary	10.500	More...	(68.262,80.32) (75.8,71) (89	10.0	13	0.00
5	New buidling - raft	5.500	More...	(68.262,80.32) (75.8,71) (89	10.0	13	0.00
6	Load A	4.200	More...	(68.262,80.32) (75.8,71) (74	10.0	3	0.00
7	Load B	5.500	More...	(74.4,69.8) (86.6,55.5) (82.2	10.0	14	0.00
8	Load B1	5.500	More...	(93.6,47.2) (94.2,46.5) (95,4	10.0	3	0.00
9	Load C	5.500	More...	(62.8,75.2) (79.2,55) (76.2,5	10.0	14	0.00
10	Load C1	4.200	More...	(75.8,71) (89.5,54.5) (88.3,5	10.0	4	0.00
11	Load D	5.500	More...	(79.2,55) (76.2,52.2) (71,58.	10.0	14	0.00
12	Load E	5.500	More...	(86.6,55.5) (88.3,53.3) (93.6	10.0	11	0.00
13	Load E1	4.200	More...	(89.5,54.5) (95.5,47.7) (94.2	10.0	4	0.00
14	Load F	5.500	More...	(83,49) (86,45) (82,41) (79,4	10.0	11	0.00
15	pile wall	-2.830	More...	(90.2,53.8) (95.5,47.7) (94.9	10.0	3	0.00
16	pile wall boundary	10.500	More...	(90.2,53.8) (95.5,47.7) (94.9	10.0	3	0.00
17			More...				

3.2 Case 2 Demolition



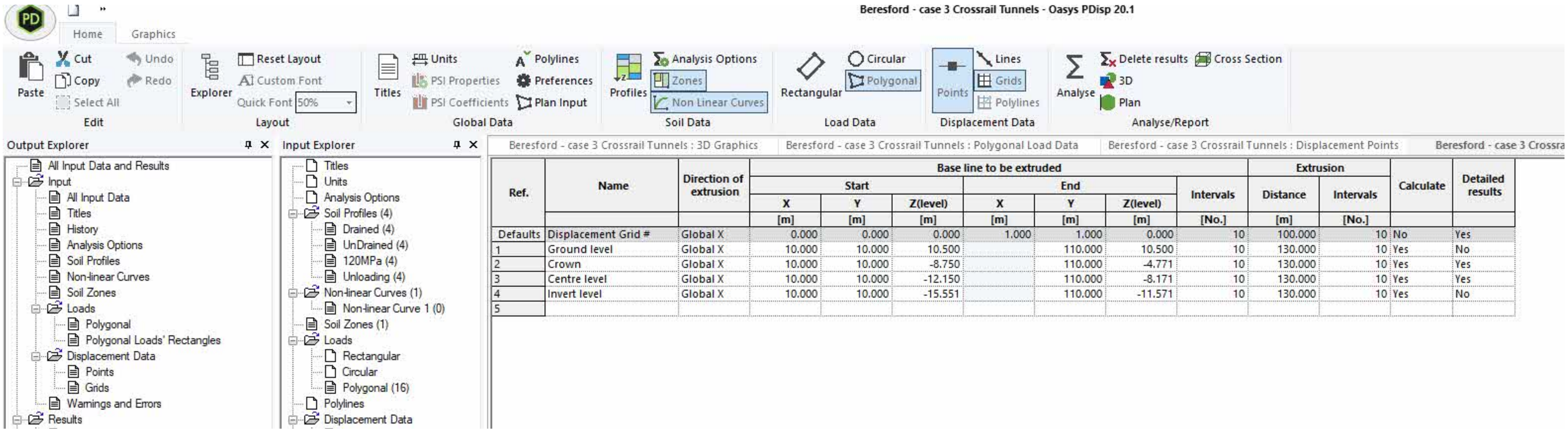
Load ref.	Name	Load position					Load value
		Z (level)	Polygon			Number of rectangles	Normal
			Wizard	Coordinates	Rectangle tolerance		(local z)
		[m]		[m]	[%]		[kN/m²]
Defaults	Poly Load #	0.000			10.0	5	0.00
1	Old building boundary	10.500	More...	(67.703,80.311) (54.846,69.	10.0	5	0.00
2	Old building Load	6.000	More...	(67.703,80.311) (54.846,69.	10.0	5	-23.56
3	Additional basement	0.000	More...	(79.2,40.3) (80.169,41.281)	10.0	7	-95.95
4	New building boundary	10.500	More...	(68.262,80.32) (75.8,71) (89	10.0	13	0.00
5	New buidling - raft	5.500	More...	(68.262,80.32) (75.8,71) (89	10.0	13	0.00
6	Load A	4.200	More...	(68.262,80.32) (75.8,71) (74	10.0	3	0.00
7	Load B	5.500	More...	(74.4,69.8) (86.6,55.5) (82.2	10.0	14	0.00
8	Load B1	5.500	More...	(93.6,47.2) (94.2,46.5) (95,4	10.0	3	0.00
9	Load C	5.500	More...	(62.8,75.2) (79.2,55) (76.2,5	10.0	14	0.00
10	Load C1	4.200	More...	(75.8,71) (89.5,54.5) (88.3,5	10.0	4	0.00
11	Load D	5.500	More...	(79.2,55) (76.2,52.2) (71,58.	10.0	14	0.00
12	Load E	5.500	More...	(86.6,55.5) (88.3,53.3) (93.6	10.0	11	0.00
13	Load E1	4.200	More...	(89.5,54.5) (95.5,47.7) (94.2	10.0	4	0.00
14	Load F	5.500	More...	(83,49) (86,45) (82,41) (79,4	10.0	11	0.00
15	pile wall	-2.830	More...	(90.2,53.8) (95.5,47.7) (94.9	10.0	3	0.00
16	pile wall boundary	10.500	More...	(90.2,53.8) (95.5,47.7) (94.9	10.0	3	0.00
17			More...				

3.3 Cases 3 & 4 Loading and Long term



Load ref.	Name	Load position: Z (level) [m]	Polygon: Wizard	Polygon: Coordinates [m]	Polygon: Rectangle tolerance [%]	Number of rectangles	Load value: Normal (local z) [kN/m²]
Defaults	Poly Load #	0.000			10.0	5	0.00
1	Old building boundary	10.500	More...	(67.703,80.311) (54.846,69.	10.0	5	0.00
2	Old building Load	6.000	More...	(67.703,80.311) (54.846,69.	10.0	5	0.00
3	Additional basement	0.000	More...	(79.2,40.3) (80.169,41.281)	10.0	7	0.00
4	New building boundary	10.500	More...	(68.262,80.32) (75.8,71) (89	10.0	13	0.00
5	New buidling - raft	5.500	More...	(68.262,80.32) (75.8,71) (89	10.0	13	0.00
6	Load A	4.200	More...	(68.262,80.32) (75.8,71) (74	10.0	3	420.70
7	Load B	5.500	More...	(74.4,69.8) (86.6,55.5) (82.2	10.0	14	324.60
8	Load B1	5.500	More...	(93.6,47.2) (94.2,46.5) (95,4	10.0	3	324.60
9	Load C	5.500	More...	(62.8,75.2) (79.2,55) (76.2,5	10.0	14	288.50
10	Load C1	4.200	More...	(75.8,71) (89.5,54.5) (88.3,5	10.0	4	348.50
11	Load D	5.500	More...	(79.2,55) (76.2,52.2) (71,58.	10.0	14	252.50
12	Load E	5.500	More...	(86.6,55.5) (88.3,53.3) (93.6	10.0	11	216.40
13	Load E1	4.200	More...	(89.5,54.5) (95.5,47.7) (94.2	10.0	4	276.40
14	Load F	5.500	More...	(83,49) (86,45) (82,41) (79,4	10.0	11	180.30
15	pile wall	-2.830	More...	(90.2,53.8) (95.5,47.7) (94.9	10.0	3	301.50
16	pile wall boundary	10.500	More...	(90.2,53.8) (95.5,47.7) (94.9	10.0	3	0.00
17			More...				

4 Grids



Ref.	Name	Direction of extrusion	Base line to be extruded							Extrusion		Calculate	Detailed results
			Start			End			Intervals	Distance	Intervals		
			X	Y	Z(level)	X	Y	Z(level)					
			[m]	[m]	[m]	[m]	[m]	[m]	[No.]	[m]	[No.]		
Defaults	Displacement Grid #	Global X	0.000	0.000	0.000	1.000	1.000	0.000	10	100.000	10	No	Yes
1	Ground level	Global X	10.000	10.000	10.500		110.000	10.500	10	130.000	10	Yes	No
2	Crown	Global X	10.000	10.000	-8.750		110.000	-4.771	10	130.000	10	Yes	Yes
3	Centre level	Global X	10.000	10.000	-12.150		110.000	-8.171	10	130.000	10	Yes	Yes
4	Invert level	Global X	10.000	10.000	-15.551		110.000	-11.571	10	130.000	10	Yes	No
5													

5 Displacement points

464 data points

Beresford - case 4 Crossrail WB Tunnel : 3D Graphics | Beresford - case 4 Crossrail WB Tunnel : Displacemen

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
1	WU1	12.640	139.210	-8.750	Yes	Yes
2	WU1	13.640	138.400	-8.715	Yes	Yes
3	WU1	14.640	137.590	-8.681	Yes	Yes
4	WU1	15.640	136.780	-8.646	Yes	Yes
5	WU1	16.640	135.970	-8.612	Yes	Yes
6	WU1	17.640	135.160	-8.577	Yes	Yes
7	WU1	18.640	134.040	-8.542	Yes	Yes
8	WU1	19.640	133.230	-8.508	Yes	Yes
9	WU1	20.640	132.420	-8.473	Yes	Yes
10	WU1	21.640	131.610	-8.439	Yes	Yes
11	WU1	22.640	130.800	-8.404	Yes	Yes
12	WU1	23.640	129.670	-8.369	Yes	Yes
13	WU1	24.640	128.860	-8.335	Yes	Yes
14	WU1	25.640	128.050	-8.300	Yes	Yes
15	WU1	26.640	127.350	-8.266	Yes	Yes
16	WU1	27.640	126.600	-8.231	Yes	Yes
17	WU1	28.640	125.880	-8.196	Yes	Yes
18	WU1	29.640	124.910	-8.162	Yes	Yes
19	WU1	30.640	124.220	-8.127	Yes	Yes
20	WU1	31.640	123.250	-8.093	Yes	Yes
21	WU1	32.640	122.400	-8.058	Yes	Yes
22	WU1	33.640	121.600	-8.023	Yes	Yes
23	WU1	34.640	120.800	-7.989	Yes	Yes
24	WU1	35.640	120.100	-7.954	Yes	Yes
25	WU1	36.640	119.300	-7.920	Yes	Yes
26	WU1	37.640	118.500	-7.885	Yes	Yes
27	WU1	38.640	117.700	-7.850	Yes	Yes
28	WU1	39.640	116.900	-7.816	Yes	Yes
29	WU1	40.640	116.200	-7.781	Yes	Yes
30	WU1	41.640	115.200	-7.747	Yes	Yes
31	WU1	42.640	114.600	-7.712	Yes	Yes
32	WU1	43.640	113.800	-7.677	Yes	Yes
33	WU1	44.640	113.000	-7.643	Yes	Yes
34	WU1	45.640	112.200	-7.608	Yes	Yes
35	WU1	46.640	111.400	-7.574	Yes	Yes
36	WU1	47.640	110.600	-7.539	Yes	Yes
37	WU1	48.640	109.900	-7.504	Yes	Yes
38	WU1	49.640	109.200	-7.470	Yes	Yes
39	WU1	50.640	108.350	-7.435	Yes	Yes
40	WU1	51.640	107.730	-7.401	Yes	Yes
41	WU1	52.640	107.200	-7.366	Yes	Yes
42	WU1	53.640	106.400	-7.331	Yes	Yes
43	WU1	54.640	105.700	-7.297	Yes	Yes
44	WU1	55.640	105.000	-7.262	Yes	Yes
45	WU1	56.640	104.200	-7.228	Yes	Yes
46	WU1	57.640	103.600	-7.193	Yes	Yes
47	WU1	58.640	103.000	-7.158	Yes	Yes
48	WU1	59.640	102.200	-7.124	Yes	Yes
49	WU1	60.640	101.600	-7.089	Yes	Yes
50	WU1	61.640	100.800	-7.055	Yes	Yes
51	WU1	62.640	100.100	-7.020	Yes	Yes

TabTable

Beresford - case 4 Crossrail WB Tunnel - Oasys

Polylines | Analysis Options | Circular | Lines
Properties | Preferences | Profiles | Zones | Rectangular | Polygonal | Points | Grids | Analys
Coefficients | Plan Input | Non Linear Curves | Polylines
Global Data | Soil Data | Load Data | Displacement Data

Beresford - case 4 Crossrail WB Tunnel : 3D Graphics | Beresford - case 4 Crossrail WB Tunnel : Displacement P

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
101	WU1	112.640	70.500	-5.290	Yes	Yes
102	WU1	113.640	69.970	-5.255	Yes	Yes
103	WU1	114.640	69.440	-5.221	Yes	Yes
104	WU1	115.640	68.900	-5.186	Yes	Yes
105	WU1	116.640	68.370	-5.152	Yes	Yes
106	WU1	117.640	68.000	-5.117	Yes	Yes
107	WU1	118.640	67.470	-5.082	Yes	Yes
108	WU1	119.640	66.940	-5.048	Yes	Yes
109	WU1	120.640	66.400	-5.013	Yes	Yes
110	WU1	121.640	65.870	-4.979	Yes	Yes
111	WU1	122.640	65.600	-4.944	Yes	Yes
112	WU1	123.640	65.070	-4.909	Yes	Yes
113	WU1	124.640	64.540	-4.875	Yes	Yes
114	WU1	125.640	64.000	-4.840	Yes	Yes
115	WU1	126.640	63.470	-4.806	Yes	Yes
116	WU1	127.640	63.100	-4.771	Yes	Yes
117	WU2	12.640	146.013	-8.750	Yes	Yes
118	WU2	13.640	145.203	-8.715	Yes	Yes
119	WU2	14.640	144.393	-8.681	Yes	Yes
120	WU2	15.640	143.583	-8.646	Yes	Yes
121	WU2	16.640	142.774	-8.612	Yes	Yes
122	WU2	17.640	141.964	-8.577	Yes	Yes
123	WU2	18.640	140.839	-8.542	Yes	Yes
124	WU2	19.640	140.029	-8.508	Yes	Yes
125	WU2	20.640	139.220	-8.473	Yes	Yes
126	WU2	21.640	138.410	-8.439	Yes	Yes
127	WU2	22.640	137.600	-8.404	Yes	Yes
128	WU2	23.640	136.470	-8.369	Yes	Yes
129	WU2	24.640	135.660	-8.335	Yes	Yes
130	WU2	25.640	134.850	-8.300	Yes	Yes
131	WU2	26.640	134.150	-8.266	Yes	Yes
132	WU2	27.640	133.400	-8.231	Yes	Yes
133	WU2	28.640	132.676	-8.196	Yes	Yes
134	WU2	29.640	131.710	-8.162	Yes	Yes
135	WU2	30.640	131.016	-8.127	Yes	Yes
136	WU2	31.640	130.050	-8.093	Yes	Yes
137	WU2	32.640	129.200	-8.058	Yes	Yes
138	WU2	33.640	128.400	-8.023	Yes	Yes
139	WU2	34.640	127.600	-7.989	Yes	Yes
140	WU2	35.640	126.900	-7.954	Yes	Yes
141	WU2	36.640	126.100	-7.920	Yes	Yes
142	WU2	37.640	125.300	-7.885	Yes	Yes
143	WU2	38.640	124.500	-7.850	Yes	Yes
144	WU2	39.640	123.700	-7.816	Yes	Yes
145	WU2	40.640	123.000	-7.781	Yes	Yes
146	WU2	41.640	122.000	-7.747	Yes	Yes
147	WU2	42.640	121.400	-7.712	Yes	Yes
148	WU2	43.640	120.600	-7.677	Yes	Yes
149	WU2	44.640	119.800	-7.643	Yes	Yes
150	WU2	45.640	119.000	-7.608	Yes	Yes
151	WU2	46.640	118.200	-7.574	Yes	Yes

TabTable

Beresford - case 4 Crossrail WB Tunnel - Oasys PDis

operties | Polylines | Preferences | efficients | Plan Input | lobal Data

Profiles | Analysis Options | Zones | Non Linear Curves | Soil Data

Rectangular | Circular | Polygonal | Load Data

Points | Lines | Grids | Polylines | Displacement Data

Analyse

Beresford - case 4 Crossrail WB Tunnel : 3D Graphics | Beresford - case 4 Crossrail WB Tunnel : Displacement Point

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
201	WU2	96.640	85.900	-5.844	Yes	Yes
202	WU2	97.640	85.400	-5.809	Yes	Yes
203	WU2	98.640	84.868	-5.774	Yes	Yes
204	WU2	99.640	84.337	-5.740	Yes	Yes
205	WU2	100.640	83.805	-5.705	Yes	Yes
206	WU2	101.640	83.273	-5.671	Yes	Yes
207	WU2	102.640	82.600	-5.636	Yes	Yes
208	WU2	103.640	82.068	-5.601	Yes	Yes
209	WU2	104.640	81.537	-5.567	Yes	Yes
210	WU2	105.640	81.005	-5.532	Yes	Yes
211	WU2	106.640	80.473	-5.498	Yes	Yes
212	WU2	107.640	79.900	-5.463	Yes	Yes
213	WU2	108.640	79.368	-5.428	Yes	Yes
214	WU2	109.640	78.837	-5.394	Yes	Yes
215	WU2	110.640	78.305	-5.359	Yes	Yes
216	WU2	111.640	77.773	-5.325	Yes	Yes
217	WU2	112.640	77.300	-5.290	Yes	Yes
218	WU2	113.640	76.768	-5.255	Yes	Yes
219	WU2	114.640	76.237	-5.221	Yes	Yes
220	WU2	115.640	75.705	-5.186	Yes	Yes
221	WU2	116.640	75.173	-5.152	Yes	Yes
222	WU2	117.640	74.800	-5.117	Yes	Yes
223	WU2	118.640	74.268	-5.082	Yes	Yes
224	WU2	119.640	73.737	-5.048	Yes	Yes
225	WU2	120.640	73.205	-5.013	Yes	Yes
226	WU2	121.640	72.673	-4.979	Yes	Yes
227	WU2	122.640	72.400	-4.944	Yes	Yes
228	WU2	123.640	71.868	-4.909	Yes	Yes
229	WU2	124.640	71.337	-4.875	Yes	Yes
230	WU2	125.640	70.805	-4.840	Yes	Yes
231	WU2	126.640	70.273	-4.806	Yes	Yes
232	WU2	127.640	69.900	-4.771	Yes	Yes
233	WL1	12.640	139.213	-15.550	Yes	Yes
234	WL1	13.640	138.403	-15.515	Yes	Yes
235	WL1	14.640	137.593	-15.481	Yes	Yes
236	WL1	15.640	136.783	-15.446	Yes	Yes
237	WL1	16.640	135.974	-15.412	Yes	Yes
238	WL1	17.640	135.164	-15.377	Yes	Yes
239	WL1	18.640	134.039	-15.342	Yes	Yes
240	WL1	19.640	133.229	-15.308	Yes	Yes
241	WL1	20.640	132.420	-15.273	Yes	Yes
242	WL1	21.640	131.610	-15.239	Yes	Yes
243	WL1	22.640	130.800	-15.204	Yes	Yes
244	WL1	23.640	129.670	-15.169	Yes	Yes
245	WL1	24.640	128.860	-15.135	Yes	Yes
246	WL1	25.640	128.050	-15.100	Yes	Yes
247	WL1	26.640	127.350	-15.066	Yes	Yes
248	WL1	27.640	126.600	-15.031	Yes	Yes
249	WL1	28.640	125.876	-14.996	Yes	Yes
250	WL1	29.640	124.910	-14.962	Yes	Yes
251	WL1	30.640	124.216	-14.927	Yes	Yes

TabTable

Beresford - case 4 Crossrail WB Tunnel - Oasys PL

Beresford - case 4 Crossrail WB Tunnel : 3D Graphics | Beresford - case 4 Crossrail WB Tunnel : Displacement Poi

Ref.	Name	X [m]	Y [m]	Z(level) [m]	Calculate	Detailed Results
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
301	WL1	80.640	88.400	-13.197	Yes	Yes
302	WL1	81.640	87.800	-13.163	Yes	Yes
303	WL1	82.640	87.137	-13.128	Yes	Yes
304	WL1	83.640	86.512	-13.093	Yes	Yes
305	WL1	84.640	85.887	-13.059	Yes	Yes
306	WL1	85.640	85.263	-13.024	Yes	Yes
307	WL1	86.640	84.638	-12.990	Yes	Yes
308	WL1	87.640	84.200	-12.955	Yes	Yes
309	WL1	88.640	83.600	-12.920	Yes	Yes
310	WL1	89.640	83.000	-12.886	Yes	Yes
311	WL1	90.640	82.500	-12.851	Yes	Yes
312	WL1	91.640	81.875	-12.817	Yes	Yes
313	WL1	92.640	81.300	-12.782	Yes	Yes
314	WL1	93.640	80.700	-12.747	Yes	Yes
315	WL1	94.640	80.200	-12.713	Yes	Yes
316	WL1	95.640	79.600	-12.678	Yes	Yes
317	WL1	96.640	79.100	-12.644	Yes	Yes
318	WL1	97.640	78.600	-12.609	Yes	Yes
319	WL1	98.640	78.068	-12.574	Yes	Yes
320	WL1	99.640	77.537	-12.540	Yes	Yes
321	WL1	100.640	77.005	-12.505	Yes	Yes
322	WL1	101.640	76.473	-12.471	Yes	Yes
323	WL1	102.640	75.800	-12.436	Yes	Yes
324	WL1	103.640	75.268	-12.401	Yes	Yes
325	WL1	104.640	74.737	-12.367	Yes	Yes
326	WL1	105.640	74.205	-12.332	Yes	Yes
327	WL1	106.640	73.673	-12.298	Yes	Yes
328	WL1	107.640	73.100	-12.263	Yes	Yes
329	WL1	108.640	72.568	-12.228	Yes	Yes
330	WL1	109.640	72.037	-12.194	Yes	Yes
331	WL1	110.640	71.505	-12.159	Yes	Yes
332	WL1	111.640	70.973	-12.125	Yes	Yes
333	WL1	112.640	70.500	-12.090	Yes	Yes
334	WL1	113.640	69.968	-12.055	Yes	Yes
335	WL1	114.640	69.437	-12.021	Yes	Yes
336	WL1	115.640	68.905	-11.986	Yes	Yes
337	WL1	116.640	68.373	-11.952	Yes	Yes
338	WL1	117.640	68.000	-11.917	Yes	Yes
339	WL1	118.640	67.468	-11.882	Yes	Yes
340	WL1	119.640	66.937	-11.848	Yes	Yes
341	WL1	120.640	66.405	-11.813	Yes	Yes
342	WL1	121.640	65.873	-11.779	Yes	Yes
343	WL1	122.640	65.600	-11.744	Yes	Yes
344	WL1	123.640	65.068	-11.709	Yes	Yes
345	WL1	124.640	64.537	-11.675	Yes	Yes
346	WL1	125.640	64.005	-11.640	Yes	Yes
347	WL1	126.640	63.473	-11.606	Yes	Yes
348	WL1	127.640	63.100	-11.571	Yes	Yes
349	WL2	12.640	146.013	-15.550	Yes	Yes
350	WL2	13.640	145.203	-15.515	Yes	Yes
351	WL2	14.640	144.393	-15.481	Yes	Yes

TabTable

its | Polylines | Profiles | Analysis Options | Rectangular | Circular | Points | Lines | Analyse
Properties | Preferences | Zones | Polygonal | Grids
Coefficients | Plan Input | Non Linear Curves | Polylines

Global Data | Soil Data | Load Data | Displacement Data

Beresford - case 4 Crossrail WB Tunnel : 3D Graphics | Beresford - case 4 Crossrail WB Tunnel : Displacement Po

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
401	WL2	64.640	105.500	-13.751	Yes	Yes
402	WL2	65.640	104.800	-13.716	Yes	Yes
403	WL2	66.640	104.200	-13.682	Yes	Yes
404	WL2	67.640	103.531	-13.647	Yes	Yes
405	WL2	68.640	102.882	-13.612	Yes	Yes
406	WL2	69.640	102.232	-13.578	Yes	Yes
407	WL2	70.640	101.583	-13.543	Yes	Yes
408	WL2	71.640	100.933	-13.509	Yes	Yes
409	WL2	72.640	100.200	-13.474	Yes	Yes
410	WL2	73.640	99.600	-13.439	Yes	Yes
411	WL2	74.640	98.900	-13.405	Yes	Yes
412	WL2	75.640	98.200	-13.370	Yes	Yes
413	WL2	76.640	97.600	-13.336	Yes	Yes
414	WL2	77.640	97.000	-13.301	Yes	Yes
415	WL2	78.640	96.400	-13.266	Yes	Yes
416	WL2	79.640	95.800	-13.232	Yes	Yes
417	WL2	80.640	95.200	-13.197	Yes	Yes
418	WL2	81.640	94.600	-13.163	Yes	Yes
419	WL2	82.640	93.937	-13.128	Yes	Yes
420	WL2	83.640	93.312	-13.093	Yes	Yes
421	WL2	84.640	92.687	-13.059	Yes	Yes
422	WL2	85.640	92.063	-13.024	Yes	Yes
423	WL2	86.640	91.438	-12.990	Yes	Yes
424	WL2	87.640	91.000	-12.955	Yes	Yes
425	WL2	88.640	90.400	-12.920	Yes	Yes
426	WL2	89.640	89.800	-12.886	Yes	Yes
427	WL2	90.640	89.300	-12.851	Yes	Yes
428	WL2	91.640	88.675	-12.817	Yes	Yes
429	WL2	92.640	88.100	-12.782	Yes	Yes
430	WL2	93.640	87.500	-12.747	Yes	Yes
431	WL2	94.640	87.000	-12.713	Yes	Yes
432	WL2	95.640	86.400	-12.678	Yes	Yes
433	WL2	96.640	85.900	-12.644	Yes	Yes
434	WL2	97.640	85.400	-12.609	Yes	Yes
435	WL2	98.640	84.868	-12.574	Yes	Yes
436	WL2	99.640	84.337	-12.540	Yes	Yes
437	WL2	100.640	83.805	-12.505	Yes	Yes
438	WL2	101.640	83.273	-12.471	Yes	Yes
439	WL2	102.640	82.600	-12.436	Yes	Yes
440	WL2	103.640	82.068	-12.401	Yes	Yes
441	WL2	104.640	81.537	-12.367	Yes	Yes
442	WL2	105.640	81.005	-12.332	Yes	Yes
443	WL2	106.640	80.473	-12.298	Yes	Yes
444	WL2	107.640	79.900	-12.263	Yes	Yes
445	WL2	108.640	79.368	-12.228	Yes	Yes
446	WL2	109.640	78.837	-12.194	Yes	Yes
447	WL2	110.640	78.305	-12.159	Yes	Yes
448	WL2	111.640	77.773	-12.125	Yes	Yes
449	WL2	112.640	77.300	-12.090	Yes	Yes
450	WL2	113.640	76.768	-12.055	Yes	Yes
451	WL2	114.640	76.237	-12.021	Yes	Yes

TabTable

Delete results Cross Section
3D
alyse Plan
Analyse/Report

nt Points ×

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
51	WU1	62.640	100.100	-7.020	Yes	Yes
52	WU1	63.640	99.400	-6.985	Yes	Yes
53	WU1	64.640	98.700	-6.951	Yes	Yes
54	WU1	65.640	98.000	-6.916	Yes	Yes
55	WU1	66.640	97.400	-6.882	Yes	Yes
56	WU1	67.640	96.730	-6.847	Yes	Yes
57	WU1	68.640	96.080	-6.812	Yes	Yes
58	WU1	69.640	95.430	-6.778	Yes	Yes
59	WU1	70.640	94.780	-6.743	Yes	Yes
60	WU1	71.640	94.130	-6.709	Yes	Yes
61	WU1	72.640	93.400	-6.674	Yes	Yes
62	WU1	73.640	92.800	-6.639	Yes	Yes
63	WU1	74.640	92.100	-6.605	Yes	Yes
64	WU1	75.640	91.400	-6.570	Yes	Yes
65	WU1	76.640	90.800	-6.536	Yes	Yes
66	WU1	77.640	90.200	-6.501	Yes	Yes
67	WU1	78.640	89.600	-6.466	Yes	Yes
68	WU1	79.640	89.000	-6.432	Yes	Yes
69	WU1	80.640	88.400	-6.397	Yes	Yes
70	WU1	81.640	87.800	-6.363	Yes	Yes
71	WU1	82.640	87.140	-6.328	Yes	Yes
72	WU1	83.640	86.510	-6.293	Yes	Yes
73	WU1	84.640	85.890	-6.259	Yes	Yes
74	WU1	85.640	85.260	-6.224	Yes	Yes
75	WU1	86.640	84.640	-6.190	Yes	Yes
76	WU1	87.640	84.200	-6.155	Yes	Yes
77	WU1	88.640	83.600	-6.120	Yes	Yes
78	WU1	89.640	83.000	-6.086	Yes	Yes
79	WU1	90.640	82.500	-6.051	Yes	Yes
80	WU1	91.640	81.880	-6.017	Yes	Yes
81	WU1	92.640	81.300	-5.982	Yes	Yes
82	WU1	93.640	80.700	-5.947	Yes	Yes
83	WU1	94.640	80.200	-5.913	Yes	Yes
84	WU1	95.640	79.600	-5.878	Yes	Yes
85	WU1	96.640	79.100	-5.844	Yes	Yes
86	WU1	97.640	78.600	-5.809	Yes	Yes
87	WU1	98.640	78.070	-5.774	Yes	Yes
88	WU1	99.640	77.540	-5.740	Yes	Yes
89	WU1	100.640	77.000	-5.705	Yes	Yes
90	WU1	101.640	76.470	-5.671	Yes	Yes
91	WU1	102.640	75.800	-5.636	Yes	Yes
92	WU1	103.640	75.270	-5.601	Yes	Yes
93	WU1	104.640	74.740	-5.567	Yes	Yes
94	WU1	105.640	74.200	-5.532	Yes	Yes
95	WU1	106.640	73.670	-5.498	Yes	Yes
96	WU1	107.640	73.100	-5.463	Yes	Yes
97	WU1	108.640	72.570	-5.428	Yes	Yes
98	WU1	109.640	72.040	-5.394	Yes	Yes
99	WU1	110.640	71.500	-5.359	Yes	Yes
100	WU1	111.640	70.970	-5.325	Yes	Yes
101	WU1	112.640	70.500	-5.290	Yes	Yes

TabTable

PDisp 20.1

Delete results Cross Section
3D
Plan
Analyse/Report

Poin

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
151	WU2	46.640	118.200	-7.574	Yes	Yes
152	WU2	47.640	117.400	-7.539	Yes	Yes
153	WU2	48.640	116.700	-7.504	Yes	Yes
154	WU2	49.640	116.000	-7.470	Yes	Yes
155	WU2	50.640	115.150	-7.435	Yes	Yes
156	WU2	51.640	114.532	-7.401	Yes	Yes
157	WU2	52.640	114.000	-7.366	Yes	Yes
158	WU2	53.640	113.200	-7.331	Yes	Yes
159	WU2	54.640	112.500	-7.297	Yes	Yes
160	WU2	55.640	111.800	-7.262	Yes	Yes
161	WU2	56.640	111.000	-7.228	Yes	Yes
162	WU2	57.640	110.400	-7.193	Yes	Yes
163	WU2	58.640	109.800	-7.158	Yes	Yes
164	WU2	59.640	109.000	-7.124	Yes	Yes
165	WU2	60.640	108.400	-7.089	Yes	Yes
166	WU2	61.640	107.600	-7.055	Yes	Yes
167	WU2	62.640	106.900	-7.020	Yes	Yes
168	WU2	63.640	106.200	-6.985	Yes	Yes
169	WU2	64.640	105.500	-6.951	Yes	Yes
170	WU2	65.640	104.800	-6.916	Yes	Yes
171	WU2	66.640	104.200	-6.882	Yes	Yes
172	WU2	67.640	103.531	-6.847	Yes	Yes
173	WU2	68.640	102.882	-6.812	Yes	Yes
174	WU2	69.640	102.232	-6.778	Yes	Yes
175	WU2	70.640	101.583	-6.743	Yes	Yes
176	WU2	71.640	100.933	-6.709	Yes	Yes
177	WU2	72.640	100.200	-6.674	Yes	Yes
178	WU2	73.640	99.600	-6.639	Yes	Yes
179	WU2	74.640	98.900	-6.605	Yes	Yes
180	WU2	75.640	98.200	-6.570	Yes	Yes
181	WU2	76.640	97.600	-6.536	Yes	Yes
182	WU2	77.640	97.000	-6.501	Yes	Yes
183	WU2	78.640	96.400	-6.466	Yes	Yes
184	WU2	79.640	95.800	-6.432	Yes	Yes
185	WU2	80.640	95.200	-6.397	Yes	Yes
186	WU2	81.640	94.600	-6.363	Yes	Yes
187	WU2	82.640	93.937	-6.328	Yes	Yes
188	WU2	83.640	93.312	-6.293	Yes	Yes
189	WU2	84.640	92.687	-6.259	Yes	Yes
190	WU2	85.640	92.063	-6.224	Yes	Yes
191	WU2	86.640	91.438	-6.190	Yes	Yes
192	WU2	87.640	91.000	-6.155	Yes	Yes
193	WU2	88.640	90.400	-6.120	Yes	Yes
194	WU2	89.640	89.800	-6.086	Yes	Yes
195	WU2	90.640	89.300	-6.051	Yes	Yes
196	WU2	91.640	88.675	-6.017	Yes	Yes
197	WU2	92.640	88.100	-5.982	Yes	Yes
198	WU2	93.640	87.500	-5.947	Yes	Yes
199	WU2	94.640	87.000	-5.913	Yes	Yes
200	WU2	95.640	86.400	-5.878	Yes	Yes
201	WU2	96.640	85.900	-5.844	Yes	Yes

TabTable

ıp 20.1

Delete results Cross Secti
3D
Plan
Analyse/Report

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
251	WL1	30.640	124.216	-14.927	Yes	Yes
252	WL1	31.640	123.250	-14.893	Yes	Yes
253	WL1	32.640	122.400	-14.858	Yes	Yes
254	WL1	33.640	121.600	-14.823	Yes	Yes
255	WL1	34.640	120.800	-14.789	Yes	Yes
256	WL1	35.640	120.100	-14.754	Yes	Yes
257	WL1	36.640	119.300	-14.720	Yes	Yes
258	WL1	37.640	118.500	-14.685	Yes	Yes
259	WL1	38.640	117.700	-14.650	Yes	Yes
260	WL1	39.640	116.900	-14.616	Yes	Yes
261	WL1	40.640	116.200	-14.581	Yes	Yes
262	WL1	41.640	115.200	-14.547	Yes	Yes
263	WL1	42.640	114.600	-14.512	Yes	Yes
264	WL1	43.640	113.800	-14.477	Yes	Yes
265	WL1	44.640	113.000	-14.443	Yes	Yes
266	WL1	45.640	112.200	-14.408	Yes	Yes
267	WL1	46.640	111.400	-14.374	Yes	Yes
268	WL1	47.640	110.600	-14.339	Yes	Yes
269	WL1	48.640	109.900	-14.304	Yes	Yes
270	WL1	49.640	109.200	-14.270	Yes	Yes
271	WL1	50.640	108.350	-14.235	Yes	Yes
272	WL1	51.640	107.732	-14.201	Yes	Yes
273	WL1	52.640	107.200	-14.166	Yes	Yes
274	WL1	53.640	106.400	-14.131	Yes	Yes
275	WL1	54.640	105.700	-14.097	Yes	Yes
276	WL1	55.640	105.000	-14.062	Yes	Yes
277	WL1	56.640	104.200	-14.028	Yes	Yes
278	WL1	57.640	103.600	-13.993	Yes	Yes
279	WL1	58.640	103.000	-13.958	Yes	Yes
280	WL1	59.640	102.200	-13.924	Yes	Yes
281	WL1	60.640	101.600	-13.889	Yes	Yes
282	WL1	61.640	100.800	-13.855	Yes	Yes
283	WL1	62.640	100.100	-13.820	Yes	Yes
284	WL1	63.640	99.400	-13.785	Yes	Yes
285	WL1	64.640	98.700	-13.751	Yes	Yes
286	WL1	65.640	98.000	-13.716	Yes	Yes
287	WL1	66.640	97.400	-13.682	Yes	Yes
288	WL1	67.640	96.731	-13.647	Yes	Yes
289	WL1	68.640	96.082	-13.612	Yes	Yes
290	WL1	69.640	95.432	-13.578	Yes	Yes
291	WL1	70.640	94.783	-13.543	Yes	Yes
292	WL1	71.640	94.133	-13.509	Yes	Yes
293	WL1	72.640	93.400	-13.474	Yes	Yes
294	WL1	73.640	92.800	-13.439	Yes	Yes
295	WL1	74.640	92.100	-13.405	Yes	Yes
296	WL1	75.640	91.400	-13.370	Yes	Yes
297	WL1	76.640	90.800	-13.336	Yes	Yes
298	WL1	77.640	90.200	-13.301	Yes	Yes
299	WL1	78.640	89.600	-13.266	Yes	Yes
300	WL1	79.640	89.000	-13.232	Yes	Yes

TabTable

Disp 20.1

Delete results Cross Section

3D

Plan

Analyse/Report

ints ×

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
351	WL2	14.640	144.393	-15.481	Yes	Yes
352	WL2	15.640	143.583	-15.446	Yes	Yes
353	WL2	16.640	142.774	-15.412	Yes	Yes
354	WL2	17.640	141.964	-15.377	Yes	Yes
355	WL2	18.640	140.839	-15.342	Yes	Yes
356	WL2	19.640	140.029	-15.308	Yes	Yes
357	WL2	20.640	139.220	-15.273	Yes	Yes
358	WL2	21.640	138.410	-15.239	Yes	Yes
359	WL2	22.640	137.600	-15.204	Yes	Yes
360	WL2	23.640	136.470	-15.169	Yes	Yes
361	WL2	24.640	135.660	-15.135	Yes	Yes
362	WL2	25.640	134.850	-15.100	Yes	Yes
363	WL2	26.640	134.150	-15.066	Yes	Yes
364	WL2	27.640	133.400	-15.031	Yes	Yes
365	WL2	28.640	132.676	-14.996	Yes	Yes
366	WL2	29.640	131.710	-14.962	Yes	Yes
367	WL2	30.640	131.016	-14.927	Yes	Yes
368	WL2	31.640	130.050	-14.893	Yes	Yes
369	WL2	32.640	129.200	-14.858	Yes	Yes
370	WL2	33.640	128.400	-14.823	Yes	Yes
371	WL2	34.640	127.600	-14.789	Yes	Yes
372	WL2	35.640	126.900	-14.754	Yes	Yes
373	WL2	36.640	126.100	-14.720	Yes	Yes
374	WL2	37.640	125.300	-14.685	Yes	Yes
375	WL2	38.640	124.500	-14.650	Yes	Yes
376	WL2	39.640	123.700	-14.616	Yes	Yes
377	WL2	40.640	123.000	-14.581	Yes	Yes
378	WL2	41.640	122.000	-14.547	Yes	Yes
379	WL2	42.640	121.400	-14.512	Yes	Yes
380	WL2	43.640	120.600	-14.477	Yes	Yes
381	WL2	44.640	119.800	-14.443	Yes	Yes
382	WL2	45.640	119.000	-14.408	Yes	Yes
383	WL2	46.640	118.200	-14.374	Yes	Yes
384	WL2	47.640	117.400	-14.339	Yes	Yes
385	WL2	48.640	116.700	-14.304	Yes	Yes
386	WL2	49.640	116.000	-14.270	Yes	Yes
387	WL2	50.640	115.150	-14.235	Yes	Yes
388	WL2	51.640	114.532	-14.201	Yes	Yes
389	WL2	52.640	114.000	-14.166	Yes	Yes
390	WL2	53.640	113.200	-14.131	Yes	Yes
391	WL2	54.640	112.500	-14.097	Yes	Yes
392	WL2	55.640	111.800	-14.062	Yes	Yes
393	WL2	56.640	111.000	-14.028	Yes	Yes
394	WL2	57.640	110.400	-13.993	Yes	Yes
395	WL2	58.640	109.800	-13.958	Yes	Yes
396	WL2	59.640	109.000	-13.924	Yes	Yes
397	WL2	60.640	108.400	-13.889	Yes	Yes
398	WL2	61.640	107.600	-13.855	Yes	Yes
399	WL2	62.640	106.900	-13.820	Yes	Yes
400	WL2	63.640	106.200	-13.785	Yes	Yes
401	WL2	64.640	105.500	-13.751	Yes	Yes

TabTable

Delete results   Cross Section

3D

Plan

Analyse/Report

Ref.	Name	X	Y	Z(level)	Calculate	Detailed Results
		[m]	[m]	[m]		
Defaults	Displacement Point #	0.000	0.000	0.000	Yes	Yes
416	WL2	79.640	95.800	-13.232	Yes	Yes
417	WL2	80.640	95.200	-13.197	Yes	Yes
418	WL2	81.640	94.600	-13.163	Yes	Yes
419	WL2	82.640	93.937	-13.128	Yes	Yes
420	WL2	83.640	93.312	-13.093	Yes	Yes
421	WL2	84.640	92.687	-13.059	Yes	Yes
422	WL2	85.640	92.063	-13.024	Yes	Yes
423	WL2	86.640	91.438	-12.990	Yes	Yes
424	WL2	87.640	91.000	-12.955	Yes	Yes
425	WL2	88.640	90.400	-12.920	Yes	Yes
426	WL2	89.640	89.800	-12.886	Yes	Yes
427	WL2	90.640	89.300	-12.851	Yes	Yes
428	WL2	91.640	88.675	-12.817	Yes	Yes
429	WL2	92.640	88.100	-12.782	Yes	Yes
430	WL2	93.640	87.500	-12.747	Yes	Yes
431	WL2	94.640	87.000	-12.713	Yes	Yes
432	WL2	95.640	86.400	-12.678	Yes	Yes
433	WL2	96.640	85.900	-12.644	Yes	Yes
434	WL2	97.640	85.400	-12.609	Yes	Yes
435	WL2	98.640	84.868	-12.574	Yes	Yes
436	WL2	99.640	84.337	-12.540	Yes	Yes
437	WL2	100.640	83.805	-12.505	Yes	Yes
438	WL2	101.640	83.273	-12.471	Yes	Yes
439	WL2	102.640	82.600	-12.436	Yes	Yes
440	WL2	103.640	82.068	-12.401	Yes	Yes
441	WL2	104.640	81.537	-12.367	Yes	Yes
442	WL2	105.640	81.005	-12.332	Yes	Yes
443	WL2	106.640	80.473	-12.298	Yes	Yes
444	WL2	107.640	79.900	-12.263	Yes	Yes
445	WL2	108.640	79.368	-12.228	Yes	Yes
446	WL2	109.640	78.837	-12.194	Yes	Yes
447	WL2	110.640	78.305	-12.159	Yes	Yes
448	WL2	111.640	77.773	-12.125	Yes	Yes
449	WL2	112.640	77.300	-12.090	Yes	Yes
450	WL2	113.640	76.768	-12.055	Yes	Yes
451	WL2	114.640	76.237	-12.021	Yes	Yes
452	WL2	115.640	75.705	-11.986	Yes	Yes
453	WL2	116.640	75.173	-11.952	Yes	Yes
454	WL2	117.640	74.800	-11.917	Yes	Yes
455	WL2	118.640	74.268	-11.882	Yes	Yes
456	WL2	119.640	73.737	-11.848	Yes	Yes
457	WL2	120.640	73.205	-11.813	Yes	Yes
458	WL2	121.640	72.673	-11.779	Yes	Yes
459	WL2	122.640	72.400	-11.744	Yes	Yes
460	WL2	123.640	71.868	-11.709	Yes	Yes
461	WL2	124.640	71.337	-11.675	Yes	Yes
462	WL2	125.640	70.805	-11.640	Yes	Yes
463	WL2	126.640	70.273	-11.606	Yes	Yes
464	WL2	127.640	69.900	-11.571	Yes	Yes
465						

TabTable

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