Queries from Campbell Reith 14/09/2016

Response to para 4.7 - Item 1

Our query with respect to the length of the elements was in relation to wall lengths and heights. We had the impression that width and height of the New End Theatre are less than assumed in your modelling (i.e. is it appropriate to take 7.9m when it is a single storey structure with a pitched roof?). It would also appear from KSR drawing NEN - PL - 003 that the theatre is only 2 -3 m from the proposed basement.

Although some wall heights of New End Theatre are smaller in reality than assumed, the adopted wall height of 7.9m used in the analyses should provide more conservative estimates of the building damage category for this structure.

The maximum flexural tensile strain in the wall will be proportional to the distance from the neutral axis to the extreme bending fibre, per the relationship M/I = σ/y. It is considered then that a larger wall height will be subject to relatively higher tensile flexural strain then a shorter height wall, for the same greenfield ground movement. Another way of looking at it would be that if the wall height was infinitesimally small, it could only be damaged due to tensile ground strains. The damage of the wall is increased as the wall height increases due to additional tensile strains developed through flexure, which are proportional to wall height.

Referring to Figure 1 below, the relative location of New End Theatre to the proposed basement retaining wall can be seen explicitly. The basement retaining wall outline can be seen to divert away from New End Theatre. The relative setting out of the excavation and the surrounding buildings used for the Xdisp analyses is based on the available survey information as presented. It is our belief that building damage assessment captures this geometry accurately.

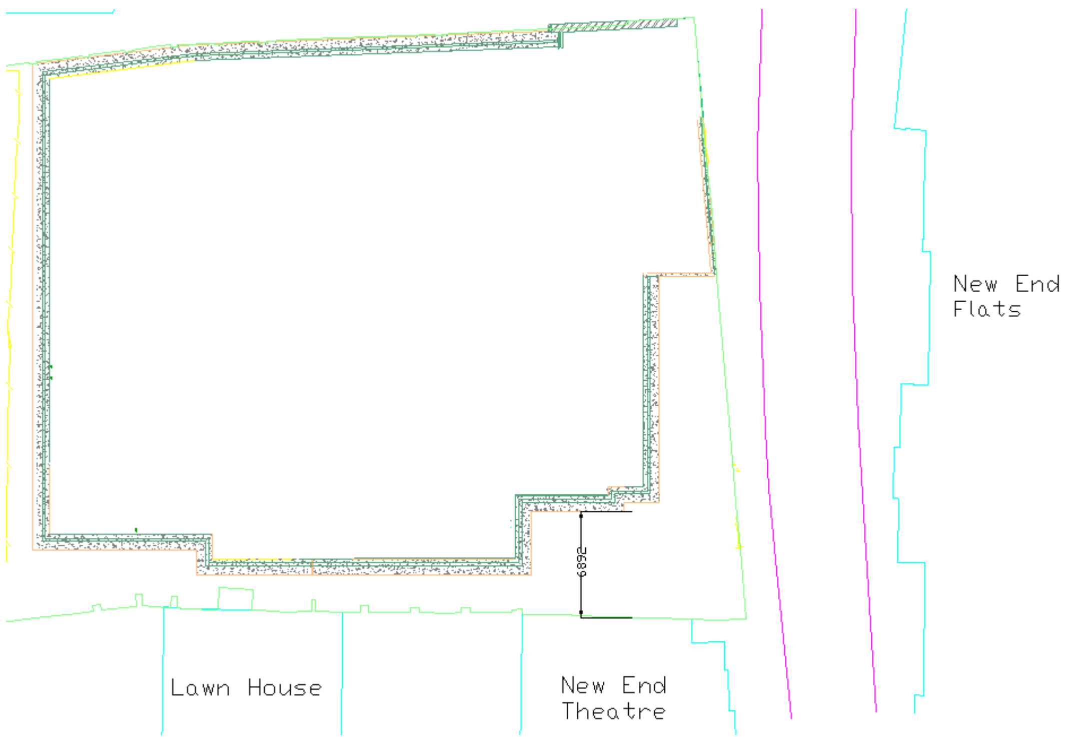


Figure 1: Relative position of New End Theatre to proposed development. Offset approximately 6.8m.

Response to para 4.7 - Item 3

You refer to cohesive soils below 102m OD. The factual information supplied by SCL shows a significant cohesive layer below 112m OD. Can you please clarify the ground model (that presented in Tables 2.1 and 2.2 does not give elevations and Fig 2.3 is difficult to interpret).
Is there a possible explanation for the 'outlier' in the data exhibited by BH101? It is difficult to ignore it if it cannot be explained.

The ground model adopted for the analysis was as follows:

EGL to +113m AOD: Bagshot Sand

+113m AOD to 105m AOD: Bagshot Sandy Silty Clays

+105 m to 102m AOD: Bagshot Sand

<102m AOD: Claygate beds underlain by the London Clay Formation.

The clay layer referred to is a part of the Bagshot Formation, which was typically described as a sandy/silty Clays and identified between approximately +113m AOD to +105m AOD in the site investigation report. Figure 2 reproduced from the recent GIR illustrates the assumed stratigraphic profile through the site.

This layer was incorporated into the FE modelling, between the elevations described previously. For modelling purposes it was considered to be conservative to model this layer as drained, as there may be numerous drainage paths from interconnected sand lenses within the deposit, which may enable relatively fast dissipation of excess pore pressures. The effective stress parameters were estimated based on the plasticity index of the clay, as shown in the GMA. This is considered to be conservative as the shear strength of the soil based on effective stress parameters would be typically less than the strength of the soil if a short-term undrained strength was adopted (based on say $s_u = 5N_{60}$). Thus, in the FE modelling, larger ground strains would be induced.

The exact reason for the outlier values at BH101 is not known with absolute certainty. It is suspected that it may be related to the development history of the site and potentially associated with the construction of a undercroft housing boiler/plant room in close proximity to this borehole (refer Figure 3). Additionally, the materials in nearer the ground surface are logged as comprising a relatively higher clay content (below the made ground), so the SPT results may be reflecting this as well.

Notwithstanding, the values of BH101 (or the presence of worse than expected ground conditions) have not been ignored. Sensitivity analyses were carried out in-house (which were not presented as part of the GMA) adopting stiffness properties of the Bagshot Beds equal to half of the base assessment case (which would effectively coincide with the low values identified in BH101). The stiffness of all the wall and plate elements were also halved. The increase in ground movements was not extreme, with maximum horizontal wall deflections in the order of 25mm. This level of movement was not anticipated to increase the damage category of Lawn House beyond the currently estimated damage category of Slight.

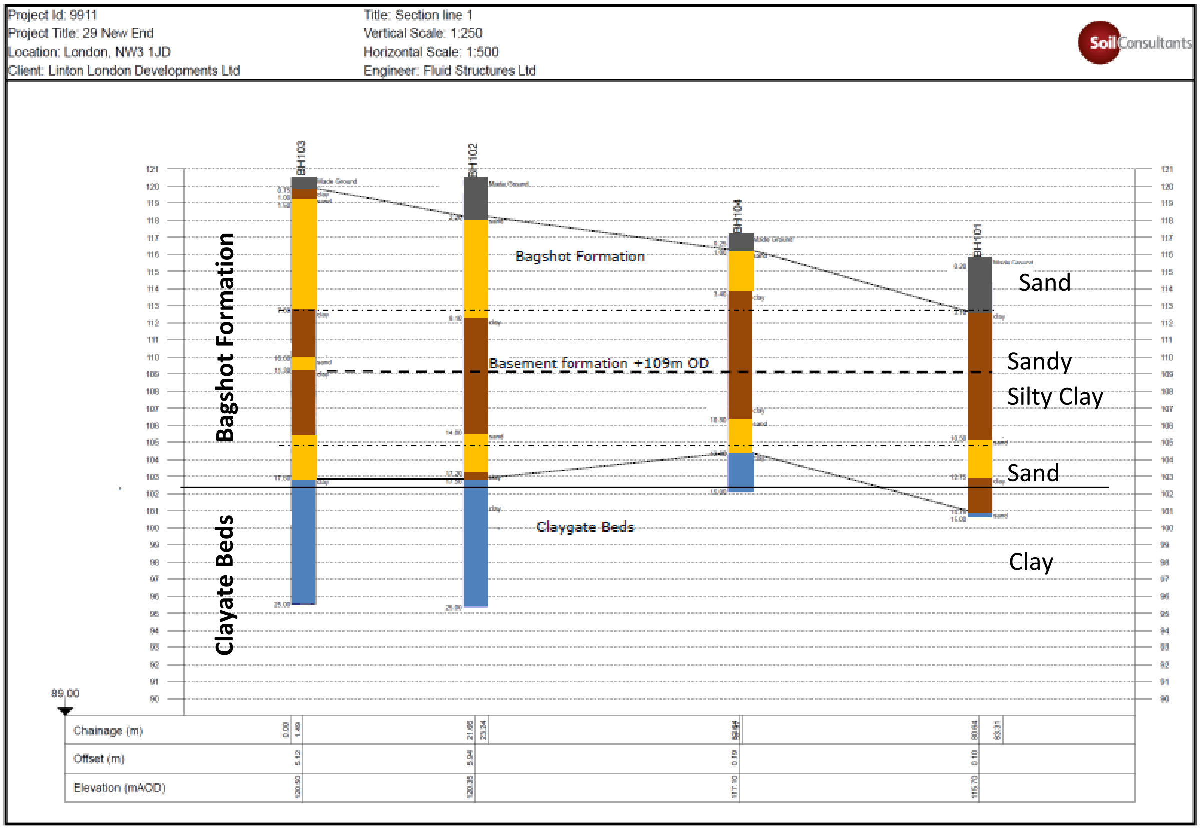


Figure 2: Delineation of Sand and sandy silty Clay of Bagshot Formation (modified from GIR report in BIA).

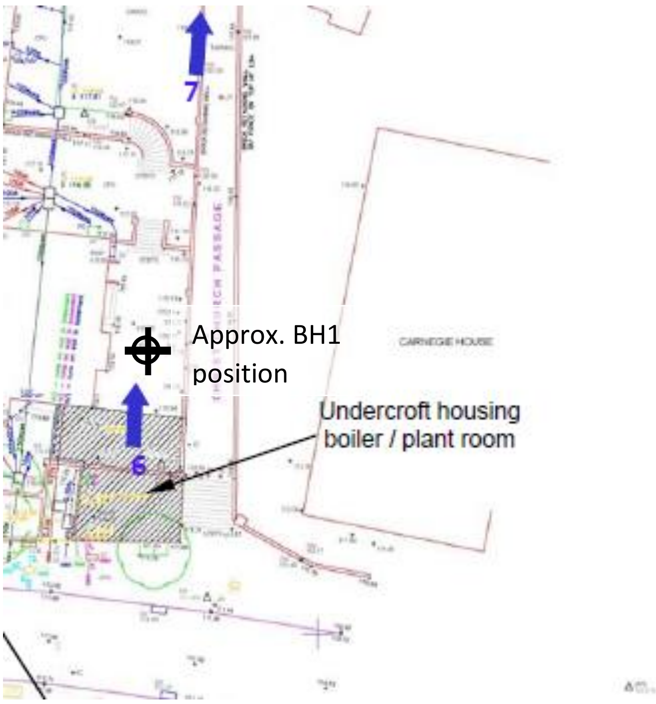


Figure 3: Position of BH1 near to existing undercroft (extracted from GIR).

I am confused as to whether walls are propped or are to act as cantilevers, and have some other queries.

For clarity:

- During construction, the temporary sheet pile walls required to enable secant pile wall installation are shown as having some temporary propping provided. Refer highlights in Figure 4.
- During construction, the secant pile walls are propped from a high level with large diameter CHS Sections. Refer highlights in Figure 5.
- In the permanent case, the walls are partially propped by the permanent basement/floor slabs with the top portion of the wall cantilevering in some locations. Drawing sections BIA/006-1 to BIA/006-5 (Appendix E of BIA) best illustrate the typical wall restraint following the end of construction.

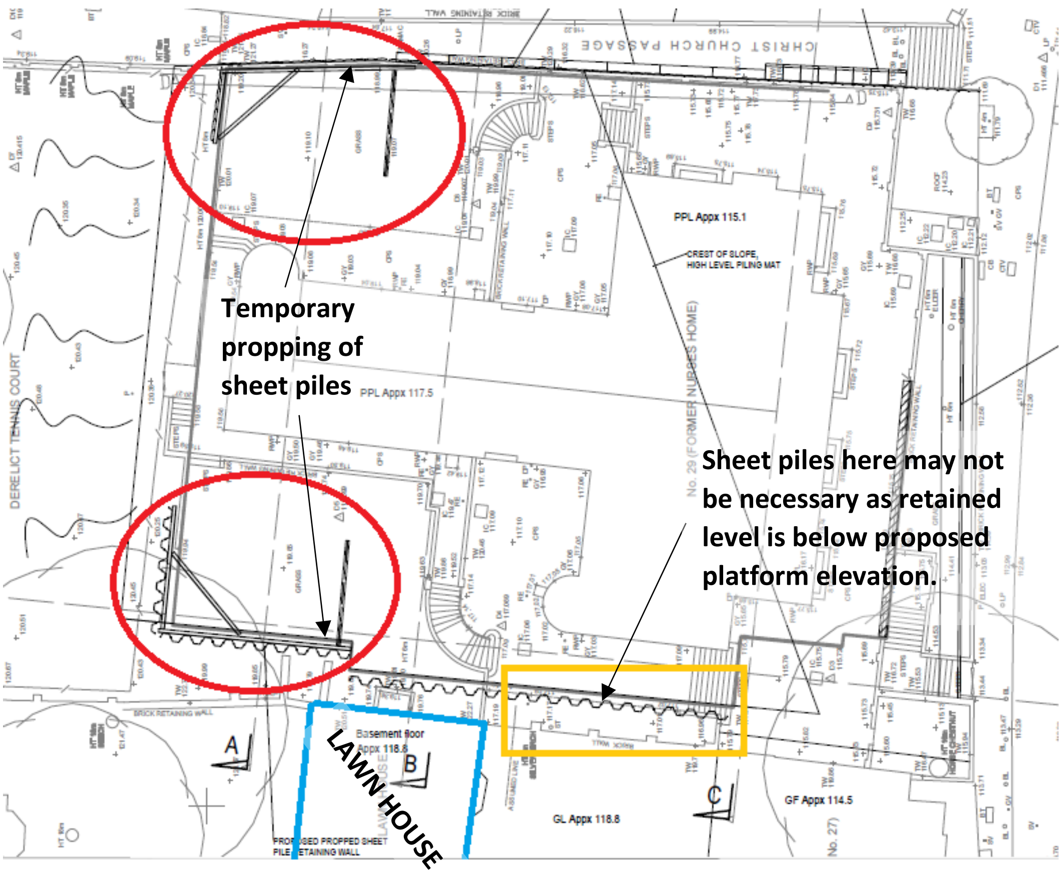


Figure 4: Preliminary arrangement of temporary sheet pile and propping to enable secant pile wall construction.

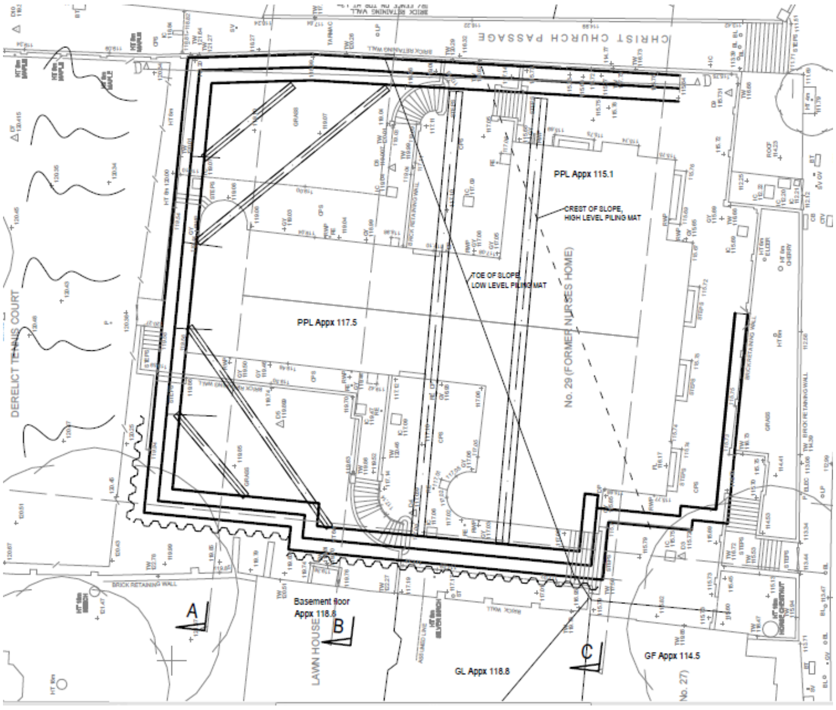


Figure 5: Temporary propping of secant piles during construction (lower level shown). Temporary sheet piles are not actively retaining any ground.

Item 5 - paras 1 & 2 - you note that the sheet pile walls have been considered in the FEA and then state that 'it is expected that the proposed temporary retention ..... will not lead to excessive ground deformations'. Is that confirmed by the FEA?

Yes.

We have assessed two scenarios, which incorporate sheet piles without a temporary prop and sheet piles with a temporary prop. The horizontal ground movements at the sheet pile wall are estimated to be less than 5mm in both cases. Output from both cases is provided in Figure 6 and Figure 7.

It is considered that the magnitude of deflection is unlikely to be associated with damage to the existing condition of Lawn House. Furthermore, as noted in our correspondence, the foundation level of Lawn House walls is estimated to be lower than the level assumed in the GMA, so the predicted movements should err on the side of conservatism.

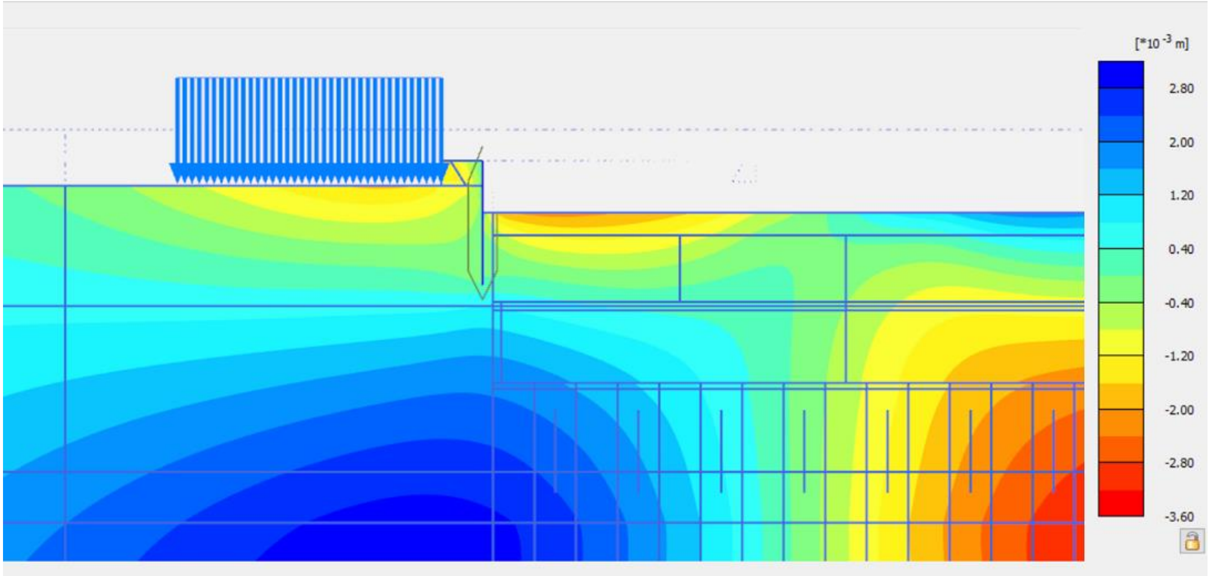


Figure 6: Horizontal ground deformation with sheet pile wall cantilevered in temporary case.

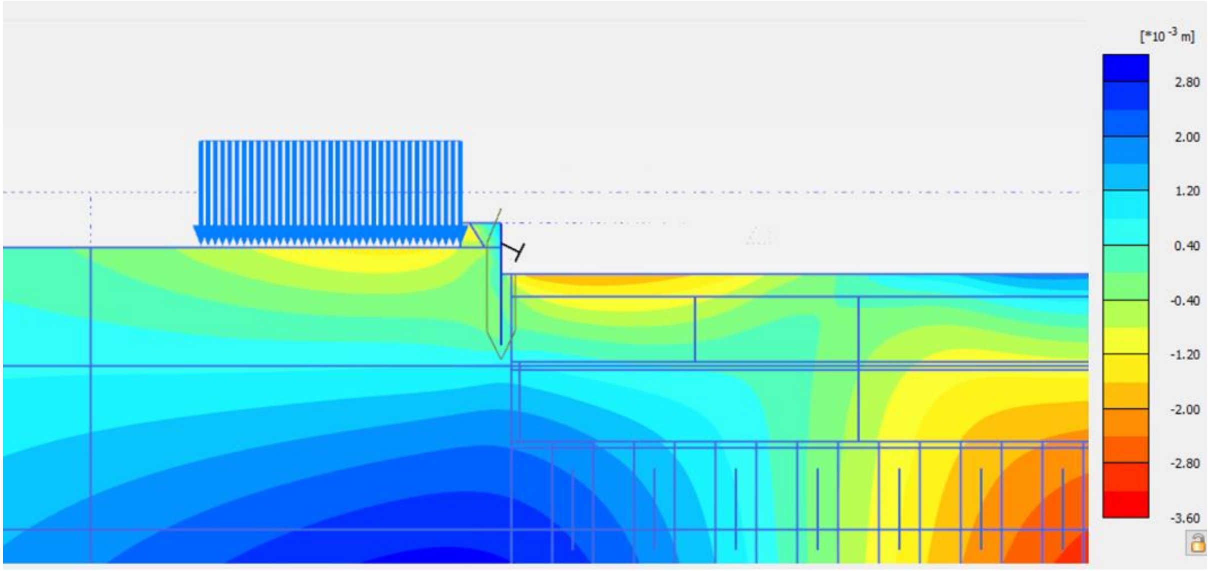


Figure 7: Horizontal Ground Movement with propped temporary sheet pile to enabling secant piling operations

Item 5 - para 3 - when you refer to nearby propping, does this mean the sheet pile walls are not cantilevers?

As noted previously, Contractors Preliminary temporary works sketches (included in the BIA), do show some propping of the temporary sheet pile wall will be installed in front of and adjacent too Lawn House. As noted, we have considered two cases with temporary propping and without temporary propping. Both scenarios appear feasible based on the analyses, evidently the propped scenario will always lead to lower estimates of ground movement.

Given that the drawings are of Preliminary status, it is our expectation that the final position of temporary propping for the temporary sheet pile wall may be refined/optimised to best meet the needs of the mitigating risk of ground movements affecting adjacent buildings, during this phase of the works, whilst accommodating buildability requirements.

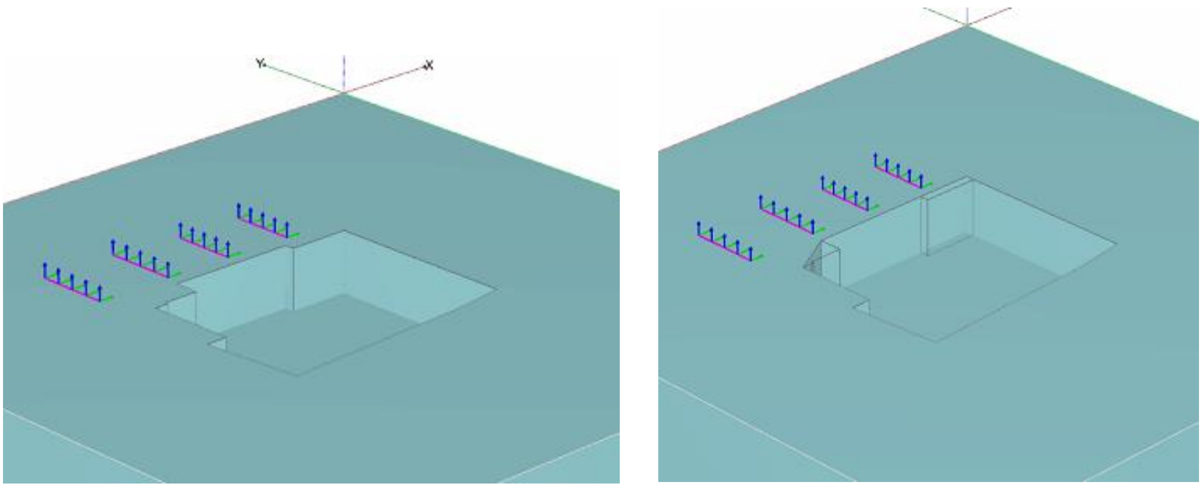
Item 6 - para 3 - this suggests that all walls are propped in the permanent and temporary case which appears to contradict the paragraphs above and below.

It is hoped that the previous discussions and figures have cleared this up appropriately.

Item 6 - para 4 - whilst we concur that 2D analyses tend to overestimate ground movements, your modelling at the moment does not allow for the re-entrant corners in the SW and NW. How might this affect the damage predictions?

There is no consistent means by which the effect of re-entrant corners can be handled with simplified models such as Xdisp. The approach taken for the New End basement analysis was to simplify the excavation geometry and remove the re-entrant corners by offsetting the excavation perimeter as shown in Figure 8. The removal of the re-entrant corners by the adopted method, was assessed to be conservative because the process effectively decreased the distance between the nearest retaining wall and neighbouring structure.

A check was carried out by modelling both (actual and simplified, i.e. without re-entrant corners) excavation geometries in a simplified 3D model, with the ground mass represented by a linear elastic material. Figure 9 and 10 illustrate the distribution in ground contours between the “realistic” and “simplified” excavation geometries. It is noted that the patterns of ground movement between both methods are very similar. Secondly, a comparison was made between the ground movements at the north and south walls of Lawn House and New End Theatre, which are shown in Figure 11. These figures show the ratio of total ground movement estimated from the simplified excavation geometry to the actual excavation geometry. It is observed that the simplified excavation geometry tends to predict larger ground movements than if the actual geometry was adopted (typically about 102% – 105% at the north and south walls of Lawn House and New End Theatre), due to the relative increased proximity of the excavation to the wall elements. On this basis it was assessed that the simplified excavation geometry adopted for the building damage assessment was satisfactory.



(a) (b)

Figure 8: (a) Actual excavation geometry (b) Simplified excavation geometry

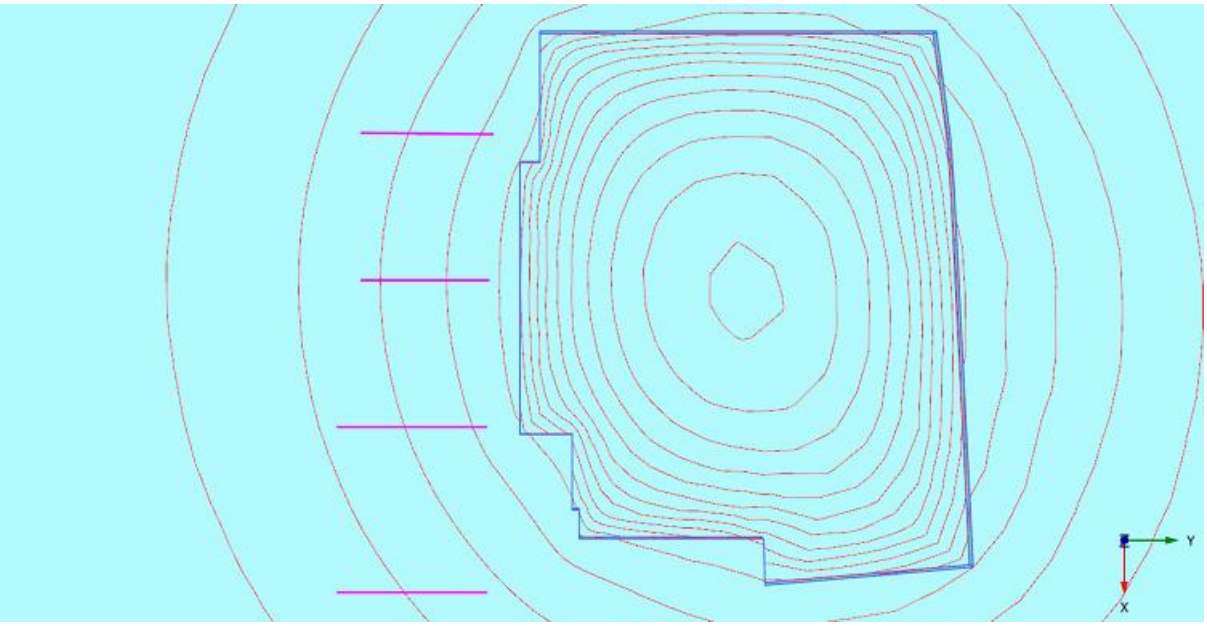


Figure 9: Contours of total ground movement due to excavation using actual basement geometry.

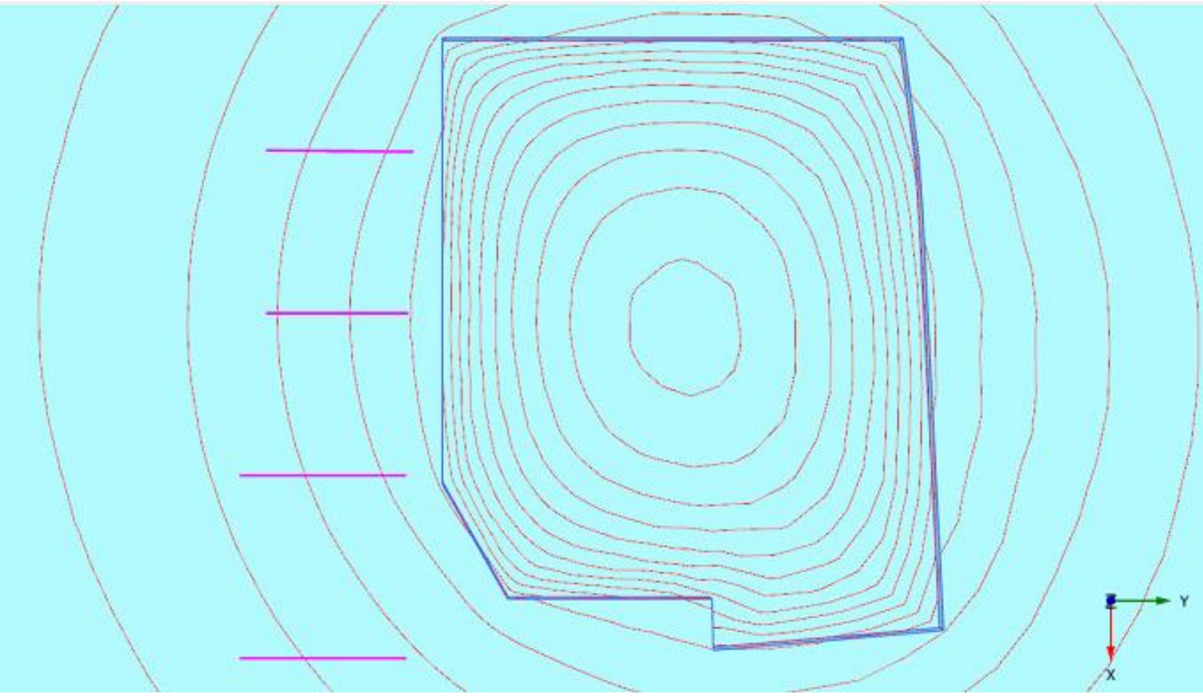


Figure 10: Contours of total ground surface movement from simplified model with re-entrant corners removed.

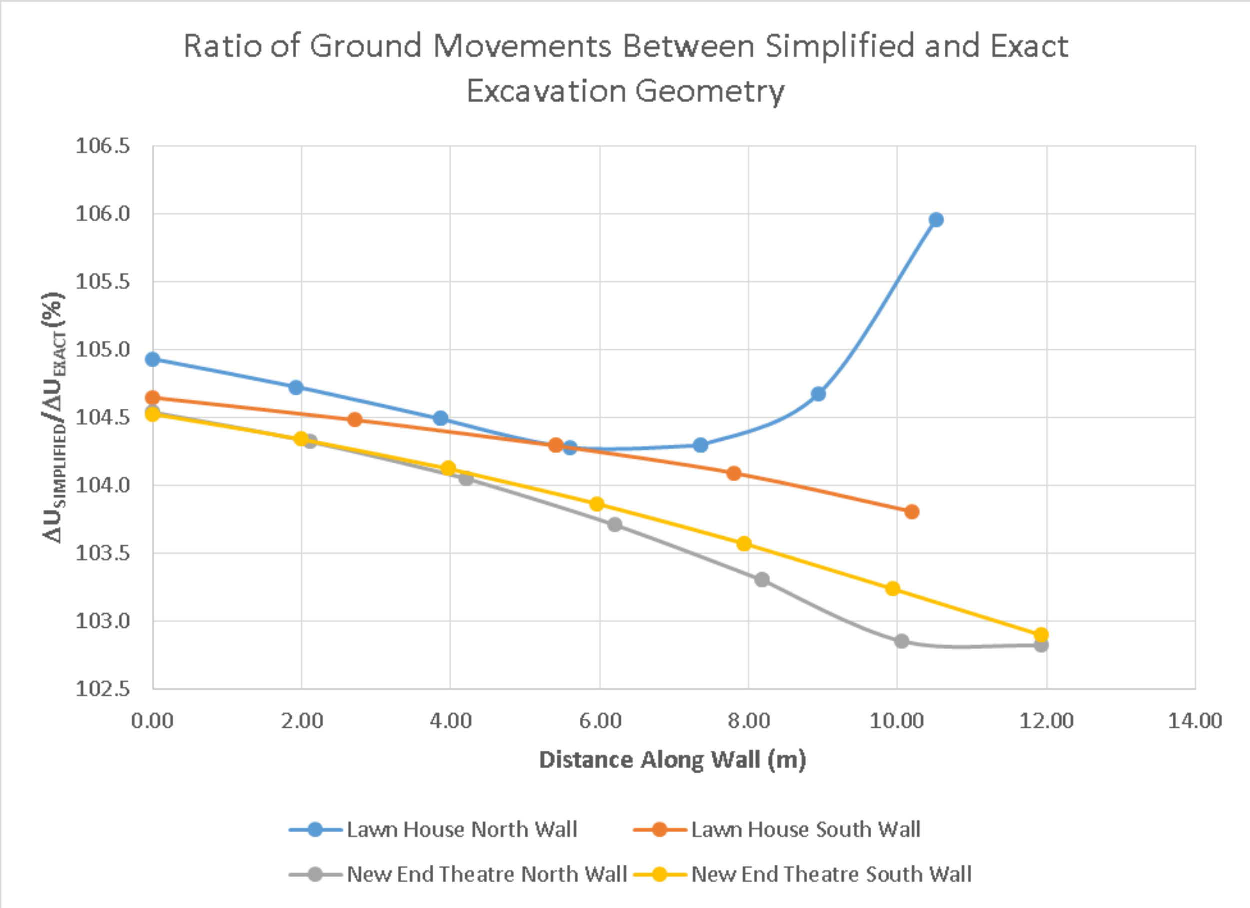


Figure 11: Ratio of ground movements at building walls evaluated from simplified excavation geometry and exact excavation geometry.

Finally, Fluid Structures note in their letter dated 22 July that a 3D model has been developed. Can you confirm the results of that modelling?

The bulk of the modelling has been finsihed, with some parametric analyses being concluded. Without preceding the outcomes of the report, the ground movements predicted by the 3D modelling thus far are generally compatible with the magnitudes estimated from the 2D/Ciria approach.

Can you also confirm the mitigation measures that have been incorporated to minimise potential damage as required by CPG4.

Please refer to Section 10 of the BIA where, based on the estimated building damage categories of zero and borderline 1-2, no further mitigation measures are deemed necessary or appropriate. This is also consistent with and validates the previously audited pre-planning BIA and GMA prepared by others (September 2012).

It should be noted that Campbell Reith has not undertaken a detailed check but has reviewed the submitted information for clarity, reasonableness and robustness. Due to the geometry of the site and the sensitivity of the surrounding structures, we will be recommending that a Basement

Construction Plan is prepared in which a more detailed analysis will be required together with an independent detailed check.

Noted.