Reef Group c/o the Trustees of the St Pancras Way Block A Unit Trust

SITE AT THE UGLY BROWN BUILDING, LONDON

Thames Water Asset Assessment Report

Project no. 371654-03 (03)

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RSK GENERAL NOTES

Project No.: 371654-03 (03)

Title: Thames Water Asset Assessment Report for Ugly Brown Building, London, NW1 0TB

Client: Reef Group c/o the Trustees of the St Pancras Way Block A Unit Trust

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

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1 INTRODUCTION

On the instructions of GD Partnership, on behalf of Reef Group c/o the Trustees of the St Pancras Way Block A Unit Trust (the client), RSK Environment Ltd has been commissioned to assess the likely ground movements and associated potential impacts to local Thames Water (TW) sewer assets that will result from the redevelopment of the site through the demolition of the existing UBB building and erection of 6 new buildings ranging in height from 2 storeys to 12 storeys above ground and 2 basement levels, for a mixed use business floorspace, residential, hotel, gym and flexible retail and storage space development and with associated landscaping The TW sewer assets to be assessed within this report are detailed below.

- An existing ~2100 mm diameter (ID) Thames Water (TW) brick sewer, formerly part of London historic sewer system, which bisects the site beneath the northern part of the site; and
- An existing ~1200 mm diameter becoming 1100 mm (ID) Thames Water brick sewer (Culverted River Fleet), which is located beneath St Pancras Way.
- An existing 4" cast iron clean water asset located beneath St Pancras Way.
- An existing ~400mm ductile iron foul water connection from the site (located between Plot A and B), joining into the 1200mm Thames Water brick sewer in St Pancras Way.

See Figure Nos 1, 2 and 3 for site location plan, outline plan of proposed scheme and layout of TW sewers relative to the proposed development.

The opinions and recommendations expressed in this report are based on the ground conditions encountered and the results of field and laboratory testing and interpretation between exploratory holes from the site investigation works undertaken by RSK Environment Ltd in August 2019, report ref provided in Section 2. The material encountered and samples obtained represent only a small proportion of the materials present on-site, therefore other conditions may prevail at the site which have not been revealed by the investigation.

This report is subject to the RSK service constraints given in **Appendix A**.

2 PROJECT BACKGROUND

The site is located at 2-6 St Pancras Way in the London Borough of Camden and is occupied with a concrete structure known as the Ugly Brown Building (UBB). The northern building is currently vacant (Former Administration Building - Block A), the central building (former Welfare block - Block B) is occupied by Ted Baker Head quarters and the southern building (former sorting office - Block C) is occupied by the Verizon Data Centre, which is very sensitive to noise and vibration. Historically the site was occupied by a five-storey masonry structure called 'St Pancras Ale & Corn store', later became known as the Granary.

The Regent's Canal is located to the Northeast and east of the site. To the southwest/west of the site is St Pancras Way, with Granary Street to the south/southeast beyond which lies St Pancras Hospital. The existing building 'Canal Side Studios', formerly known as 'Atlantic Metals Building', occupies the north/northwest boundary of the site. To the west of the site are a series of three buildings owned by Travis Perkins and a further building known as Beaumont Court.

It is understood from information provided by GD Partnership Ltd that the middle level sewer no. 2, a part of London's historic sewer system and now part of the Thames Water Authority's system, was constructed by tunnelling across the northern part of the site. The line and level survey drawing (reference 38961T-01-Rev B, dated 03/03/20), indicates the sewer is ~2.12-2.14 m in diameter, of brick construction, with an invert level, where it passes beneath the site, of 13.61 m AOD. The Thames Water service plan indicates the sewer is approximately 2.13 m in diameter and is brick lined throughout, with its crown about 4.5 m below the canal bed level at an approximate level of 15.60 m AOD. The southern end of the administration block of UBB has been built bridging over the sewer with contiguous piles outside the easement area. The culverted course of the former River Fleet is also understood to run below St Pancras Way. Reference to the line and level survey indicates that the part running parallel to Block A comprises a brick lined sewer measuring 1219 mm x 787 mm with an invert level of 16.49 m AOD. After it passes the middle level sewer no.2, the sewer measures 1093 mm x 762 mm with an invert level of 15.69 m AOD. The clean water asset, located in St Pancras way, is understood to comprise a 100mm (4") cast iron pipe. The foul water connection from the site to the Thames Water brick sewer in St Pancras Way is understood to comprise a 400mm ductile iron pipe. The line of the both the freshwater main and the foul water connection has been taken from GDP Partnership drawing reference 16-017 GDP-ZA1-00-DR-C-5201, dated July 2020. Information on the sewer is provided in **Appendix B**.

The client has requested that an assessment be undertaken to estimate the likely magnitude of ground movements and the associated damage that would impact the various sewers as a result of the proposed development.

RSK have previously completed a preliminary ground movement assessment report in 2017 and more recently a ground investigation report and an updated ground movement assessment / Thames Water asset assessment, which are referenced below.

- RSK Environment Limited, Site at the Ugly Brown Building, London NW1 0TB Preliminary Ground Movement Assessment, reference 371654-L01 (01) dated 25th October 2017.
- RSK Environment Limited, Geo-environmental and Geotechnical Assessment: The Ugly Brown Building, reference 371654-01 (01), dated 9th August 2019.
- RSK Environment Limited, Thames Water Asset Assessment Report, reference 371654-03 (02), dated August 2020.

2.1 Proposed development

The proposed redevelopment will involve the demolition of the existing UBB building and erection of 6 new buildings ranging in height from 2 storeys to 12 storeys above ground and 2 basement levels comprising a mixed-use business floorspace, residential, hotel, gym, flexible retail and storage space development with associated landscaping work. The new development comprises three plots A, B & C in which 'Plot A' will be offices, 'Plot B' will be the Ted Baker hotel & headquarters and 'Plot C' will comprise 4 major buildings for mixed-use offices, gym, residential & retail spaces.

The proposed basement level at the site varies from 13.4 m to 19.10 m AOD while the canal water level is at 23.13 m AOD and canal Bed is at average 21.15 m AOD. Plot A will have a single basement at 17.2 m/18.0 m AOD. Plot B will also have a single basement but at two different levels, the south-western portion adjacent to St Pancras Way at a level of 16.30 m AOD, and the northern and eastern portion along the Canal edge, at a level of 19.10 m AOD. Plot C will have two basements with lower basement level at 13.4 m AOD.

None of the existing foundations, which comprise piled foundations, are to be reused as part of the new scheme.

The development of Plots A, B and C will be sequenced as follows:

1) Demolition of Plot A,
2) Installation of Plot A contiguous piled wall,
3) Excavation of Plot A new basement
4) Construction of Plot A new Building
5) Demolition of Plot B and C
6) Installation of Plot B and C contiguous piled wall,
7) Excavation of Plot B and C new basement
8) Construction of Plot B and C new Buildings

Plans showing the existing building layouts, column loads, basement levels, proposed basement levels, difference between existing and proposed levels and proposed new building and foundation layouts are included in **Appendix C**.

3 ASSESSMENT APPROACH

3.1 Scope of Works

The scope of works for the project was defined in our quotation of the 1st December 2018 and is represented below.

1. Updating and revising the preliminary ground movement assessment (GMA) to reflect the actual ground conditions proven by the investigations and final building scheme design/loadings;

2. Extension of the GMA to cover the requirements of a Thames Water Asset Impact Assessment including analysis of compressive and tensile strains, pull out, joint rotation, hoop stress as applicable. This will include assessment of the main sewer and other critical shallow TW assets in pavements/roads surrounding the site.

3. Updating the previous TW Asset Impact Assessment report following TW review of the scheme and partial redesign of Plot A.

The specific scope related to completion of the TW asset assessment is outlined below.

1. Model the construction sequence on site from demolition through to the proposed development using OASYS PDISP 20.0.0.12 elastic analysis package.

2. Output displacements along line of the existing TW assets around the site at the various stages of construction.

3. Estimate the likely ground movements resulting from basement excavations based on the empirical information contained in CIRIA C760 Embedded Retaining Wall using the OASYS XDISP 20.1.1.18 software.

4. Use the program XDISP to combine the ground displacements determined from the numerical analyses PDISP and the CIRIA C760 assessment.

5. From the resulting displacements determine the strains that are likely to be induced in the various TW assets and whether or not these exceed the TW guidance as defined in the document "Working Near Our Assets".

6. Production of report summarising our findings for review by TW.

3.2 Utilities to be Assessed

The details of the sewer assets considered for the assessment have been obtained from the records provided by the Client and presented in **Appendices B** and **C**.

The utilities assessed in this report have been transposed on to **Figure 3**, which provides a system for identifying the various assets.

3.3 Condition of Existing Assets

A condition survey has been carried out for the main Middle Level 2 sewer that runs directly beneath the site. No condition survey has been completed of culverted River Fleet sewer located in St Pancras Way. Based on the defect grade description category system specified in the report (from 1 being acceptable to 5 being collapsed or collapse imminent), the report indicates the sewer to be in variable condition with categories ranging from 0 to 5 by generally in the 2 or 3 category, defined as 'Minor collapse risk in short term but potential for further deterioration' and 'Collapse unlikely in the near future but deterioration likely', respectively. The condition survey is included within **Appendix B**.

3.4 Ground Model Parameters

The distribution of Young's Modulus and other soil parameters with elevation have been based on the results of the site investigations previously completed by RSK, report referenced above.

The undrained Young's Modulus (E_u) has been obtained using a relationship of $E_u = 400c_u$ for the cohesive deposits. The drained Young's Modulus (E') has been obtained using the relationship of $E' = 0.8E_u$.

The resulting distribution of undrained and drained modulus values are presented in **Figure 6** and **7**.

The parameters adopted for the ground movement assessment in PDISP are summarised below in **Table 1**.

Table 1: Ground Model Parameters

Material	Young's Modulus (kN/m^2)	Young's Modulus – Increase with Depth ($kN/m^2/m$)	Poisson's Ratio
Made Ground - Undrained	15,000	-	0.5
Made Ground - Drained	12,000	-	0.2
London Clay Formation - Undrained	32,000	1,756	0.5
London Clay Formation - Drained	25,600	1,405	0.2
Lambeth Group (Cohesive) - Undrained	72,000	5,200	0.5
Lambeth Group (Cohesive) - Drained	57,600	4,160	0.2
Notes: Uncharacteristically low SPT N Values from dynamic sampling locations have been ignored due to the known overly efficient nature of testing when undertaken in lower strength sensitive soils.			

3.5 Adopted Ground Profile

The ground profile adopted for the ground movement assessment in PDISP is summarised below in **Table 2**.

Table 2: Ground Profile

Material	Top of Stratum (mAOD)	Thickness (m)
Made Ground	22.00	2.00
London Clay Formation	20.00	23.00
Lambeth Group	-3.00	27.00

3.6 PDISP - Ground Model Construction

A settlement / heave analysis has been completed adopting the PDISP software produced by ARUP to assess the likely ground movements to be expected from the demolition and proposed development activities.

The PDISP computer package adopts the Boussinesq method of elastic analysis to calculate the stresses and strains generated within the soil, due to an applied loading and determines the associated displacements by integrating the vertical strains. Settlements are defined as positive movements and heave as negative movements.

The loads applied in the PDISP model are split into two elements; negative loads to represent unloading or demolition and positive loads to represent reloading or construction.

A rigid boundary layer was assumed at -30 m AOD below which no movement is considered to occur.

The loads applied in the PDISP model are split into two elements; negative loads to represent unloading or basement excavation and positive loads to represent reloading or construction. The negative loads have been applied at a level at which they are considered to be acting; at the basement excavation, and for existing or proposed piles using the method discussed by Tomlinson that suggests load is distributed over an area with a load spread of 4 in 1 around the proposed pile at a depth of some two thirds of the length of the pile.

The following PDISP analyses have been undertaken to determine the ground movements at key stages in the constructions process. Both undrained and drained conditions have been considered for the appropriate stages.

- Demolition of existing building (s) – Short Term: This has been carried out by calculating the ground movements that would result from unloading the existing foundations assuming undrained soil parameters. In the absence of detailed information on the existing building foundations, the existing building load take down data provided by GD Partnership has been used to calculate approximate piled foundation dimension based on the pile configurations shown in the appended drawings. To model the unloading, we have used the method discussed by Tomlinson that suggests load is distributed over an area with a load spread of 4 in 1 around the proposed pile at a depth of some two thirds of the length of the pile;

- 2) Basement Excavation(s) – Short Term. This has been calculated by the removal of an overburden pressure for each of the proposed areas of basement extension. For this proposed development, there are three plots to be developed (Plot A, Plot B and Plot C). Plot A will comprise two excavation depths of 4.2 m an 5.0 m below existing level, resulting in an unloading of 80.6 kN/m2 ([1.7 x 18] + [2.5 x 20] = 80.6, where 18 kN/m^3 and 20 kN/m^3 are unit weights of made ground and London Clay soils, respectively) and 100 kN/m2 (5.0 x 20 = 100, where 20 kN/m3 is unit weight of London Clay). Plot B will comprise two excavation depths of 2.5 m an 5.3 m below existing level, resulting in an unloading of 50 kN/m2 (2.5 x 20 = 50, where 20 kN/m3 is unit weight of London Clay) and 103 kN/m2 (5.3 x 20 = 106, where 20 kN/m3 is unit weight of soil). Plot C will comprise a single excavation depth of 8.6 m below existing level, resulting in an unloading of 172 kN/m2 (8.6 x 20 = 172, where 20 kN/m3 is unit weight of London Clay; and

- 3) Loading from the proposed new superstructures on piled foundations –Short Term and Long Term. The loads were modelled as individual piles with a load spread area located at a depth of 2/3 the length of the piles assuming a 1 in 4 load spread. For Plot A, the analysis has considered individual piles of varying pile depth, chosen to accommodate the proposed column load provided in the appended preliminary piling schedule. In the absence of a piling scheme for Plots B and C, the analysis has considered individual piles of varying pile depth, chosen to accommodate the proposed column load or proportion of column load where pile caps are used, based on the pile layouts shown in the appended design drawings. Loads from core walls have been included in the assessment. This loading case has been considered in both the short term and long term case, using undrained and drained parameters respectively. For Plot A an additional long term case has been included to assess the effect of the proposed structural solution for the basement slab located above the Mid-Level sewer No.2 portion of the basement, required to ensure that the confinement pressure ratio remains at 1.33. The proposed structural solution is designed to provide resistance to the uplift pressures resulting from soil unloading due to excavation and hydrostatic pressures, that would result in a loss of confinement. To assess the benefit of the structural solution, a uniformly distributed load (UDL) has been applied over the footprint of the slab to mimic the resistance to the uplift force from the soil unloading component of the uplift force, to the magnitude required to maintain the confinement pressure ratio at 1.33.

The analysis has considered both undrained and drained soil conditions to give an indication of the immediate short term and the maximum expected long term ground movements resulting from the proposed development.

In order to model these conditions two analyses have been carried out, the first considering undrained ground stiffness parameters and a Poisson's ratio of 0.50 and the second considering a drained modulus and a Poisson's ratio of 0.20. The first of these analyses allows an assessment of the immediate elastic heave that would result from demolition of the existing structure and removal of overburden from the lowering of the basement levels. This would typically be expected to occur over of a period of 12 months. The second analysis allows for long term net movements, following construction of the new development, to be determined, which will include the total heave that would develop in the long term and settlement following consolidation of the underlying clay due to the construction of the new building. The fully drained (long term) conditions would typically take many years to develop (10 years or more).

The ground movements have been isolated based on the particular phases of development in addition to the anticipated time frames of which any movements are anticipated to be realised, i.e. short term / long term. These movements have then been used in the TW asset assessment, using Oasys Xdisp, as discussed in Section 4. The tabulated results for each modelled construction stage are included in **Appendix D**.

4 ASSESSMENT OF UTILITY DEFORMATIONS

The deformations and associated potential damage of the TW assets in question has been determined at the end of the stages of construction presented in **Table 3**.

Table 3 Stages of Construction at which TW Utilities are Assessed

Section of Development	No.	Construction Stage	Cumulative Effect
PLOT A	1	Demolition of existing structure (short-term)	(A)
PLOT A	2	Basement wall installation (short-term)	(A) + (C)
PLOT A	3	Basement excavation (short-term)	(A) + (C) + (E) – For TW1_1 only
			(A) + (C) + (D) – For TW2_1, 2, 3 & 4 and FWA,B,C&D & FW400
PLOT A	4	New structure (short-term)	(A) + (C) + (E) + (G) – For TW1_1 only
			(A) + (C) + (D) + (G) For TW2_1, 2, 3 & 4 and FWA,B,C&D & FW400
PLOT B + PLOT C	5	Demolition of existing structure (short-term)	PLOT A No.4 + (A)
PLOT B + PLOT C	6	Basement wall installation (short-term)	PLOT A No.4 + (A) + (C)
PLOT B + PLOT C	7	Basement excavation (short-term)	PLOT A No.4 + (A) + (C) + (D)
PLOT B + PLOT C	8	New structure (short-term)	PLOT A No.4 + (A) + (C) + (D) + (G)
FULL DEVELOPMENT	13	New structure (long-term)	{**Plot A** (B) + (C) + (F) + (H)} + {**Plot B&C** (B) + (C) + (F) + (H)} – For TW1_1 only
			{**Plot A** (B) + (C) + (D) + {(F) – (E)} + (H)} + {**Plot B&C** (B) + (C) + (D) + {(F) – (E)} + (H)} – For TW2_1, 2, 3 & 4 and FWA,B,C&D & FW400

Notes:

Sewer ID used in Modelling:

- **TWS1_1: 2134mm** = Mid-Level 2 Sewer beneath Plot A
- **TWS2_1: 1219mm** = Culverted River Fleet (St Pancras Way)
- **TWS2_2 1219mm** = Culverted River Fleet (St Pancras Way)
- **TWS2_3 1219mm** = Culverted River Fleet (St Pancras Way)

<table>
<tr><th>Section of Development</th><th>No.</th><th>Construction Stage</th><th>Cumulative Effect</th></tr>
<tr><td colspan="4">- TWS2_4 1093mm = Culverted River Fleet (St Pancras Way)
- FWA = 100mm Fresh Water Main (St Pancras Way)
- FWB = 100mm Fresh Water Main (St Pancras Way)
- FWC = 100mm Fresh Water Main (St Pancras Way)
- FWD = 100mm Fresh Water Main (St Pancras Way)
FW400 = 400mm Foul Water connection from Plot A/B to Culverted River Fleet (St Pancras Way)</td></tr>
</table>

The various elements of work used to determine the utility deformations at the various stages of construction are given in **Table 4**. This table also defines how the associated movements have been determined and whether they are long or short term.

Table 4 Construction Components

Element	Construction Component	Calculation Method	Short or Long Term
A	Demolition of existing structure	PDISP	Short Term
B	Demolition of existing structure	PDISP	Long Term
C	Basement wall installation	CIRIA C760 (XDISP)	Short Term
D	Basement excavation	CIRIA C760 (XDISP)	Short Term
E	Basement excavation	PDISP	Short Term
F	Basement excavation	PDISP	Long Term
G	Loading of new structure	PDISP	Short Term
H	Loading of new structure	PDISP	Long Term

The utility deformations following each of these stages of construction have been derived by combining the deformations calculated for the various elements of work carried out. For example the short term utility movements for TW2_1, 2, 3 & 4,FWA, B, C & D and FW400 after construction of the proposed building for PLOT A, have been calculated by summing the movements resulting from the short term movements from the demolition of the existing structure (Plot A) (A), installation of the contiguous piled wall, as estimated from CIRIA 760 (C), the short term movements resulting from excavation of the basement, also estimated from CIRIA 760 (D) and the short term settlements resulting from loading of the building of the new Plot A structure, as calculated by PDISP (G). The short term utility movements for TW2_1, 2, 3 & 4,FWA, B, C & D and FW400after construction of PLOT B and C have been calculated by summing the full short term net movements from the development sequence of Plot A with the resulting short term movements from the demolition of the existing structure (Plot B & C) (A), installation of the contiguous piled walls, as estimated from CIRIA 760 (C), the short term movements resulting from excavation of the basements, also estimated from CIRIA 760 (D) and the short term settlements resulting from loading of the building of the new Plot B and C structure, as calculated by PDISP (G). The long term utility movements for TW2_1, 2, 3 & 4,FWA, B, C & D and FW400 following completion of the full development have been calculated by summing the full long term net movements from the development sequence of Plots A, B and C using the following; the resulting long term movements from the demolition of the existing structures (Plot A, B & C) (B), installation of the contiguous piled walls, as estimated from CIRIA 760 (C), the long term movements resulting from excavation of the basements which are determined by combining the short term movements resulting from excavation of the basement estimated from CIRIA 760 (D) with the long term movements estimated from PDISP (F) minus the short term movements estimated from PDISP (E) and the long term settlements resulting from loading of the building of the new Plot A, B and C structure, as calculated by PDISP (H).

The approach is slightly varied for the TW1_1 (Mid-Level 2 Sewer), given that the sewer runs beneath the site. The use of the XDISP ground movements curves to model short term movements due to excavation is not appropriate. For TW1_1 the short term utility movements after construction of the proposed building for PLOT A, have been calculated by summing the movements resulting from the short term movements from the demolition of the existing structure (Plot A) (A), installation of the contiguous piled wall, as estimated from CIRIA 760 (C), the short term movements resulting from excavation of the basement, estimated from PDISP (E) and the short term settlements resulting from loading of the building of the new Plot A structure, as calculated by PDISP (G). The short term utility movements after construction of PLOT B and C have been calculated by summing the full short term net movements from the development sequence of Plot A with the resulting short term movements from the demolition of the existing structure (Plot B & C) (A), installation of the contiguous piled walls, as estimated from CIRIA 760 (C), the short term movements resulting from excavation of the basements, estimated from PDISP (E) and the short term settlements resulting from loading of the building of the new Plot B and C structure, as calculated by PDISP (G). The long term utility movements for TW1_1 following completion of the full development have been calculated by summing the full long term net movements from the development sequence of Plots A, B and C using the following; the resulting long term movements from the demolition of the existing structures (Plot A, B & C) (B), installation of the contiguous piled walls, as estimated from CIRIA 760 (C), the long term movements resulting from excavation of the basements which are estimated from PDISP (F) and the long term settlements resulting from loading of the building of the new Plot A, B and C structure, as calculated by PDISP (H).

The assessment has been undertaken using XDISP version 20.1.1.18 computer package supplied by OASYS, which uses the empirical approach outlined in CIRIA C760 to assess the vertical and horizontal ground movements resulting from excavation in front of the walls.

The empirical approach is well described in CIRIA C760 “Guidance on Embedded Retaining Wall Design” 2017. This document provides charts of vertical and horizontal ground movements resulting from installation of embedded retaining walls and excavation in front of the walls. These charts have been normalised with wall length and excavation depth to facilitate their use for new development.

The assessment assumes a high stiffness retaining system, considered appropriate on assumption that the excavations will be propped as the excavation is progressed.

4.1 Assessment approach

As part of the assessment process, a staged approach has been undertaken to investigate the displacements to the assets surrounding the site as a result of the proposed development works. The following stages have been implemented:

- Stage 1a: The model is then run using the assessment approach outlined in Section 4 to determine if there are exceedances over and above the prescribed Thames Water assessment criteria. If the analysis indicates there are no exceedances along the length of that particular asset, then no further action is considered to be required. However, if any particular asset highlights possible exceedances then a further stage of analysis is undertaken.
- Stage 1b: Those assets that are shown to exceed the TW assessment criteria in Stage 1a may be further assessed and consideration be given to marginal “smoothing” of the displacement data broadly in line with the discussions outlined in “The Prediction of Ground Movements Adjacent to Box Excavations” (Latham (2014)). The requirement to undertake this smoothing exercise is a function of the simplistic nature that the XDISP software applies displacements resulting from wall installation and basement excavation to the assets surrounding the site. The interpretation of displacements often leads to a series of peaks, troughs and sharp inflections that result in overly conservative estimations of strain, joint rotation, pull out and curvature within the assets. The smoothing process involves the importing of the displacement data from XDISP into an excel file prior to interrogation of the data points prior to reimporting back into XDISP and the assessment reanalysed at each of the impacted stages with the influence of the polygonal excavations removed. The smoothed data is then taken to the next construction stage to assess the impact of the subsequent stage and process repeated.

5 USE OF XDISP TO COMBINE DISPLACEMENTS

In order to combine the horizontal and vertical utility movements caused by demolition, basement excavation and loading of the proposed buildings the XDISP software package has been used.

This package allows the ground movements caused by basement excavation (short term) as presented in CIRIA C760 to be automatically calculated at the location of the various TW services. The utility movements determined by PDISP for the other stages of construction can then be imported into the software and combined with the CIRIA C760 movements. In order to achieve this, it is necessary to adopt exactly the same coordinate system in both pieces of software.

Using the resulting deformations, the software determines the associated axial and flexural strains induced in the utilities, from which the maximum tensile and compressions strains are calculated. In addition to this the software also calculates the pull out and rotation at each joint specified in a pipe. This assessment is only appropriate to pipes with joints at a known spacing. For this project the assessment has been carried out for the fresh water main pipe and foul water connection pipe with joints at a spacing of 3m for the cast iron and ductile iron pipes. This assessment is clearly not appropriate for the brick assets.

The XDISP software allows the user to define various “Utility Acceptance Criteria” which essentially represent levels of change of strain and joint rotation below which the risk of significant damage is negligible. For this project the utility acceptance criteria in **Table 5** have been adopted, most of these have been taken from the TW guidance document “Guidance on piling, heavy loads, excavations, tunnelling and dewatering”.

Table 5 Utility Acceptance Criteria

Utility ID	Utility Material	Internal Dia. (m)	Wall Thickness (m)	Allowable Increase in Strain		Confinement Pressure Ratio[2]	Allowable Joint Movement	
				Tension (με)	Compression (με)		Rot. (°)	Pull Out (mm)
TWS1_1: 2134mm	Brick Sewer	2134	0.200	500	1000[1)] (at 25% of the allowable stress)	1.33	N/A	N/A
TWS2_1: 1219mm	Brick Sewer	1219	0.200	500	1000[1)] (at 25% of the allowable stress)	1.33	N/A	N/A
TWS2_2: 1219mm	Brick Sewer	1219	0.200	500	1000[1)] (at 25% of the allowable stress)	1.33	N/A	N/A
TWS2_3: 1219mm	Brick Sewer	1219	0.200	500	1000[1)] (at 25% of the allowable stress)	1.33	N/A	N/A

Utility ID	Utility Material	Internal Dia. (m)	Wall Thickness (m)	Allowable Increase in Strain		Confinement Pressure Ratio[2]	Allowable Joint Movement	
				Tension (με)	Compression (με)		Rot. (°)	Pull Out (mm)
TWS2_4: 1093mm	Brick Sewer	1093	0.200	500	1000[1)] (at 25% of the allowable stress)	1.33	N/A	N/A
FWA	Cast Iron	100	0.005	100	1200	N/A	0.1	3.0[1]
FWB	Cast Iron	100	0.005	100	1200	N/A	0.1	3.0[1]
FWC	Cast Iron	100	0.005	100	1200	N/A	0.1	3.0[1]
FWD	Cast Iron	100	0.005	100	1200	N/A	0.1	3.0[1]
Fw400	Ductile Iron	400	0.005	100	700	N/A	0.5	3.0[1]
	Notes: 1) Considered to be conservative. 2) Not calculated in XDISP							

In addition to the above it is noted that where brick sewers run beneath the site an assessment of the confinement / pressure ratio (CPR) should be undertaken. The confinement pressure ratio (CPR), has been calculated as the ratio of overburden soil pressure at the sewer axis level to the internal water pressure with the head assumed to be controlled by the elevation of the nearest manhole covers.

Finally, the XDISP software allows the axial strains calculated in the various utilities to be downgraded using what is termed the Strain Reduction Factor (SRF). This allows the strain developed in a specific utility to be downgraded to take into consideration the difference in stiffness between the utility and the surrounding soils.

For most material types the stiffness of the utility is significantly greater than that of the surrounding soils and as such the strain transferred between the soil and utility is relatively low. Therefore, an SRF of 0.2 has been adopted in both tension and compression (Attewell 1986) for cast and ductile iron pipes. For brick sewers however a SRF of 1.0 has been adopted in both tension and compression.

6 INTERPRETATION OF RESULTS

Two specific issues with the way in which the XDISP software worked have formerly caused some difficulties with interpreting the results. To start with the software shows an overall failure of a utility if any of the acceptance criteria are exceeded. In the case of a jointed pipe such as a concrete sewer on site, which is relatively stiff, this is not necessarily the case as if the allowable joint rotation is not exceeded then no flexural stress can develop in the pipe. Therefore, if there is not a joint rotation failure there cannot be a flexural failure.

Secondly the way in which earlier versions of XDISP combined axial and tensile strains (simply add the two together) was not considered appropriate for TW utility assessment purposes as has been formerly noted by the Geotechnical Consulting Group (GCG).

For those assets which can sustain tension under flexure (e.g. metal pipes, HPPE, MDPE and reinforced concrete) the possible axial compressive and tensile strains cannot be relied on to reduce flexural tensile and compressive strains respectively. Therefore, the following method of combination needs to be adopted,

a. Combined tensile strain should be taken from one of the following;
    i. Axial tensile strain x SRF + Flexural tensile strain
    ii. Axial compressive strain x 0 + Flexural tensile strain
b. Combined compressive strain should be taken as one of the following;
    i. Axial compressive strain x SRF + Flexural compressive strain
    ii. Axial tensile strain x 0 + Flexural compressive strain

For those assets which cannot sustain tension under flexure (e.g. unreinforced concrete or masonry) the lever arm is assumed to be the full external diameter and hence there will be no flexural compressive strain. The possible axial compressive strains cannot be relied on to reduce flexural tensile strains. Therefore, the following method of combination needs to be adopted,

d. Combined tensile strain should be taken from one of the following;
    i. Axial tensile strain x SRF + Flexural tensile strain x 2 [1)]
    ii. Axial compressive strain x 0 + Flexural tensile strain x 2 [1)]

e. Combined compressive strain equals the axial compressive strain x SRF (note: there is no flexural compressive strain)

1) Factor applied to take into consideration the fact that the flexural tensile strain developed in an asset that cannot sustain tension is calculated assuming a lever arm equal to the outer diameter of the asset rather than the radius which is the case for an asset that can resist tension.

Formerly to overcome these problems the axial and tensile strains obtained for the various utilities at the different stages of construction were exported from XDISP and imported into EXCEL then appropriately combined in the way described above.

This spreadsheet then summarised the appropriately combined tensile and compressive strains and joint rotations estimated along each utility for the pile installation stage. Following a review of the XDISP release of March 2019 it is noted that the restructuring of the software and the inclusion of an option to neglect the beneficial contribution of axial strains has resulted in a comparable assessment between the EXCEL and XDISP factored outputs. As such, it is considered that the most recent XDISP version can sufficiently replicate those combinations detailed above and the supplementary data processing is longer required.

The results from XDISP are presented in **Appendix E**.

7 RESULTS, DISCUSSIONS AND CONCLUSIONS

7.1 Stage 1a - Utility Damage Assessment

Table 6: Summary of Maximum Values – Calculated Strains

Development Plot (Stage)	Sewer ID	DEMOLITION		CONTIGUOUS WALL INSTALLATION		BASEMENT EXCAVATION		NEW LOADING – SHORT TERM		FULL DEVELOPMENT – LONG TERM	
		Calculated Strain (με) (stage 1a / Stage 1b)[1]		Calculated Strain (με) (stage 1a / Stage 1b)[1]		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)	
		Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.
Plot A	**TWS1_1: 2134mm**	31.992 / n/a	15.996 / n/a	171.243	145.666	603.234 / 506.633[2]	363.873 / 277.030	532.417 / 474.067	273.617 / 273.617	--	--
Plot B & C (cumulative results from PLOT A)		507.098[2]	290.441	1141.680 / 529.343[2]	638.809 / 320.432	560.044 / 464.010	317.801 / 306.408	414.130	236.712	--	--
FINAL		--	--	--	--	--	--	--	--	1827.531 / 1331.139	975.662 / 709.685
FINAL with Robust Structural Solution		--	--	--	--	--	--	--	--	1445.320 / 719.900[3]	767.816 / 411.147
Plot A	**TWS2_1: 1219mm**	0.820	0.410	103.856	63.098	103.856	63.098	125.226	62.704	--	--

Development Plot (Stage)	Sewer ID	DEMOLITION		CONTIGUOUS WALL INSTALLATION		BASEMENT EXCAVATION		NEW LOADING – SHORT TERM		FULL DEVELOPMENT – LONG TERM	
		Calculated Strain (με) (stage 1a / Stage 1b)[1]		Calculated Strain (με) (stage 1a / Stage 1b)[1]		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)	
		Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.
	TWS2_2: 1219mm	0.688	0.344	116.318	54.772	116.318	54.773	118.640	55.903	--	--
	TWS2_3: 1219mm	0.037	0.0187	0.037	0.019	0.037	0.0187	4.142	2.071	--	--
	TWS2_4: 1093mm	0.0302	0.0151	0.030	0.015	0.030	0.015	0.793	0.396	--	--
Plot B & C (cumulative results from PLOT A)	**TWS2_1: 1219mm**	125.406	62.696	125.406	62.696	125.406	62.696	124.602	63.062	--	--
	TWS2_2: 1219mm	120.538	56.851	358.356	172.450	358.365	172.450	360.557	173.547	--	--
	TWS2_3: 1219mm	5.552	2.776	9.346	2.779	55.441	16.370	100.810	32.812	--	--
	TWS2_4: 1093mm	1.917	0.958	484.308	251.565	717.505 / 473.813	492.713 / 818.523	478.802	816.757	--	-

Development Plot (Stage)	Sewer ID	DEMOLITION		CONTIGUOUS WALL INSTALLATION		BASEMENT EXCAVATION		NEW LOADING – SHORT TERM		FULL DEVELOPMENT – LONG TERM	
		Calculated Strain (με) (stage 1a / Stage 1b)[1]		Calculated Strain (με) (stage 1a / Stage 1b)[1]		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)	
		Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.
FINAL	**TWS2_1: 1219mm**	--	--	--	--	--	--	--	--	146.577	73.273
	TWS2_2: 1219mm	--	--	--	--	--	--	--	--	360.346	173.458
	TWS2_3: 1219mm	--	--	--	--	--	--	--	--	87.918	32.791
	TWS2_4: 1093mm	--	--	--	--	--	--	--	--	468.704	815.005
Plot A	**FWA_100 mm**	0.016	0.016	3.220	3.219	45.710	44.906	45.900	45.101	--	--
	FWB_100 mm	0.020	0.020	1.515	1.514	23.030	5.223	23.548	5.740	--	--
	FWC_100 mm	0.001	0.001	0.001	0.001	0.001	0.001	0.027	0.027	--	--

Development Plot (Stage)	Sewer ID	DEMOLITION		CONTIGUOUS WALL INSTALLATION		BASEMENT EXCAVATION		NEW LOADING – SHORT TERM		FULL DEVELOPMENT – LONG TERM	
		Calculated Strain (με) (stage 1a / Stage 1b)[1]		Calculated Strain (με) (stage 1a / Stage 1b)[1]		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)	
		Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.
	FWD_100 mm	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	--	--
Plot B & C (cumulative results from PLOT A)	FWA_100 mm	45.939	45.141	45.939	45.141	45.940	45.141	45.864	45.067	--	--
	FWB_100 mm	23.566	5.758	23.752	9.584	23.753	9.584	23.733	9.564	--	--
	FWC_100 mm	0.0285	0.029	17.350	17.184	23.013	22.295	28.857	27.586	--	--
	FWD_100 mm	0.043	0.043	16.034	15.106	41.893	48.874	77.018	82.671	--	--
FINAL	FWA_100 mm	--	--	--	--	--	--	--	--	46.031	45.239
	FWB_100 mm	--	--	--	--	--	--	--	--	23.792	9.624

Development Plot (Stage)	Sewer ID	DEMOLITION Calculated Strain (με) (stage 1a / Stage 1b)[1]		CONTIGUOUS WALL INSTALLATION Calculated Strain (με) (stage 1a / Stage 1b)[1]		BASEMENT EXCAVATION Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		NEW LOADING – SHORT TERM Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)		FULL DEVELOPMENT – LONG TERM Calculated Strain (με) (stage 1a pre - smoothing / Stage 1b - smoothed)	
		Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.	Tensile	Comp.
	FWC_100 mm	--	--	--	--	--	--	--	--	28.768	27.508
	FWD_100 mm	--	--	--	--	--	--	--	--	77.138	82.746
Plot A	**FW400_FouL-400mm**	0.091	0.091	3.673	3.042	3.673	3.042	29.457	28.799	--	--
Plot B & C (cumulative results from PLOT A)		28.552	27.901	37.297	29.060	37.297	29.060	41.186	32.927	--	--
FINAL		--	--	--	--	--	--	--	--	76.617	68.259

Notes:

Numbers highlighted red are observed to be exceedances based on the adopted acceptance criteria.

[1] If Stage 1a (Pre-Smoothed) assessment triggers Stage 1b (Smoothed) assessment, both Pre-smoothed and smoothed results are presented. Otherwise just the Stage 1a (Pre-Smoothed) value is presented.

[2] Very marginal exceedance

[3] Exceedance in long term case with Structural Solution applied is considered to be a function of the simplicity of the modelling software and nuance caused by displacement point spacing.

Table 7: Summary of Maximum Values – Pullout & Rotation

Development Plot (Stage)	Sewer ID	DEMOLITION		CONTIGUOUS WALL INSTALLATION		BASEMENT EXCAVATION		NEW LOADING – SHORT TERM		FULL DEVELOPMENT – LONG TERM	
		Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)
		Max.	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**
Plot A	**FWA_100 mm**	0.000	0.000	0.013	0.001	0.110	0.053	0.111	0.054	--	--
	FWB_100 mm	0.000	0.000	0.009	0.005	0.350	0.015	0.352	0.016	--	--
	FWC_100 mm	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	--	--
	FWD_100 mm	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	--	--

Development Plot (Stage)	Sewer ID	DEMOLITION		CONTIGUOUS WALL INSTALLATION		BASEMENT EXCAVATION		NEW LOADING – SHORT TERM		FULL DEVELOPMENT – LONG TERM	
		Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)
		Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.
Plot B & C (cumulative results from PLOT A)	**FWA_100 mm**	0.111	0.054	0.111	0.054	0.111	0.054	0.110	0.054	--	--
	FWB_100 mm	0.352	0.016	0.352	0.022	0.352	0.022	0.352	0.022	--	--
	FWC_100 mm	0.000	0.000	0.040	0.020	0.0736	0.032	0.108	0.044	--	--
	FWD_100 mm	0.000	0.000	0.219	0.007	0.713	0.012	1.286	0.019	--	--
FINAL	**FWA_100 mm**	--	--	--	--	--	--	--	--	0.112	0.055
	FWB_100 mm	--	--	--	--	--	--	--	--	0.356	0.023

Development Plot (Stage)	Sewer ID	DEMOLITION		CONTIGUOUS WALL INSTALLATION		BASEMENT EXCAVATION		NEW LOADING – SHORT TERM		FULL DEVELOPMENT – LONG TERM	
		Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)	Pull Out (mm) (stage 1a pre - smoothing / Stage 1b - smoothed)	Joint Rotation (°) (stage 1a pre - smoothing / Stage 1b - smoothed)
		Max.	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**	**Max.**
	FWC_100 mm	--	--	--	--	--	--	--	--	0.107	0.044
	FWD_100 mm	--	--	--	--	--	--	--	--	1.285	0.019
Plot A	**FW400_FouL-400mm**	0.000	0.000	0.036	0.003	0.036	0.003	0.461	0.0624	--	--
Plot B & C (cumulative results from PLOT A)		0.454	0.0615	0.612	0.061	0.612	0.062	0.641	0.066	--	--
FINAL		--	--	--	--	--	--	--	--	1.193	0.143

Notes:

Numbers highlighted red and observed to be exceedances based on the adopted acceptance criteria.

All of tabular and graphical results and included within **Appendix D**.

7.1.1 Confinement Pressure Ratio

The confinement pressure ratio (CPR), has been calculated as the ratio of overburden soil pressure at the sewer axis level to the internal water pressure with the head assumed to be controlled by the elevation of the nearest manhole covers. The nearest manhole is located close to the west of the site at the junction of College Grove and St Pancras Way and has a cover level of 21.2 9 m AOD. The tunnel axis for TW1_2134mm running directly beneath the Plot A site is ~14.63 m AOD. With existing ground level taken to be 21.70 m AOD, this gives a current confinement pressure ratio of 2.14 (7.07*20)/(6.66*10) = 2.14 (>1.33).

Following construction of Plot A, with the excavation of a basement to a depth of 17.5 m AOD, the CPR following construction is calculated to be 0.86 (2.87*20)/(6.66*10)=0.86 (<1.33), which is below the acceptable target limit set by TW. Following recent discussions with TW, the proposed scheme will now incorporate a robust structural solution to ensure that uplift pressures resulting from removal of overburden and hydrostatic pressures will be resisted to such a degree so as to maintain a CPR of >1.33. The structural solution will utilise megadense concrete for the basement slab over the Mid-Level Sewer in conjunction with additional piles to the north of the sewer and will see the slab tied into the contiguous piles to the south of the tunnel to resist tensile forces. As assessment of the vertical pressure that the structural solution is required to resist in order to maintain the CPR >1.33 is presented in Appendix F.

Furthermore, a critical point exists during the temporary works stage, whilst the excavation and basement slab construction is taking place. A preliminary temporary works construction plan has been considered, which will incorporate temporary surcharge over the sewer during excavation and construction and with the worked sequenced so as to limit the temporary removal of overburden and maintain a sufficient CPR. Whilst the temporary works condition is outside of the remit of this report, a preliminary assessment has also been carried out to assess the number of concrete load blocks and stacking arrangement required during the temporary works stage to ensure CPR remains sufficient. This is also presented in Appendix F.

7.2 Brick Sewers

7.2.1 Demolition

From the above results it is noted that none of the brick assets will be subjected to strain levels over and above the acceptable limits stipulated by TW following the demolition of Plot A.

A very minor exceedance of tensile strain for TW1 of 507.098$\mu\varepsilon$ is noted following completion of demolition of Plot B and C, however given the very marginal exceedance no ‘smoothing’ of the data was carried out and it is considered that should this be done it would in the calculated strain dropping below the threshold limit.

7.2.2 Proposed Construction

TW1 (Middle Level 2 Sewer)

From the above results it is noted that there is an exceedance of tensile strain of 603.234με for TW1 following excavation of the proposed Plot A basement. Following 'smoothing' of the displacement (Approach Stage 1b), the is a reduction in tensile strain to 506.633με which represents and extremely marginal exceedance and is considered likely to be a function of the simplicity of the software and displacement points frequency. There is an exceedance of tensile strain of 532.417με for TW1 following completion of the Plot A development in the short term. Again, following 'smoothing' of the displacement data there is a reduction in tensile strain to an acceptable 474.067με.

Following installation of the installation of the basement wall for plots B and C, it is noted that there is an exceedance of tensile strain of 1141.680με, which is reduced to a very marginal exceedance of 529.343με following the 'smoothing' process. Following excavation of the Plot B basement there is a slight increase in tensile strain of 560.044με, which again is reduced to acceptable level of 464.010με with a moderate smoothing of the data. In the long term case, following full development of Plots A, B and C, but without the 'robust structural solution' taken into consideration, there is an exceedance of the tensile strain of 1827.531με. Following the smoothing process, this is reduced to 1331.139με, which represent a significant exceedance of the acceptable limit. However, if the robust structural solution is taken in consideration, the magnitude of strain is found to be 719.900με once the smoothing process is completed. Whilst this represents a moderate exceedance the strain threshold, it is considered to be a function of the model simplicity, owing to the lack of displacement pints calculated, which prevent adequate application of the smoothing principle in removing artificially induced strains.

Brick sewer in St Pancras Way, sewer ID's TW2_1, TW2_2, TW2_3 & TW2_4

It is noted that there is an exceedance of tensile strain of 717.505με for TW2_4 following the excavation of the basement for Plot B and C. Following application of the smoothing principle, the strain level is reduced to an acceptable 473.813με. No further exceedances are noted for any of the other development phases for the brick sewer in St Pancras Way.

7.3 Cast Iron and Ductile Iron Pipes

7.3.1 All Stages of Development

From the above results it is noted that neither the cast iron water mains or ductile iron foul water connection assets will be subjected to strain levels, pullout or rotation over and above the acceptable limits stipulated by TW for all stages of the development.

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8 CONCLUSIONS

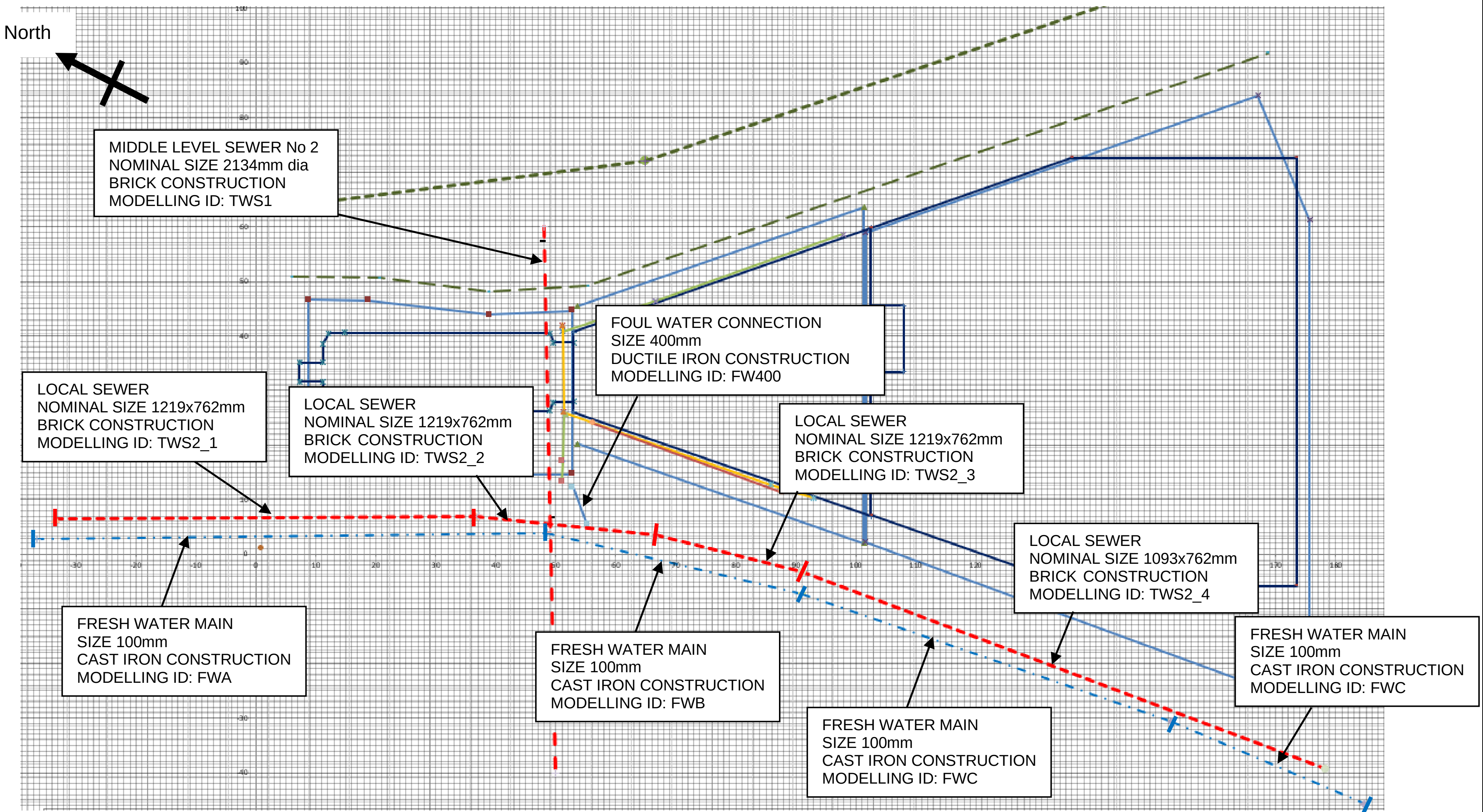
As discussed in Section 7.2, a single strains exceedance is noted for the Culverted River Fleet Sewer in St Pancras Way (TW2_4) following the excavation stage of plot B and C. However, following application of the ‘smoothing’ principle described in Section 4.1 the strain level is reduced to within acceptable limits. It is considered that the proposed development presents little risk of impacting the Culverted River Fleet Sewer in a detrimental way.

The strain exceedances seen in the TW1_1 (Mid-Level Sewer 2) beneath Plot A have, for the most part, been explained asway through the smoothing of the displacement data. However, in the long term case, with the robust structural solution taken into consideration, there remains a moderate strain exceedance of 719.900$\mu\varepsilon$, following application of the smoothing principle. It should be noted that with the limitations of the data set (i.e. number of data points) it was not possible to fully smooth out the displacement curve for this long term case, and it is considered highly likely that should the data set be enhance through a refined number of displacement points, the smoothing process would have adequately demonstrated a reduction in strain to acceptable or near acceptable limits. However, it should also be considered that the proposed development of Plot A over the Mid-Level Sewer 2 is complex and may well result in these slight exceedances as the locations seen in the data. It is recommended that as part of the development and construction programme a robust monitoring scheme is adopted to check for impacts on the sewer from the development. This should be coupled with ensuring strict best practice construction methods are adopted and that the temporary works construction plan is complied with by the main contractor

FIGURES

RSK	**SITE LOCATION PLAN**	**Client:**	Reef Estates Ltd	**Figure:**	1
		Site:	Ugly Brown Building (UBB), St Pancras Way, London	**Job No:**	371654
		Source:	Google	**Scale**	NTS

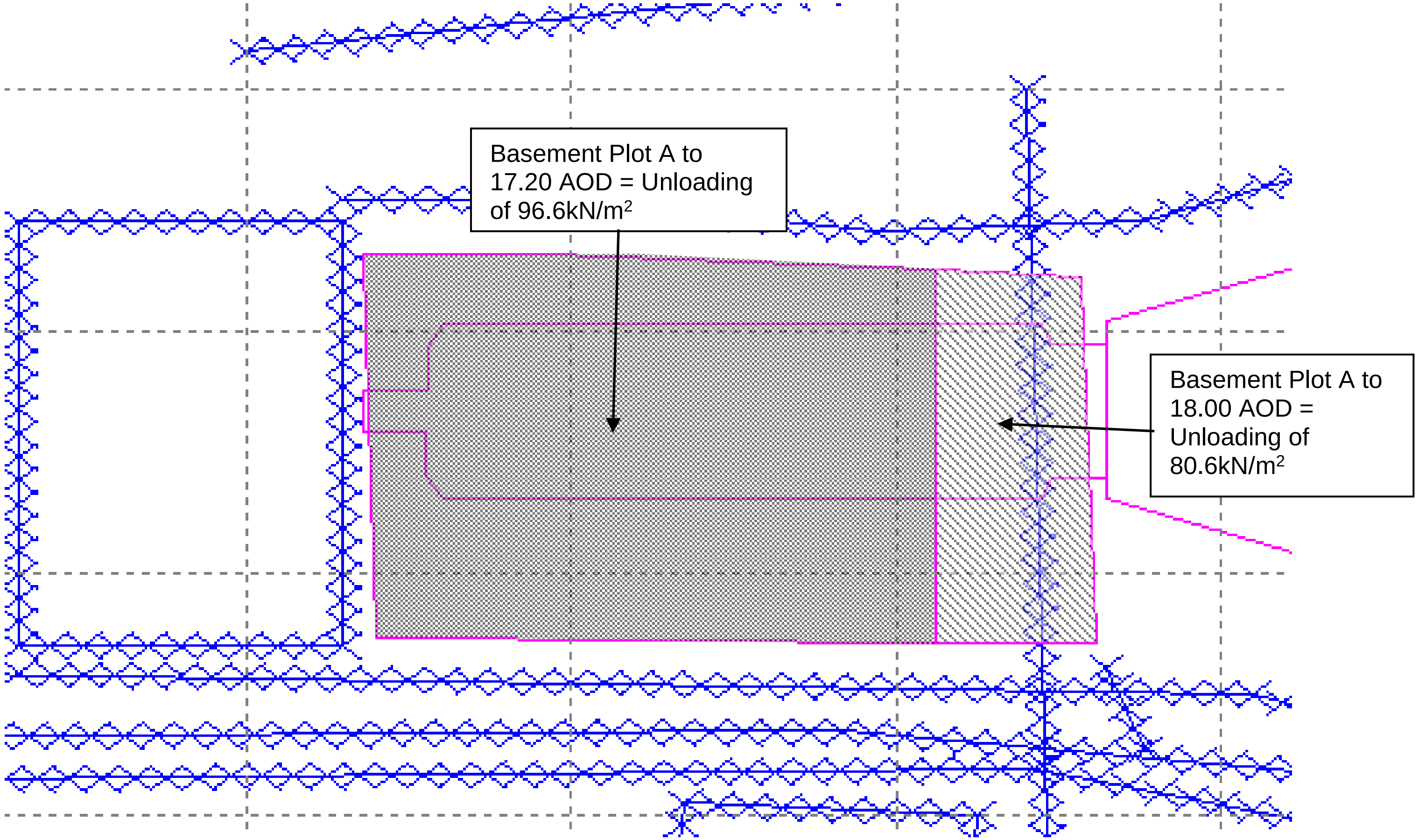
Plan Showing Proposed Building Configuration	**Client:**	Reef Estates Ltd	**Figure: 2**	
	Project:	Ugly Brown Building (UBB) Redevelopment	**Job No:**	371654
	Site:	UBB	**Scale:**	NTS



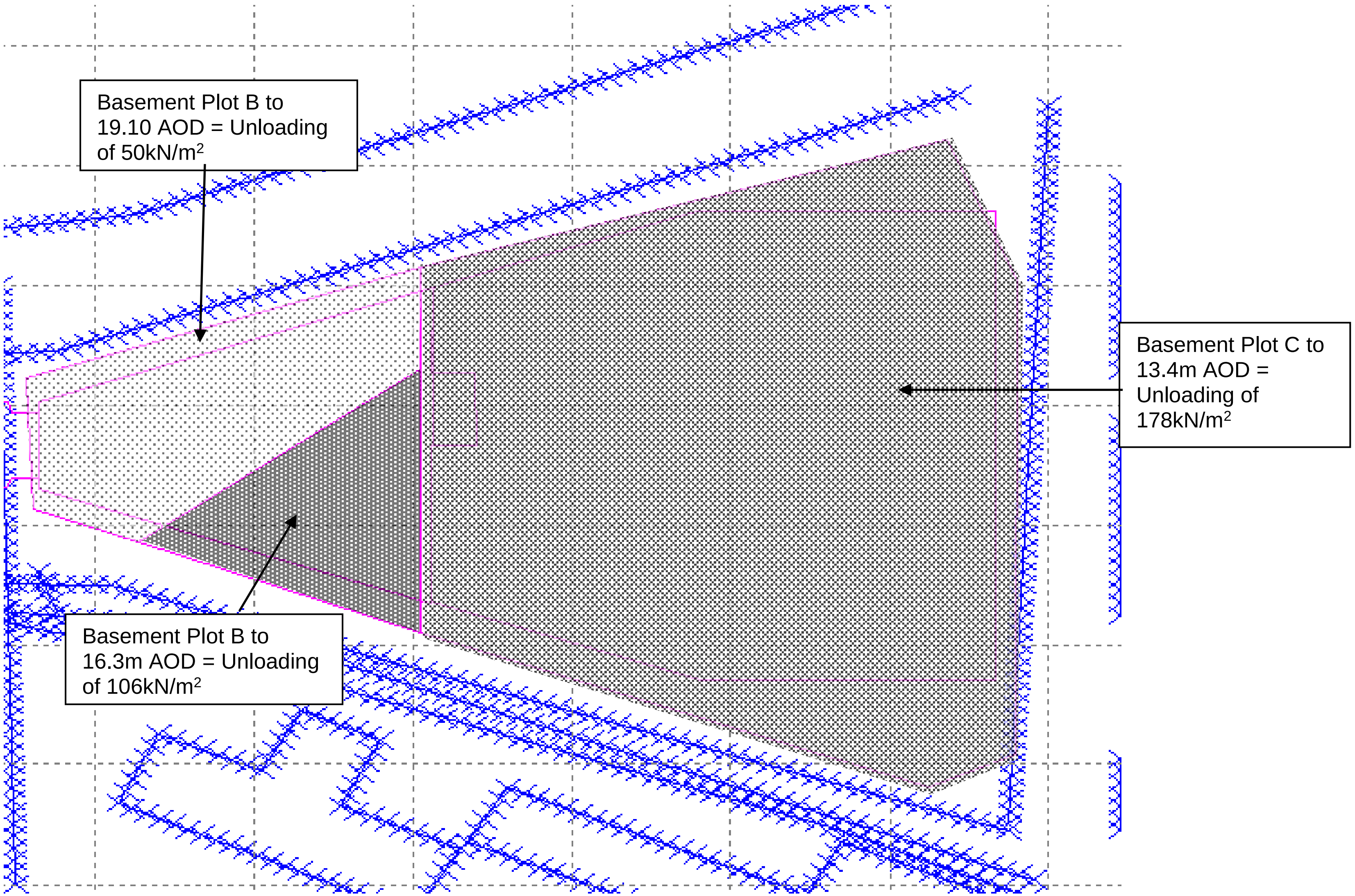
RSK

Plan Showing Thames Water Assets Relative to Development

Client:	The Trustees of St Pancras Way	**Figure: 3**	
Project:	Ugly Brown Building Redevelopment	**Job No:**	371654
Site:	Ugly Brown Building	**Scale:**	NTS

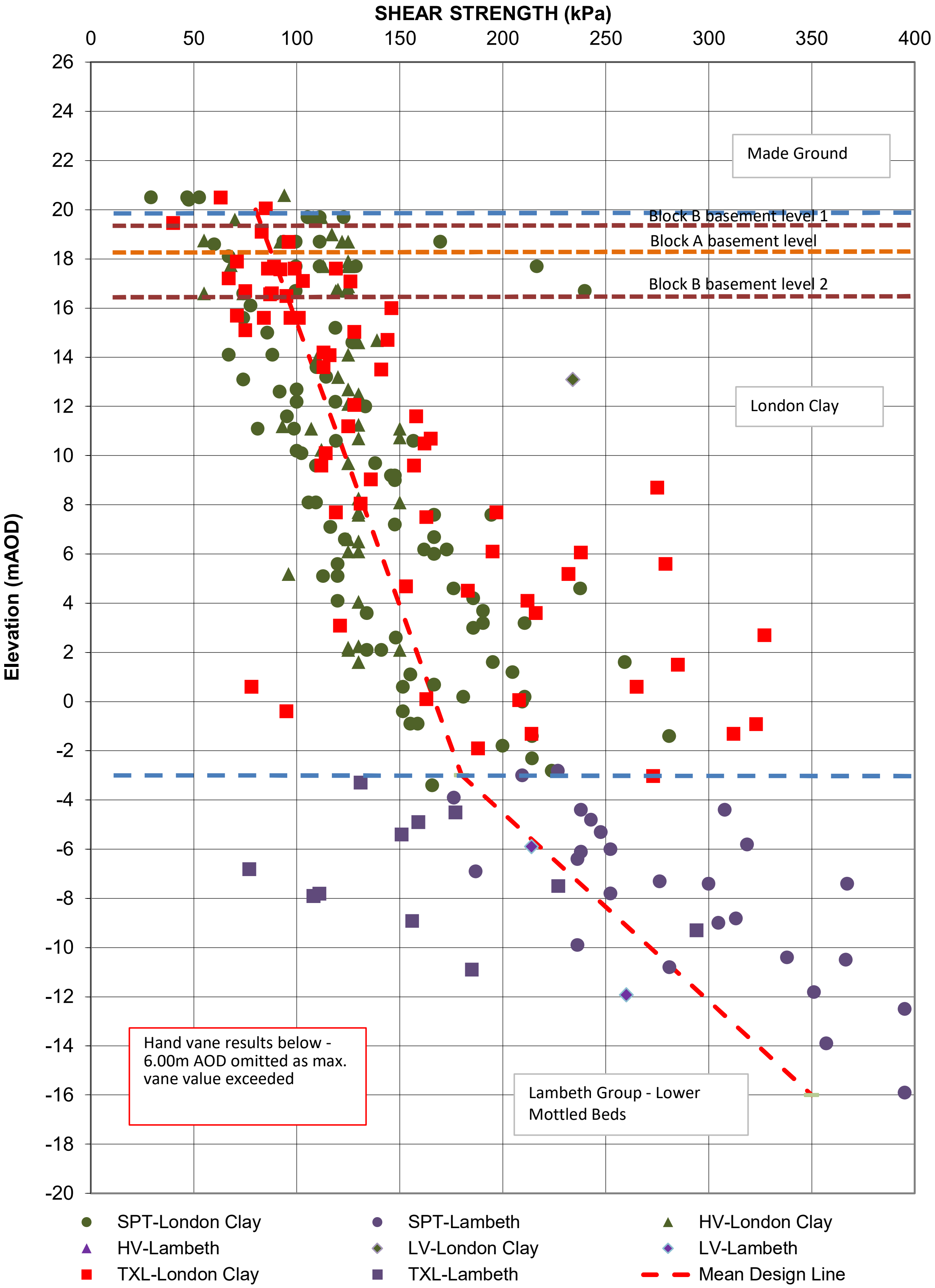


RSK	**Plan Showing Areas of Unloading**	**Client:**	Reef Estates Ltd	**Figure: 4**	
		Project:	Ugly Brown Building (UBB) Redevelopment	**Job No:**	371654
		Site:	UBB	**Scale:**	NTS

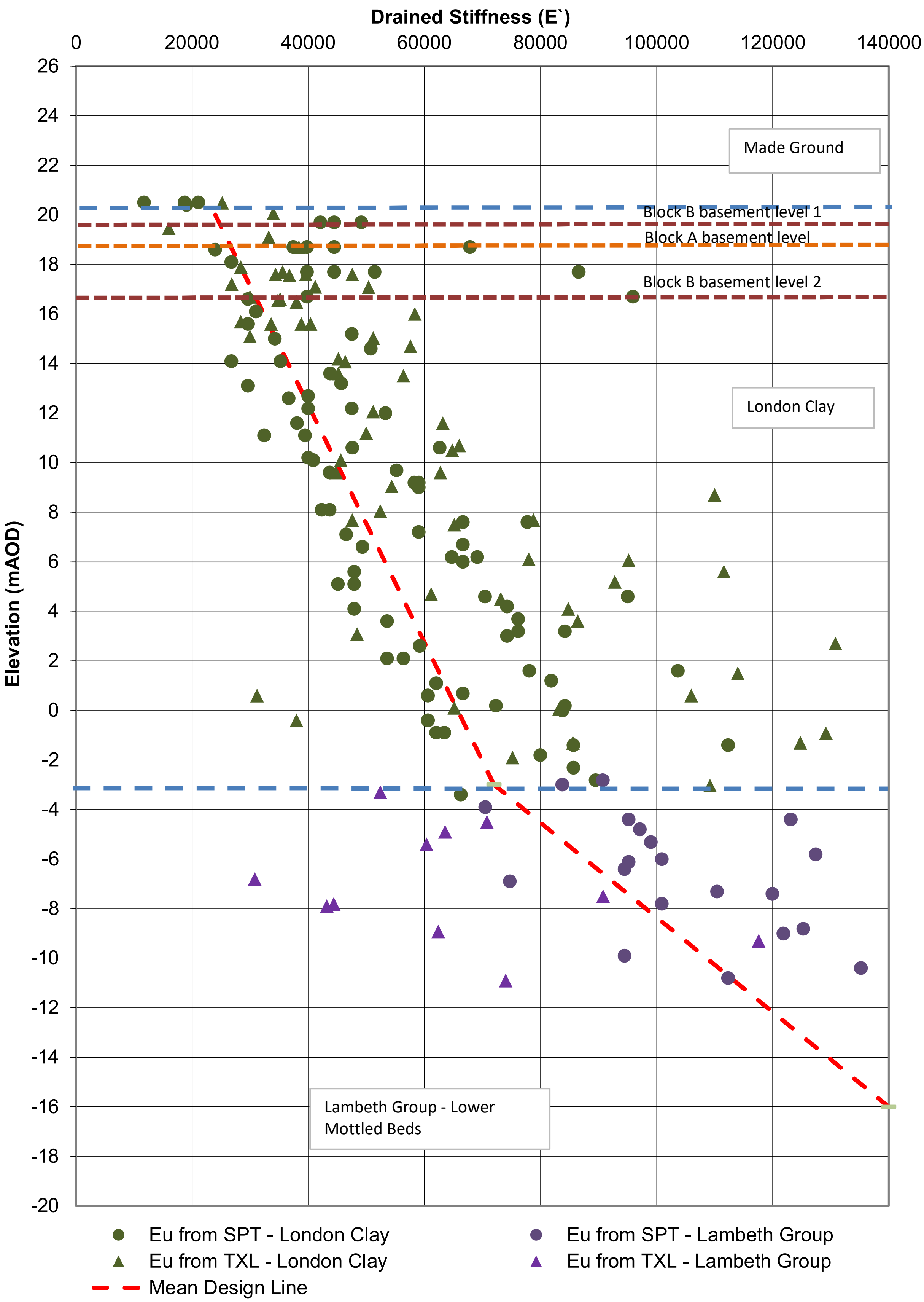


RSK	**Plan Showing Areas of Unloading**	**Client:** Reef Estates Ltd		**Figure: 4**
		Project: Ugly Brown Building (UBB) Redevelopment		**Job No:** 371654
		Site: UBB		**Scale:** NTS

RSK	SHEAR STRENGTH vs ELEVATION		
Site: Ugly Brown Building	**Client:** The Trustees of The St Pancras Way Block A Unit Trust & Big Lobster	**Job Number:**	371654
		Figure:	5

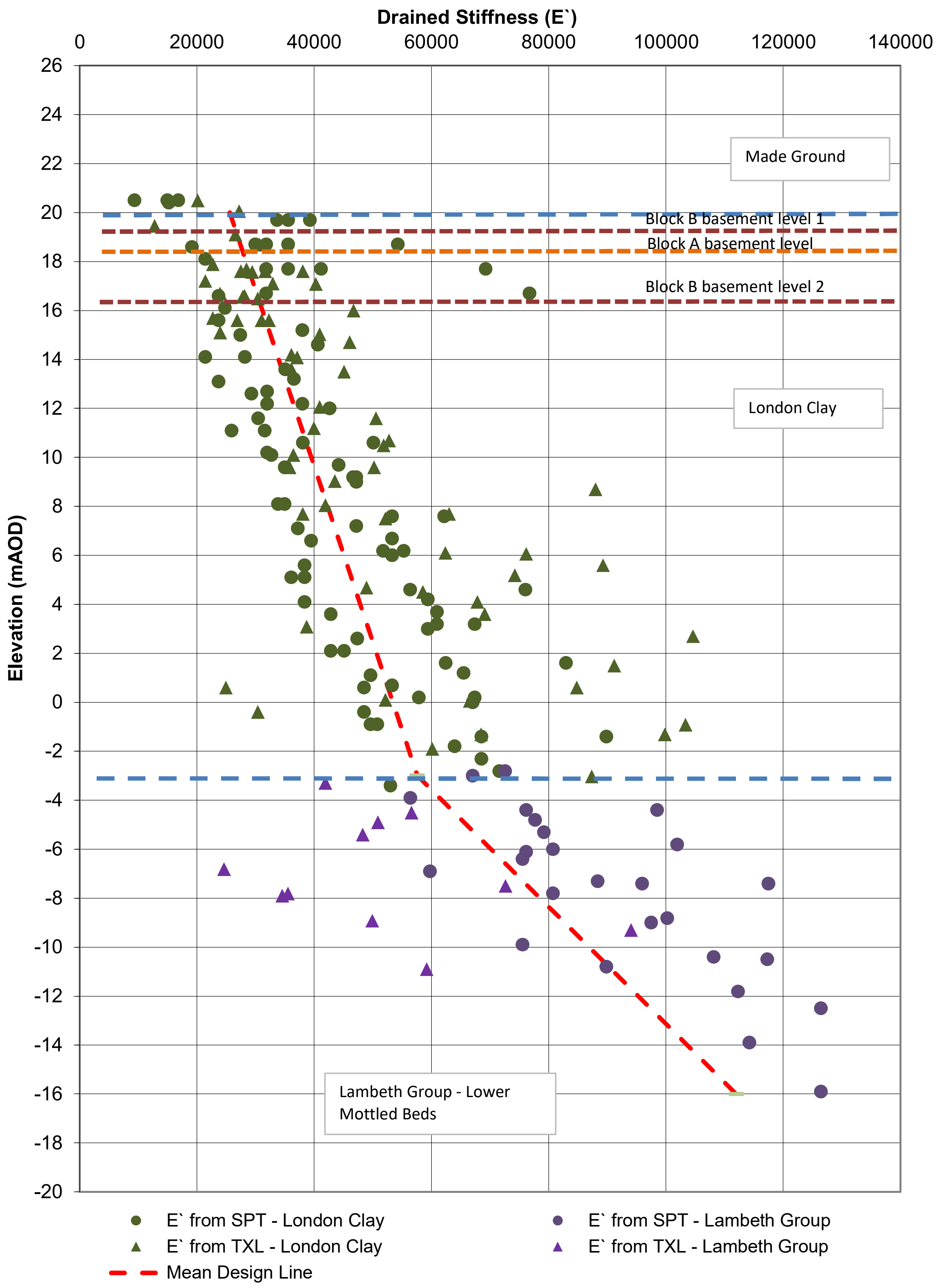


RSK	DRAINED STIFFNESS vs ELEVATION		
Site: Ugly Brown Building	**Client:** The Trustees of The St Pancras Way Block A Unit Trust & Big Lobster	**Job Number:**	371654
		Figure:	6



DRAINED STIFFNESS vs ELEVATION

Site:	Client:	Job Number:	371654
Ugly Brown Building	The Trustees of The St Pancras Way Block A Unit Trust & Big Lobster	Figure:	7



APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Reef Group c/o the Trustees of the St Pancras Way Block A Unit Trust (the "client"). The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the Client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials, unless specifically identified in the Services.

7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of information, including documentation, obtained from third parties and from the Client on the history and usage of the site, unless specifically identified in the Services or accreditation system (such as UKAS ISO 17020:2012 clause 7.1.6):

    a. The Services were based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely.

    b. The Services were limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the visual inspection.

    c. The Services did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services.

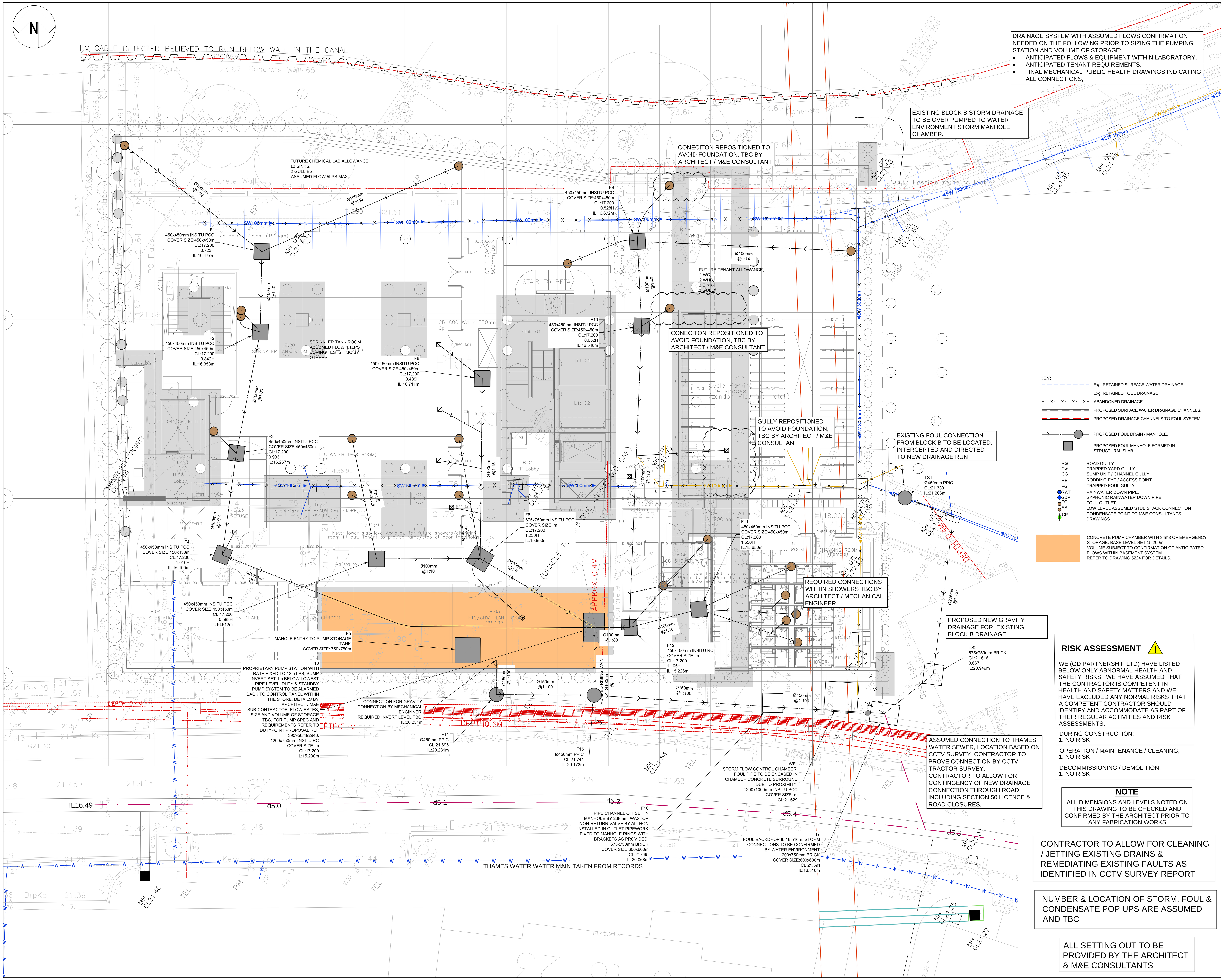
    RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the Client and RSK.

8. The intrusive environmental site investigation aspects of the Services are a limited sampling of the site at pre-determined locations based on the known historic / operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the properties of the materials adjacent and local conditions, together with the position of any current structures and underground utilities and facilities, and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters (as stipulated in the scope between the client and RSK, based

on an understanding of the available operational and historical information) and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.
10. The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows, may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.
11. Asbestos is often observed to be present in soils in discrete areas. Whilst asbestos-containing materials may have been locally encountered during the fieldworks or supporting laboratory analysis, the history of brownfield and demolition sites indicates that asbestos fibres may be present more widely in soils and aggregates, which could be encountered during more extensive ground works.
12. Unless stated otherwise, only preliminary geotechnical recommendations are presented in this report and these should be verified in a Geotechnical Design Report, once proposed construction and structural design proposals are confirmed.

APPENDIX B
THAMES WATER ASSET INFORMATION



RISK ASSESSMENT

WE (GD PARTNERSHIP LTD) HAVE LISTED BELOW ONLY ABNORMAL HEALTH AND SAFETY RISKS. WE HAVE ASSUMED THAT THE CONTRACTOR IS COMPETENT IN HEALTH AND SAFETY MATTERS AND WE HAVE EXCLUDED ANY NORMAL RISKS THAT A COMPETENT CONTRACTOR SHOULD IDENTIFY AND ACCOMMODATE AS PART OF THEIR REGULAR ACTIVITIES AND RISK ASSESSMENTS.

DURING CONSTRUCTION;
1. NO RISK

OPERATION / MAINTENANCE / CLEANING;
1. NO RISK

DECOMMISSIONING / DEMOLITION;
1. NO RISK

NOTE

ALL DIMENSIONS AND LEVELS NOTED ON THIS DRAWING TO BE CHECKED AND CONFIRMED BY THE ARCHITECT PRIOR TO ANY FABRICATION WORKS

CONTRACTOR TO ALLOW FOR CLEANING / JETTING EXISTING DRAINS & REMEDIATING EXISTING FAULTS AS IDENTIFIED IN CCTV SURVEY REPORT

NUMBER & LOCATION OF STORM, FOUL & CONDENSATE POP UPS ARE ASSUMED AND TBC

ALL SETTING OUT TO BE PROVIDED BY THE ARCHITECT & M&E CONSULTANTS

General Notes:

1. DO NOT SCALE THIS DRAWING.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS AND ARCHITECTS DRAWINGS, SCHEDULES AND SPECIFICATIONS.
3. ALL WORKS SHALL BE INSTALLED & TESTED IN ACCORDANCE WITH SEWERS FOR ADOPTION 7th ED, SPECIFICATION FOR HIGHWAY WORKS, THE BUILDING REGULATIONS AND ALL RELEVANT BRITISH STANDARDS.
4. ALL FOUL PIPEWORK IS Ø100mm UNLESS OTHERWISE STATED, ALL SURFACE WATER PIPEWORK IS Ø150mm UNLESS OTHERWISE STATED.
5. FLOWS MUST BE MAINTAINED AT ALL TIMES, AT THE TIME OF MAKING NEW CONNECTIONS OVER-PUMPING MUST BE PROVIDED TO MAINTAIN FLOWS.
6. ANY REDUNDANT PIPEWORK AND MANHOLES SHALL BE EXCAVATED AND THE VOID BACKFILLED WITH WELL GRADED, GRANULAR MATERIAL WELL COMPACTED IN LAYERS TO 'THE SPECIFICATION FOR HIGHWAY WORKS SERIES 600 - EARTHWORKS', OR SEALED WITH CEMENT GROUT.
7. ALL TOPS TO BE TO BS EN 124 : 1994 WITH A Min CLEAR OPENING IN ACCORDANCE WITH THE DRAINAGE SCHEDULE. D400 TOPS TO HAVE A FRAME DEPTH OF 150mm.
8. ALL NEW 100Ø CONNECTIONS TO EXISTING 100Ø PIPEWORK TO BE MADE USING PROPRIETARY JUNCTION PIECE BANDSEAL CONNECTED TO EXISTING PIPEWORK.
9. EXISTING MANHOLE TOPS & FRAMES SHALL BE INSPECTED AND REPLACED IF THEY ARE FOUND NOT TO COMPLY WITH THE FOLLOWING:
   - WITHIN THE ACCESS ROAD / CAR PARK & SERVICE YARD CLASS D400
   - WITHIN PEDESTRIAN AREAS CLASS C250.
   - WITHIN LANDSCAPED AREAS CLASS B125 .
10. LOCATION OF AIR VENTS AT HEAD OF DRAINS AND FOR THE PETROL INTERCEPTORS ARE SHOWN INDICATIVELY AND SHOULD BE AGREED BY THE ARCHITECT.
11. LOCATION OF RAINWATER PIPES, CONDENSATE AND FOUL POP-UPS ARE TAKEN FROM THE ARCHITECTS / M&E PLANS AND COORDINATION SHOULD BE CHECKED PRIOR TO INSTALLATION OF THE BELOW GROUND DRAINAGE.
12. WHERE THE GAP BETWEEN PIPES AT A CROSSING IS LESS THAN 150mm THE PIPES AND GAP SHALL BE ENCASED IN ST4 CONCRETE.
13. PIPE CONNECTIONS WITHOUT A CHAMBER SHALL BE MADE WITH A PROPRIETARY JUNCTION PIECE.
14. IL FOR REST BENDS BELOW FFL SHALL BE 408mm BELOW FFL UNLESS OTHERWISE STATED AND CAST WITHIN THE SLAB, REFER TO DETAIL.
15. FOR FLOOR SLAB REINSTATEMENT DETAILS REFER TO GDP STRUCTURES DRAWINGS.
16. ALL EXISTING SEWERS TO BE ABANDONED SHOULD BE CCTV SURVEYED TO PROVE THEY DO NOT SERVE ANY PROPERTIES TO BE RETAINED AS PART OF THE SCHEME.
17. EXISTING SEWERS TO BE RETAINED / USED AS PART OF THE SCHEME SHOULD BE CCTV SURVEYED TO PROVE CONDITION AND IDENTIFY NECESSARY REMEDIAL WORKS / REPAIRS.
18. EXISTING SEWER LEVELS HAVE BEEN TAKEN FROM THE LOCAL SEWERAGE UNDERTAKERS SEWER RECORDS. THE LEVELS SHOULD BE PROVED ON SITE.
19. UNLESS OTHERWISE SPECIFIED BY THE ARCHITECT, ALL INTERNAL COVERS TO BE RECESSED DOUBLE SEALED, C250 BY HOWE GREEN OR SIMILAR APPROVED.
20. PRIOR TO THE FINISHED SURFACING BEING LAID ALL DRAINAGE SHALL BE TESTED IN ACCORDANCE WITH SEWERS FOR ADOPTION AND SPECIFICATION FOR HIGHWAY WORKS.

Rev.	Date:	By:	Chkd:	Revision Notes:
P05	06.11.20	M.Ev	RD	SCHEME ADJUSTED TO LATEST DRAWINGS, STORAGE REQUIREMENT ADJUSTED, TEMPORARY DRAINAGE ADDED & MAIN OUTFALL ADJUSTED.
P04	24.09.20	M.Ev	RD	THAMES WATER WATER MAIN ADDED TO DRAWING
P03	04.09.20	M.Ev	RD	REVISED TO MECHANICAL & ARCHITECTS DRAWINGS. ADDED ASSUMED CALCULATIONS.
P02	20.07.20	M.Ev	RD	REVISED FOLLOWING DTM, COORDINATION WITH STRUCTURE AND ARCHITECTS MARK-UP
P01	06.07.20	M.Ev	RD	ISSUED FOR INFORMATION

Client:
REEF ESTATES

G D Partnership Ltd
Consulting Engineers
GDP
The Cart Lodge, Lullingstone Lane, Eynsford, Kent. DA40HZ
Tel: 01322 868622 Fax: 01322 861050
Email : contact@gdteam.co.uk

Project:
UGLY BROWN BUILDING - PLOT A

Drawing:
PROPOSED DRAINAGE LAYOUT

Drawing Status
STAGE 3 FINAL ER SUBMISSION

Scale: 1:100 at A1 | GDP Reference: 16-017
Drawn: M.Ev | Checked: RD | Date: JUL'20

Project No. 16-017 | Rev: P05

Originator / Zone / Level / Type / Role / Number
GDP -ZA1-00-DR- C -5201

McALLISTER GROUP

PLOWMAN CRAVEN - ST PANCRAS WAY - MID-LEVEL 2

01 July 2019

McAllister Group, Unit 34 Thorney Business Park, Iver, Buckinghamshire, SL0 9HF
Telephone 01403 268 673 Facsimile 01483 762226

GRADE 3,4 & 5 Summary

STRUCTURAL DEFECTS

Structural defects			
Section	PLR	Grade	Fault description
Acceptable Structural Condition			

Grade 3; Best practice suggests consideration be given to repair in the medium term
Grade 4; Best practice suggests consideration be given to a repair to avoid potential collapse
Grade 5; Best practice suggests this pipe is at risk of collapse at any time; urgent consideration should be given to a repair to avoid collapse

SERVICE / OPERATIONAL DEFECTS

Service defects			
Section	PLR	Grade	Fault description
1	MAIN RUN X	5	Multiple defects at 20.0m
2	TQ29835701 X	5	Multiple defects at 120.0m

Grade 3; Best practice suggests consideration be given to maintenance activities in the medium term
Grade 4; Best practice suggests consideration be given to maintenance activity to avoid potential blockage
Grade 5; Best practice suggests this pipe is at immediate risk of backing up / causing flooding

Abandoned Surveys

Camera no access		
Section	PLR	Fault description
All Surveys Completed		

Information

These summaries are based on the SRM grading from the WRC

McALLISTER GROUP
UNIT B, HORTON TRADING ESTATE
STANWELL ROAD
Tel.: 01753 916339
Fax:
Email: dave.paul@mcallistergroup.com

Table of contents

Project Name:	Project number:	Date:	Contact:	
St Pancras Way		21/06/2019		

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STANWELL ROAD
Tel: 01753 916339
Fax:
Email: dave.paul@mcallistergroup.com

Service / Operational Defects (SRM 4)

Project name : St Pancras Way	Project Number :	Contact :	Date : **15/06/2019**

No.	PLR	Dir.	Use	Shape / Size	Date	Mat.	Total Length	Insp. Length	Peak HWG	Peak Score	Grade	Mean Score	Total Score
1	MAIN RUNX	U	C	C 2134	21/06/2019	BR	50.00	50.00	3	26	5	12.42	621.2
2	TQ29835701X	D	C	C 2134	15/06/2019	BR	120.00	120.00	3	24	5	12.2	1463.4

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Structural Defects (SRM 4)

Project name : **St Pancras Way**	Project Number :	Contact :	Date : **15/06/2019**

No.	PLR	Dir.	Use	Shape / Size	Date	Mat.	Total Length	Insp. Length	Peak HWG	Peak Score	Grade	Mean Score	Total Score
1	MAIN RUNX	U	C	C 2134	21/06/2019	BR	50.00	50.00	-	10	2	0.2	10
2	TQ29835701X	D	C	C 2134	15/06/2019	BR	120.00	120.00	-	10	2	9.92	1190

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Project-information

Project name : St Pancras Way	Project Number :	Contact :	Date : 21/06/2019

Client:	**REEF GROUP**
Contact Name:	**JASON RUSSELL**
Department:	
Road:	**51 WELBECK STREET**
Town:	**LONDON, W1G 9HL**
County:	
Telephone:	
Fax:	
Mobile:	
E-mail:	

Site:	
Contact Name:	
Department:	
Road:	**ST PANCRAS WAY**
Town:	**LONDON**
County:	**NW1 0PT**
Telephone:	
Fax:	
Mobile:	
E-mail:	

Contractor	**McALLISTER GROUP**
Contact Name:	**DAVE PAUL**
Department:	
Road:	**UNIT B, HORTON TRADING ESTATE**
Town:	**STANWELL ROAD**
County:	**SLOUGH, SL3 9PF**
Telephone:	**01753 916339**
Fax:	
Mobile:	
E-mail:	**dave.paul@mcallistergroup.com**

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Defect Grade Description

Project Name : St Pancras Way	Project number :	Contact :	Date : 21/06/2019

1:

Brick: No Structural Defects
Pipe: No Structural Defects

Acceptable Structural Condition

2:

Brick: Minor cracking, Surface mortar loss, Spalling slight, wear slight
Pipe: Circumfrential crack, Moderate joint defects, Spalling slight, Wear slight

Minor collapse risk in short term but potential for further deterioration

3:

Brick: Total mortorloss without other defects, single brick displaced, Deformation up to 5%, Spalling medium, Wear medium
Pipe: Fractures with deformation up tp 5%, Longitudinal cracking or mulitlpe cracking, Minor loss of level, More severe joint

! Collapse unlikely in near future but future deterioration likely !

4:

Brick: Total mortorloss with deformation greater than 10%, Deformation up to 10% and fractured, Displaced/hanging brickwork, Small number of missing bricks
Pipe: Broken, Deformation up to 10% and broken,, Fractured with deformation 5 - 10%, Multipl

!! Collapse likely in foreseeable future !!

5:

Brick: Already Collapsed, Missing invert, Deformation over 10% and fractured, Displaced/hanging brickwork and deformation over 10%, Extensive missing bricks
Pipe: Already collapsed, Deformation over 10% and broken, Extensive areas of fabric missin

!!! Collapsed or collapse imminent !!!

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Inspection report

Date :	Job number :	Weather :	Operator :	Section number :	PLR SUFFIX:
21/06/2019	**-**	**no rain or snow**	**D. VERITY**	**1**	**X**
Weather	Vehicle :	Camera :	Preset :	Cleaned :	Operator :
no rain or snow	**LT62 RXW**	**GO-PRO**		**no**	**D. VERITY**

Place :	**LONDON**	Location details:		U/S MH :	**MAIN RUN**
Road :	**ST PANCRAS WAY**	Catchment:	**NW1**	U/S Depth :	
Location	**Difficult access**	Tape number :	**42774**	D/S MH :	**TQ29835701**
Inspection	**TQ29835701 (U/S) MAIN RUN**	Pipe Length	0.00 m	D/S Depth :	

Use:	**Combined**	Pipe shape :	**Circular**
Year laid :	**Z**	Pipe size :	**2134 mm**
Purpose :	**Sample survey to determine asset condition**	Pipe material :	**Brick**
Total length :	**50.00 m**	Lining :	

Comment : **DIVERSIONS IN PLACE**

1:180	Position		Code	Observation	Grade
	0.00		MH	Start node type, manhole, reference number : TQ29835701	0
TQ29835701	0.00		WL	Water level, 5% of the vertical dimension	0
	0.90	S01	DEG	Attached deposits, grease, from 4 to 8 o'clock, 5% cross-sectional area loss, Start Remarks: PATCHY	3
	0.90	S02	OBP	Other obstacles, external pipe or cable, from 2 to 3 o'clock, 5% cross-sectional area loss, Start Remarks: CABLES	5
	1.00		MM	Missing mortar, from 8 to 5 o'clock, between 5mm and 15mm	2
	2.00		IS	Infiltration, seeping, from 10 to 11 o'clock	0
	2.00		DEE	Attached deposits, encrustation, from 8 to 11 o'clock, 5% cross-sectional area loss	3
	4.00		DEE	Attached deposits, encrustation, from 8 to 11 o'clock, 5% cross-sectional area loss	3
	9.00		DEE	Attached deposits, encrustation, from 1 to 3 o'clock, 5% cross-sectional area loss	3
	10.00		GP	General photograph taken at this point Remarks: 10 METERS	0
	17.50		DEE	Attached deposits, encrustation, from 8 to 10 o'clock, 5% cross-sectional area loss	3
	20.00	S03	OBP	Other obstacles, external pipe or cable, from 10 to 11 o'clock, 5% cross-sectional area loss, Start Remarks: CABLES	5
	20.00		GP	General photograph taken at this point Remarks: 20 METERS	0
	20.00	F02	OBP	Other obstacles, external pipe or cable, from 2 to 3 o'clock, 5% cross-sectional area loss, End Remarks: CABLES	5
	21.50		DEE	Attached deposits, encrustation, from 1 to 3 o'clock, 10% cross-sectional area loss	3


0.9 m


0.9 m


2 m


2 m


4 m

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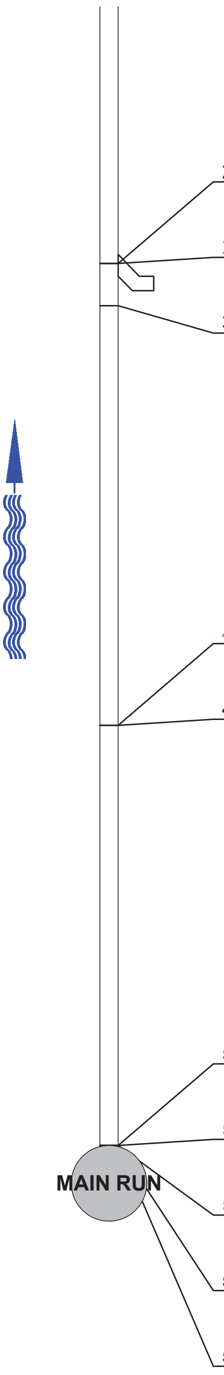
Inspection Report

Date :	Job number :	Weather :	Operator :	Section number :	PLR :
21/06/2019	**-**	**no rain or snow**	**D. VERITY**	**1**	**X**
Weather **no rain or snow**	Vehicle : **LT62 RXW**	Camera : **GO-PRO**	Preset : **0**	Cleaned : **no**	Grade:



1:180 Position		Code	Observation	Grade
29.00		JNC	Junction closed, at 9 o'clock, diameter 150mm Remarks: CAPPED OFF	0
29.00		DEE	Attached deposits, encrustation, from 2 to 4 o'clock, 5% cross-sectional area loss	3
30.00		GP	General photograph taken at this point Remarks: 30 METERS	0
40.00	**S04**	DER	Settled deposits, coarse, 5% cross-sectional area loss, Start	3
40.00		GP	General photograph taken at this point Remarks: 40 METERS	0
50.00	**F03**	OBP	Other obstacles, external pipe or cable, from 10 to 11 o'clock, 5% cross-sectional area loss, End Remarks: CABLES	5
50.00	**F04**	DER	Settled deposits, coarse, 5% cross-sectional area loss, End	3
50.00	**F01**	DEG	Attached deposits, grease, from 4 to 8 o'clock, 5% cross-sectional area loss, End Remarks: PATCHY	3
50.00		REM	General remark Remarks: REQUIRED METERAGE REACHED	0
50.00		MHF	Finish node type, manhole reference number: MAIN RUN Remarks: REQUIRED METERAGE REACHED SURVEY FINISHED & COMPLETE	0

STR no def	STR peak	STR mean	STR total	STR grade	SER no def	SER peak	SER mean	SER total	SER grade
1	10	0.2	10	2	10	26	12.42	621.2	5

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Inspection pictures

Place :	Road :	Date :	Section number :	PLR Suffix :
LONDON	**ST PANCRAS WAY**	**21/06/2019**	**1**	**X**

Photo: 1_1_5_A.jpg, Media No:: 42774, 00:00:02
0.9m, Attached deposits, grease, from 4 to 8 o'clock, 5% cross-sectional area loss, Start
Remarks: PATCHY

Photo: 1_1_6_A.jpg, Media No:: 42774, 00:00:02
0.9m, Other obstacles, external pipe or cable, from 2 to 3 o'clock, 5% cross-sectional
area loss, Start Remarks: CABLES

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Inspection pictures

Place :	Road :	Date :	Section number :	PLR Suffix :
LONDON	**ST PANCRAS WAY**	**21/06/2019**	**1**	**X**

Photo: TQ29835701_U_210619_075829_-_1.jpg, Media No:: 42774, 00:00:19
2m, Infiltration, seeping, from 10 to 11 o'clock

Photo: 1_1_23_A.jpg, Media No:: 42774, 00:00:19
2m, Attached deposits, encrustation, from 8 to 11 o'clock, 5% cross-sectional area loss