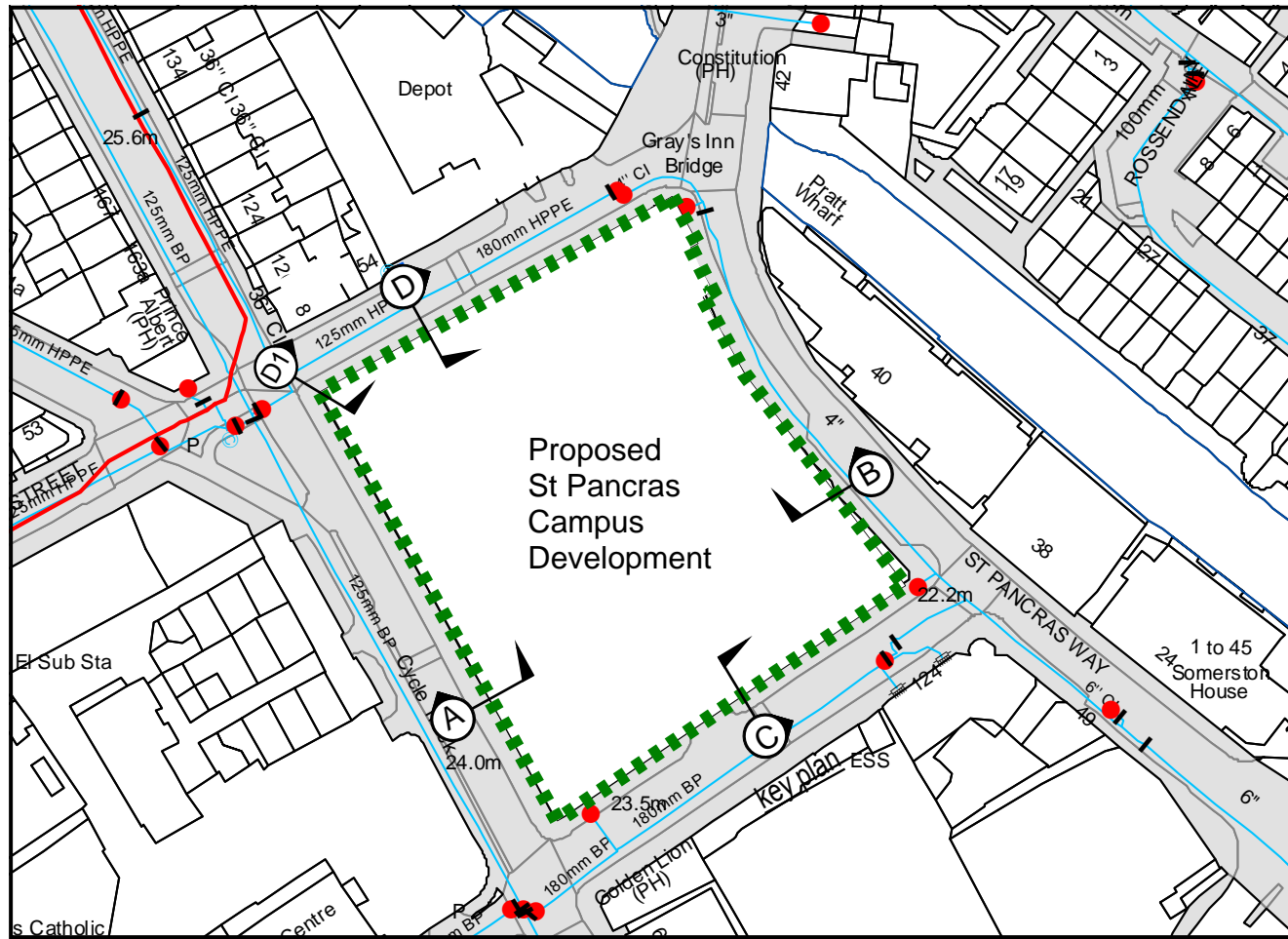
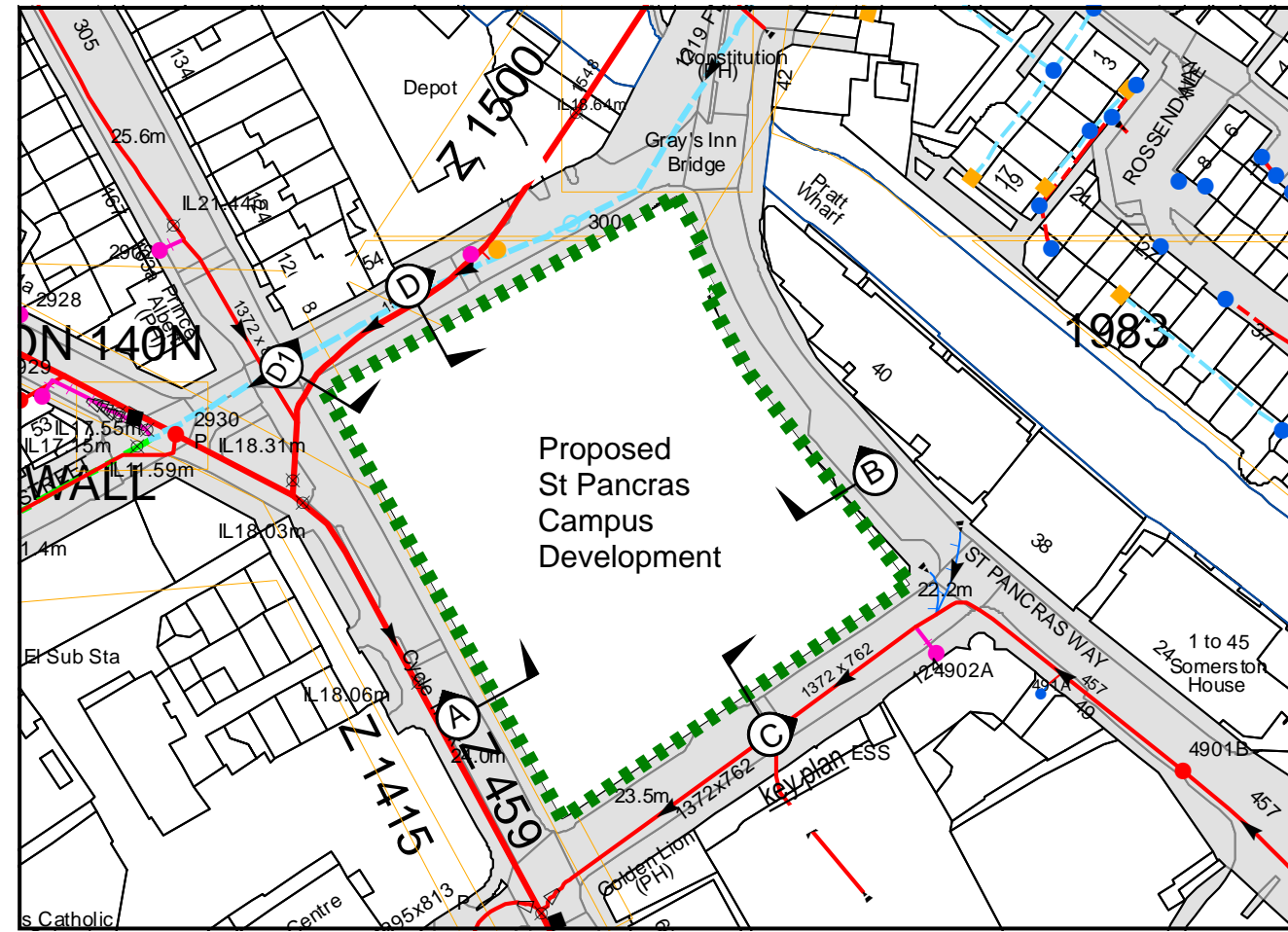


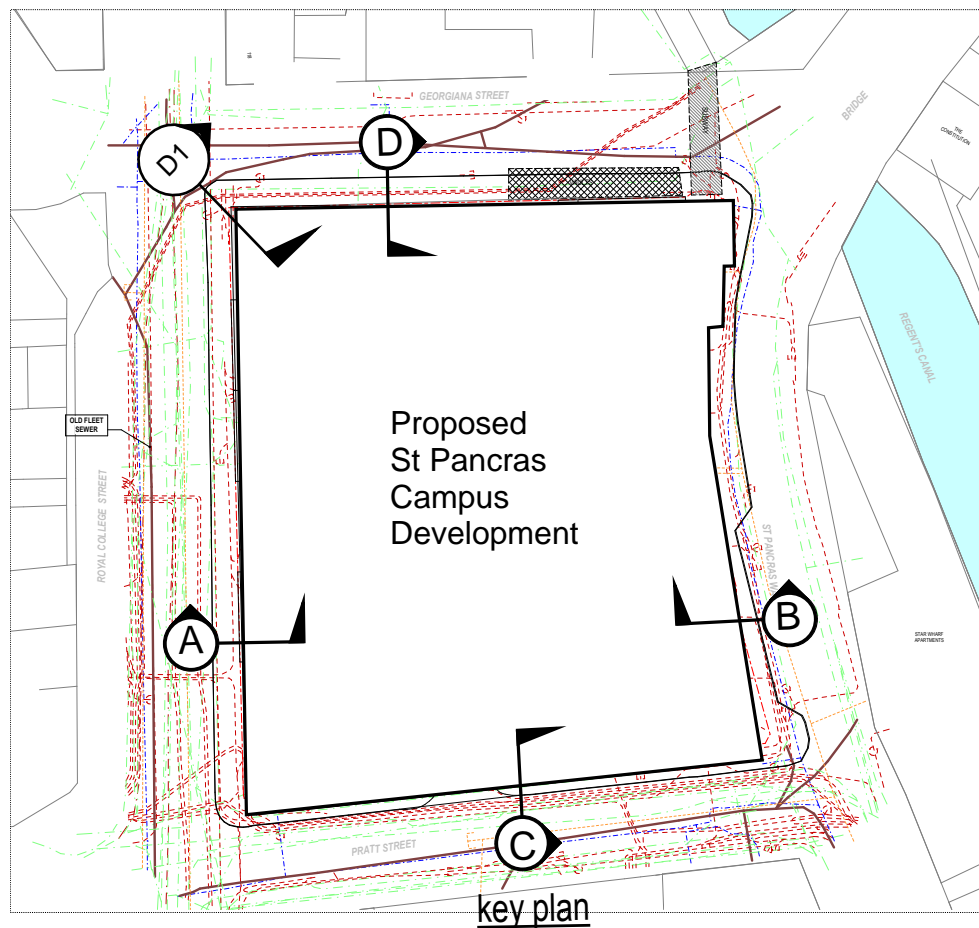
Extract of Thames Water Asset Location - Clean Water Map



Extract of Thames Water Asset Location - Sewer Map



Indicative Thames Water plans showing locations of below ground sewers and clean water pipes networks adjacent to proposed development site.



Extract of AKTII below ground Site Constraints Information showing indicative locations of Utilities surrounding the site.

Notes:

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All other possible buried structures (including national grid tunnels/ assets) are not shown here for clarity.

REV	P3	08/08/2019
	P2	25/07/2019
	P1	08/07/2019

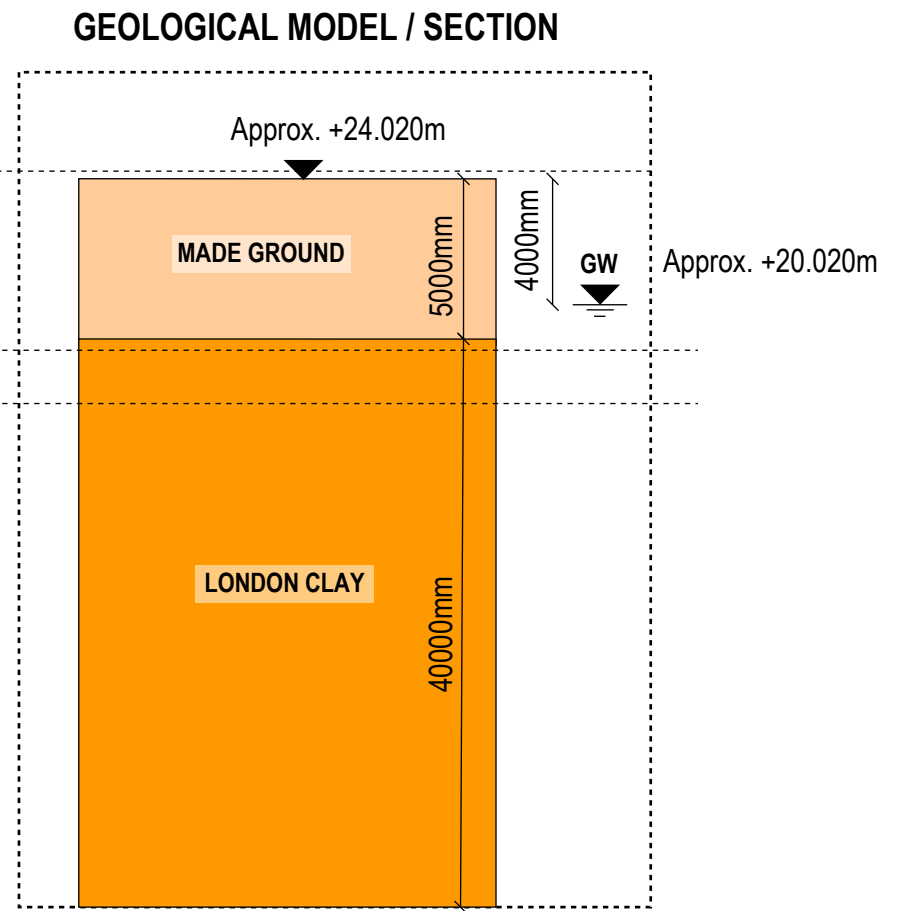
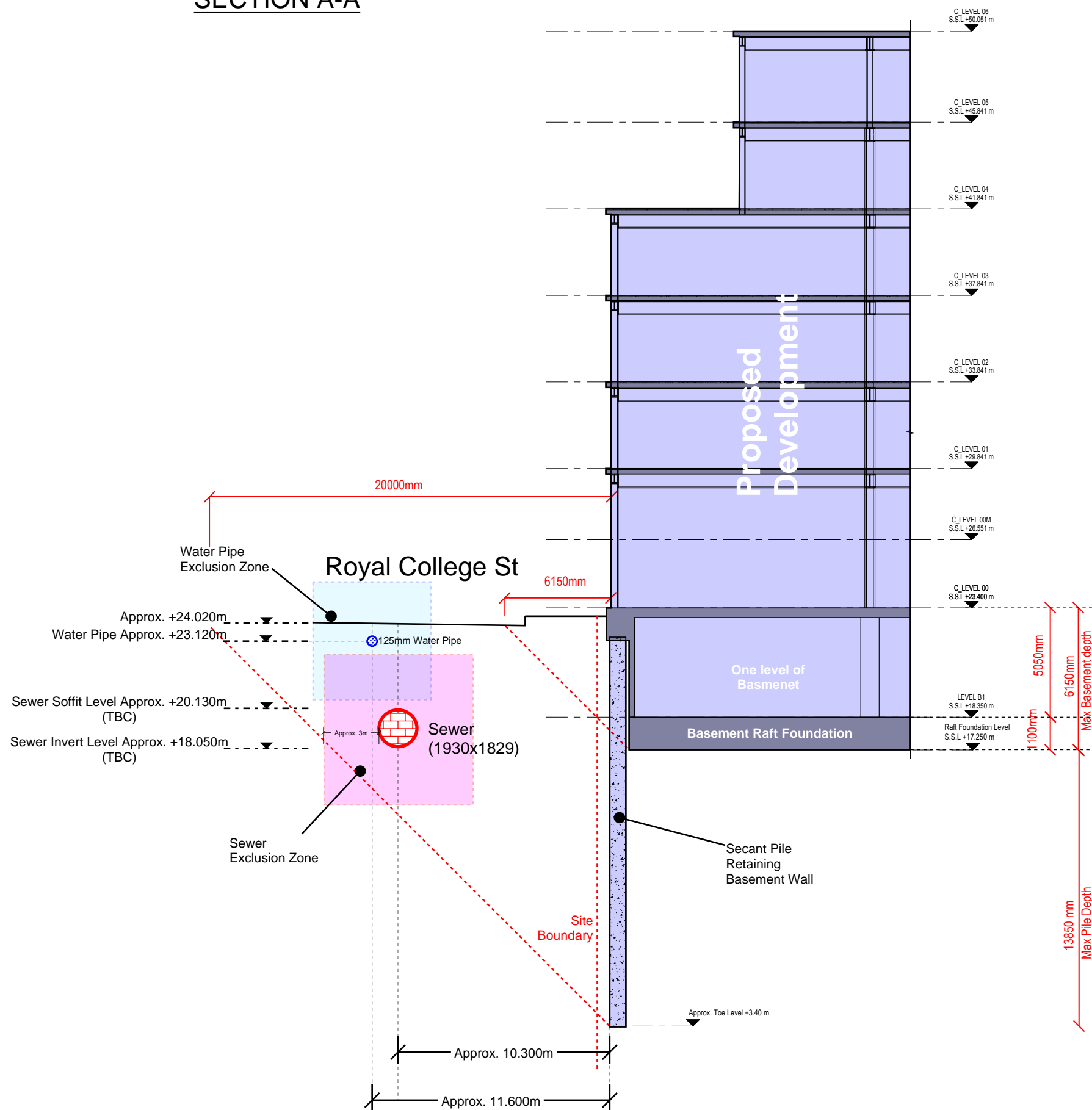
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	Thames Water Assets - Fleet Sewer
	Thames Water Assets - Fleet Sewer

SK	LM
SK	LM
BY SK	CHECKED LM



PROJECT	4409 - St Pancras Campus	TITLE	Thames Water Assets - Fleet Sewer - Plan View
DATE	05/12/19	SCALE	NTS
		CAD FILENAME	-
		STATUS	PRELIMINARY
DRAWN	SK	CHECKED	LM
PROJECT No.	4409	DRAWING No.	4409 - HSK_GN_106_1
		REV	P4

SECTION A-A



Notes:

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REV	P3	08/08/2019
	P2	25/07/2019
	P1	08/07/2019

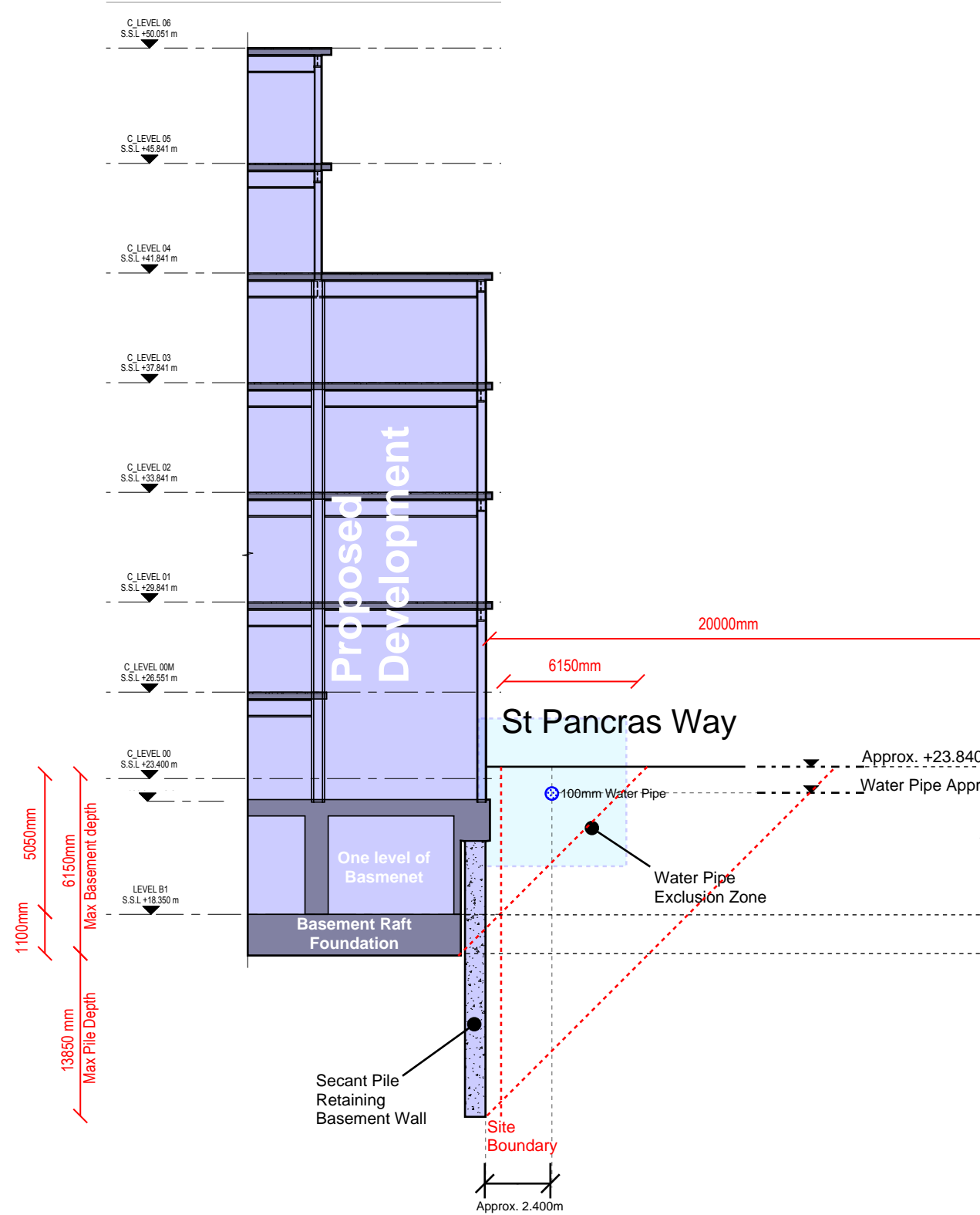
DESCRIPTION Thames Water Assets - Fleet Sewer
 Thames Water Assets - Fleet Sewer
 Thames Water Assets - Fleet Sewer

BY SK
 SK
 SK
 CHECKED LM



PROJECT	4409 - St Pancras Campus	TITLE	Thames Water Assets - Fleet Sewer - Section A-A		
DATE	05/12/19	SCALE	NTS	CAD FILENAME	-
				STATUS	PRELIMINARY
DRAWN	SK	CHECKED	LM	PROJECT No.	4409
				DRAWING No.	4409 - HSK_GN_106_2
				REV	P4

SECTION B-B



Notes:

This sketch has been produced to assist discussions between the project team and Thames Water with regards to the Fleet Sewer and provide options in keeping with the current development proposals.

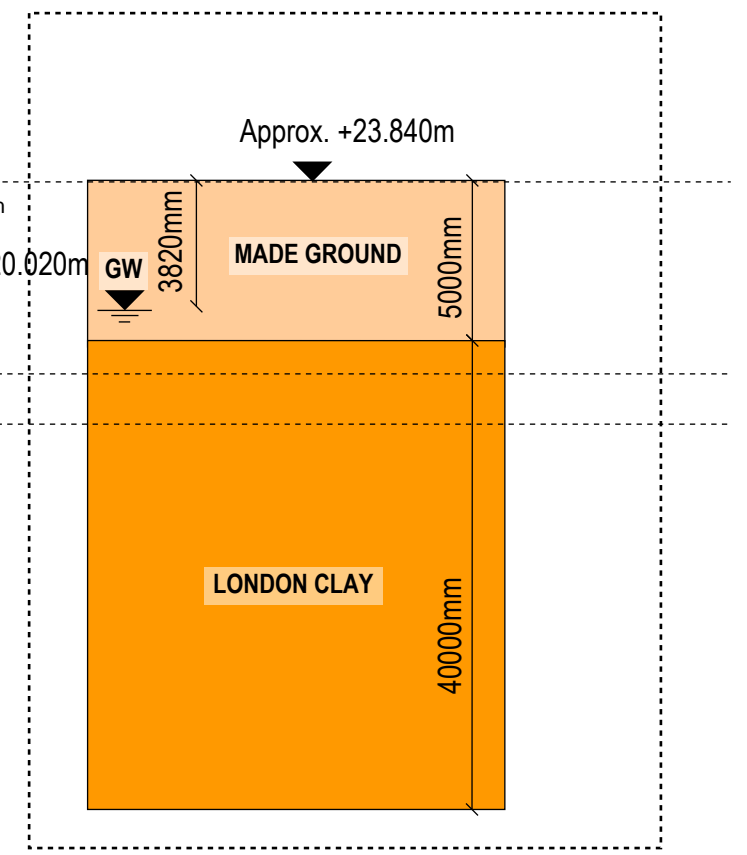
All information drawn is indicative.

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GEOLOGICAL MODEL / SECTION



REV	P3	08/08/2019
	P2	25/07/2019
	P1	08/07/2019

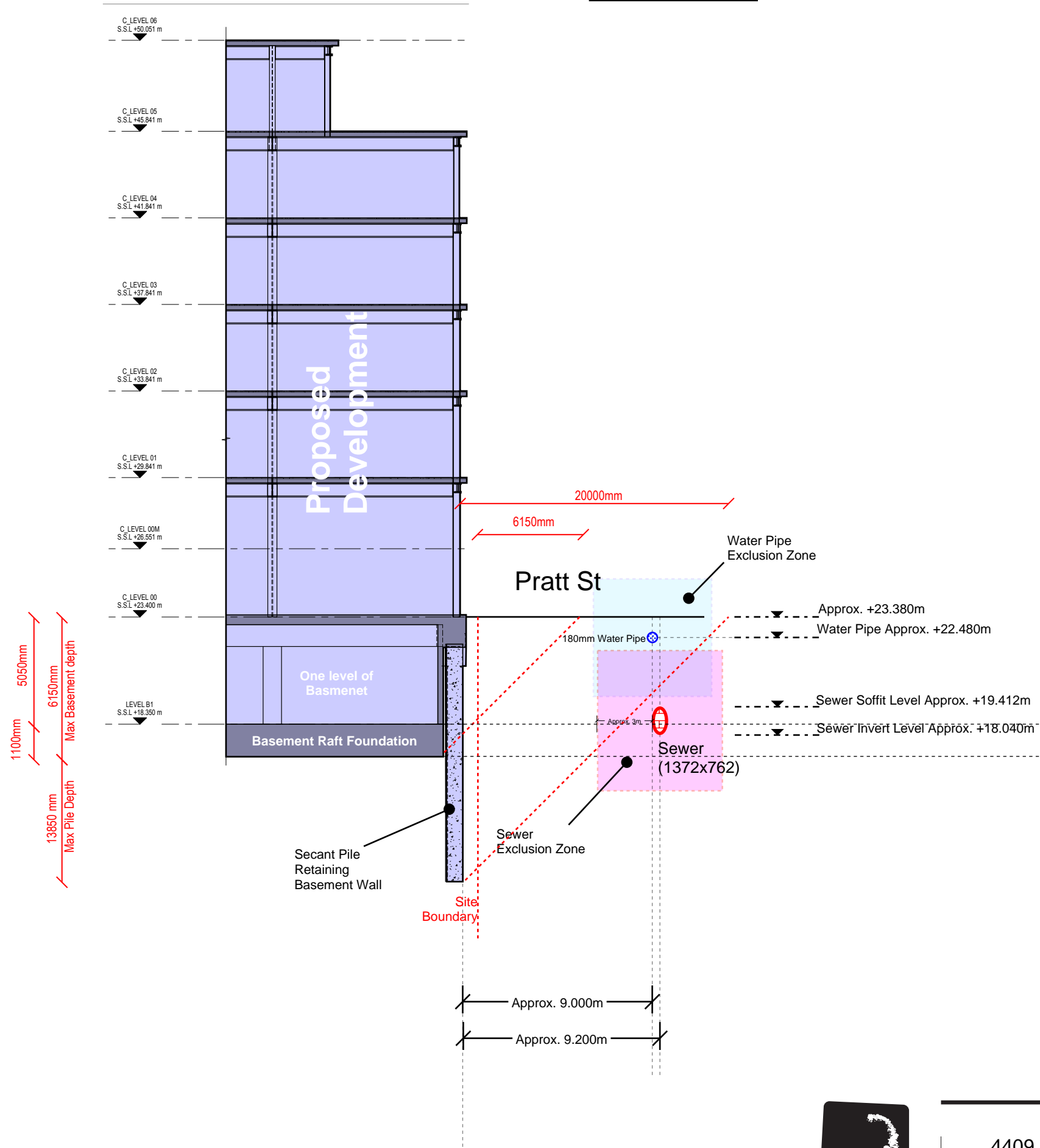
DESCRIPTION Thames Water Assets - Fleet Sewer
 Thames Water Assets - Fleet Sewer
 Thames Water Assets - Fleet Sewer

SK LM
 SK LM
 BY SK CHECKED LM



PROJECT	4409 - St Pancras Campus	TITLE	Thames Water Assets - Fleet Sewer - Section B-B
DATE	05/12/19	SCALE	NTS
CAD FILENAME	-	STATUS	PRELIMINARY
DRAWN	SK	CHECKED	LM
PROJECT No.	4409	DRAWING No.	4409 - HSK_GN_106_3
REV	P4		

SECTION C-C



Notes:

This sketch has been produced to assist discussions between the project team and Thames Water with regards to the Fleet Sewer and provide options in keeping with the current development proposals.

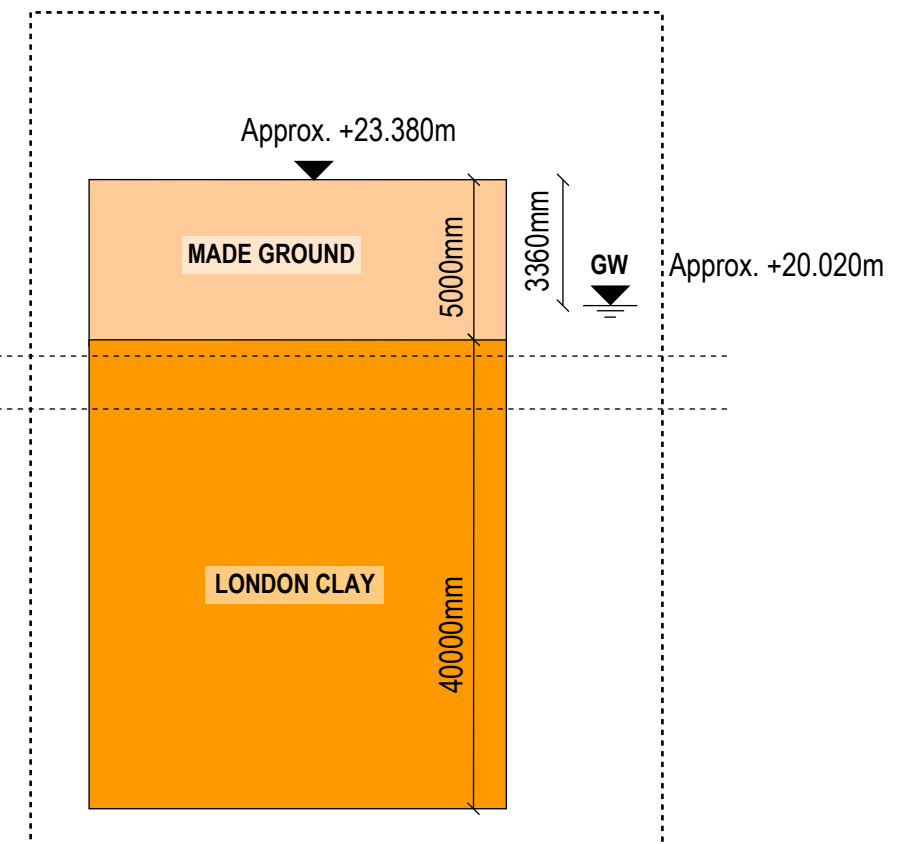
All information drawn is indicative.

All information relating to Thames Water assets have been drawn indicatively based on information available / received to date.

Extent of the development layout / massing is indicated as currently proposed by the design team. The options presented relate to maintaining these current proposals in massing.

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GEOLOGICAL MODEL / SECTION



REV	P3	08/08/2019
	P2	25/07/2019
	P1	08/07/2019

DESCRIPTION Thames Water Assets - Fleet Sewer
 Thames Water Assets - Fleet Sewer
 Thames Water Assets - Fleet Sewer

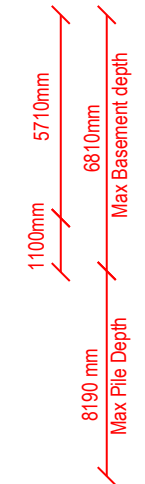
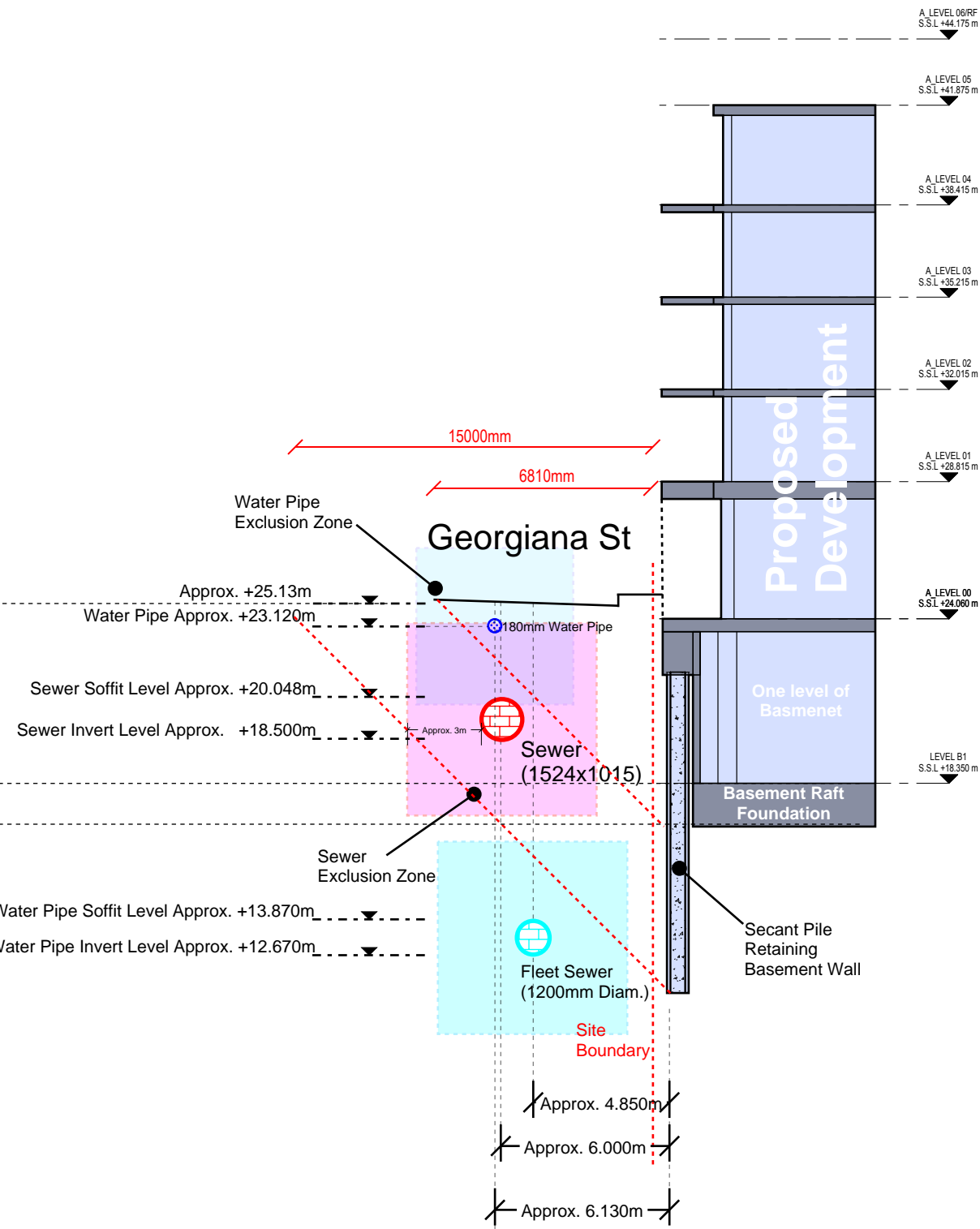
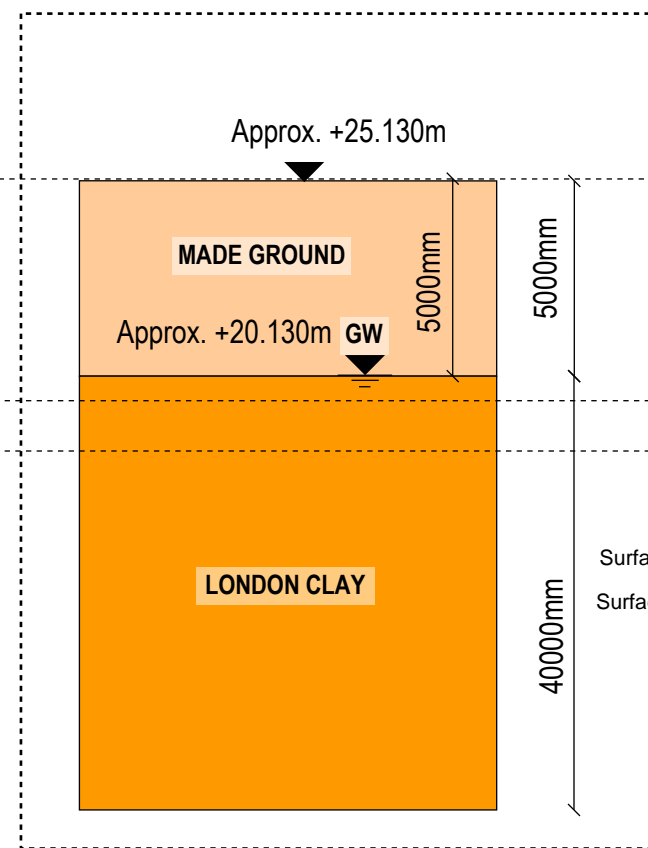
SK LM
 SK LM
 BY SK CHECKED LM



PROJECT	4409 - St Pancras Campus	TITLE	Thames Water Assets - Fleet Sewer - Section C-C		
DATE	05/12/19	SCALE	NTS	CAD FILENAME	-
				STATUS	PRELIMINARY
DRAWN	SK	CHECKED	LM	PROJECT No.	4409
				DRAWING No.	4409 - HSK_GN_106_4
				REV	P4

SECTION D-D

GEOLOGICAL MODEL / SECTION



Notes:

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REV	P3	08/08/2019
	P2	25/07/2019
	P1	08/07/2019

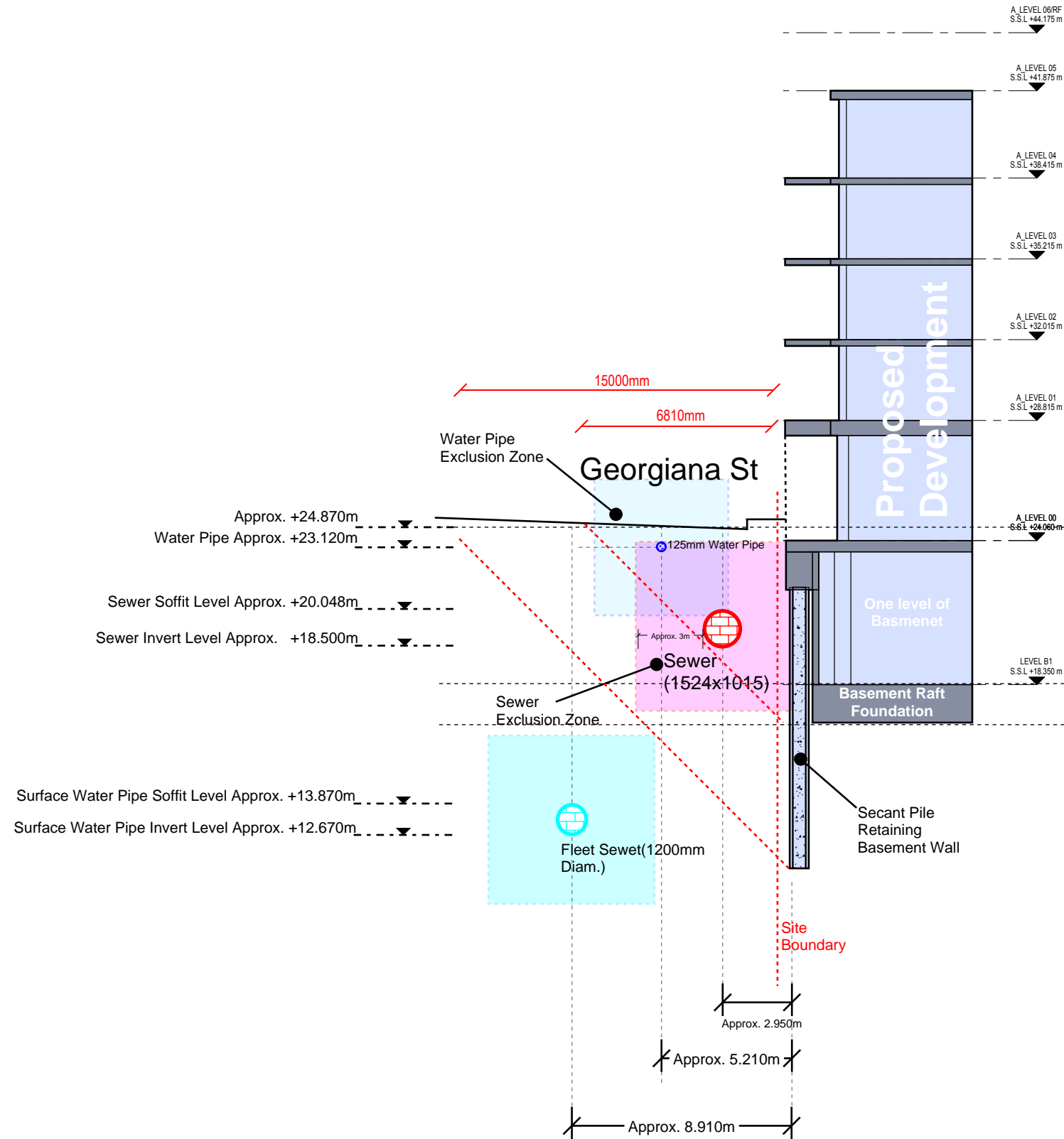
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	Thames Water Assets - Fleet Sewer

BY	SK	CHECKED	LM
	SK		LM
	SK		LM



PROJECT	4409 - St Pancras Campus	TITLE	Thames Water Assets - Fleet Sewer - Section D-D		
DATE	05/12/19	SCALE	NTS	CAD FILENAME	-
					STATUS PRELIMINARY
DRAWN	SK	CHECKED	LM	PROJECT No.	4409
				DRAWING No.	4409 - HSK_GN_106_5
				REV	P4

SECTION D1-D1



Notes:

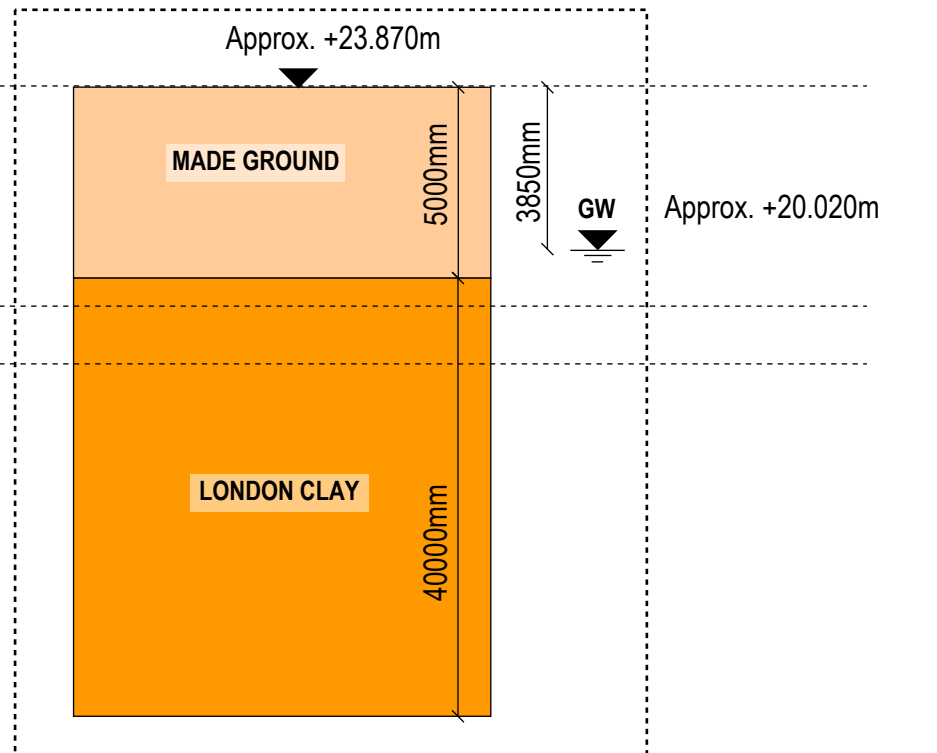
This sketch has been produced to assist discussions between the project team and Thames Water with regards to the Fleet Sewer and provide options in keeping with the current development proposals.

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GEOLOGICAL MODEL / SECTION

REV	P3	08/08/2019
	P2	25/07/2019
	P1	DATE 08/07/2019

DESCRIPTION	Thames Water Assets - Fleet Sewer
	Thames Water Assets - Fleet Sewer
	Thames Water Assets - Fleet Sewer

SK	LM
SK	LM
BY SK	CHECKED LM



PROJECT	4409 - St Pancras Campus	TITLE	Thames Water Assets - Fleet Sewer- Section D1-D1
DATE	05/12/19	SCALE	NTS
		CAD FILENAME	-
		STATUS	PRELIMINARY
DRAWN	SK	CHECKED	LM
PROJECT No.	4409	DRAWING No.	4409 - HSK_GN_106_6
		REV	P4

UTILITIES

The figures below show the Thames Water sewers and mains, and Cadent Gas mains around the site.

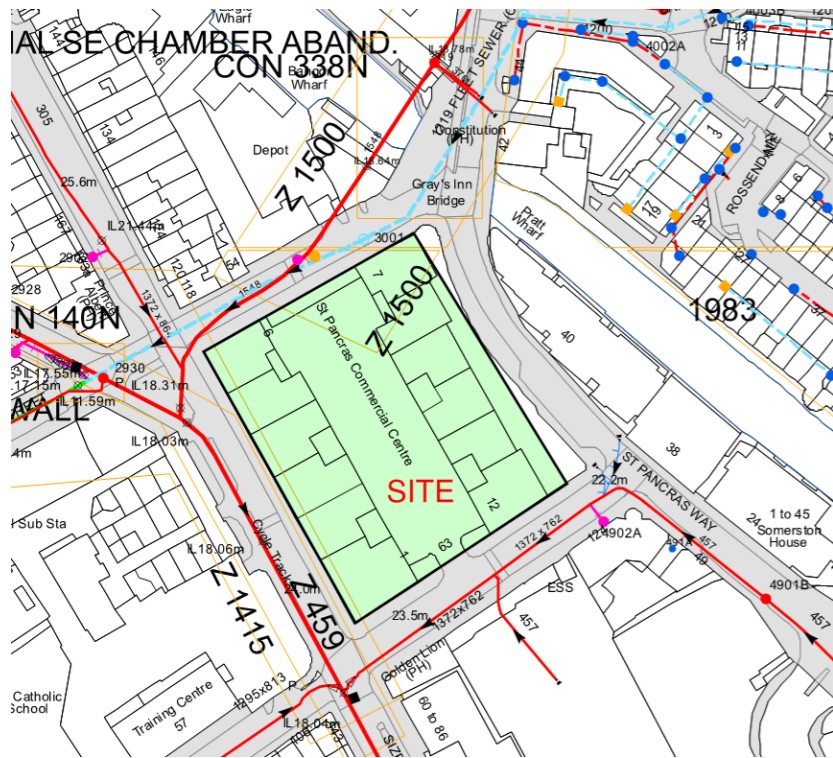


Figure A1. Thames Water asset map - Sewers

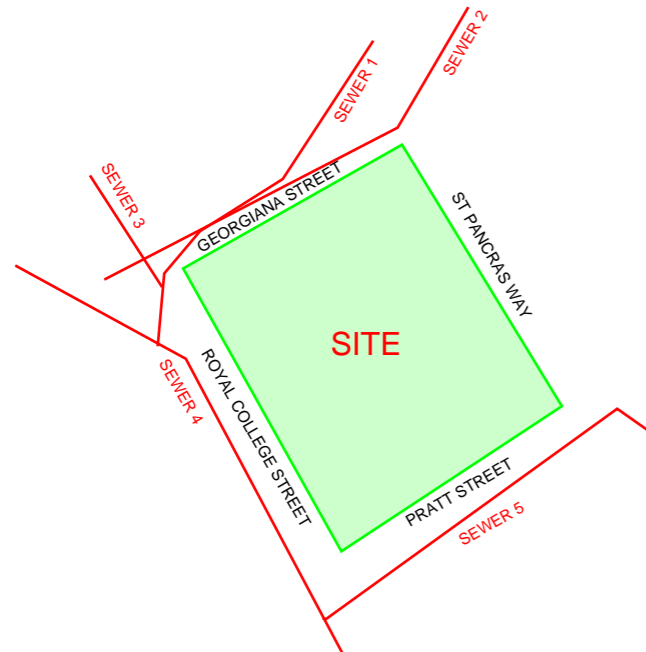


Figure A2. Assessed Thames Water sewers

Asset Reference	Material	Diameter (mm)	Cover Level (mOD)	Assumed Lining Thickness (mm)
Sewer 1	Masonry	1219	11.5	225
Sewer 2	Masonry	1548	17.1	225
Sewer 3	Masonry	1372x864	20.1	225
Sewer 4	Masonry	1930x1829	19.9	225
Sewer 5	Masonry	1372x762	19.4	225
Water Main 1	Cast Iron	102	24.1	20

Table A1. Assessed Thames Water sewers and mains details

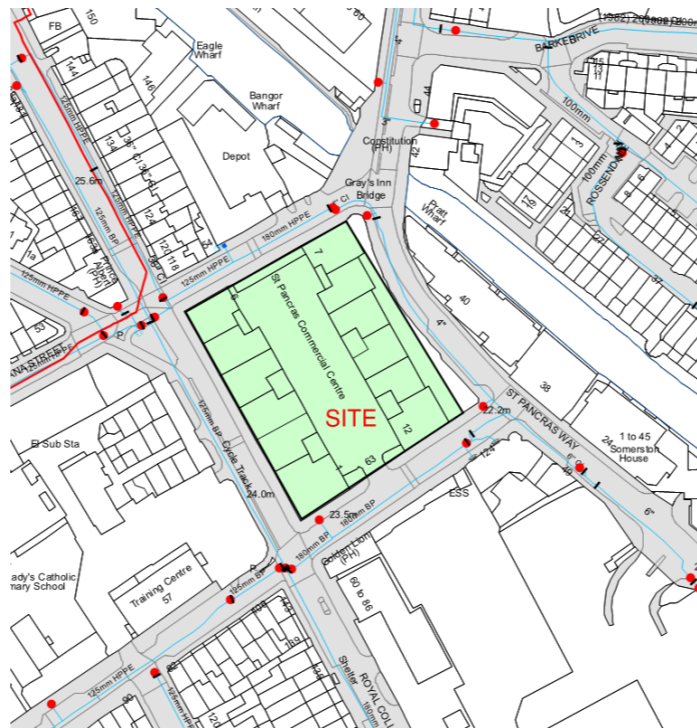


Figure A3. Thames Water asset map - Mains

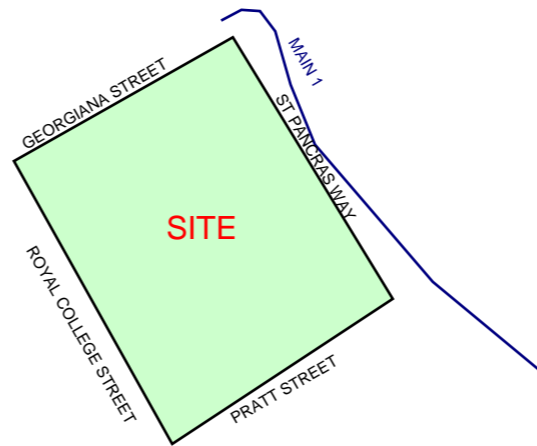


Figure A4. Assessed Thames Water mains

Table 1 - Assessment Criteria for Existing Thames Water Pipeline and Sewer Assets

PIPE TYPE	Diameter (mm)	Allowable Increase in Strain (µε)		Rotation (deg.)
		Tension	Compression	
Brick Sewer (red / yellow / blue brick)	N/A	500	25% of the allowable stress	N/A
Cast Iron Lead-yarn joints	N/A	100	1200	0.1
Ductile Iron (Lead-yarn gasket joints)	N/A	500	700	0.5
Ductile Iron (Rubber gasket joints)	N/A	500	700	2.0
Steel	N/A	450	450	1.5
Vitrified Clay	<125	80	400	0.5
	>125	80	400	See Table 2
Concrete (unreinforced)	<225	20	400	0.5
	225 - 750	40	400	See Table 2
	>750	60	400	See Table 2

Figure A5. Thames Water assessment criteria

The Cadent Gas pipes around the site are of plastic type that have the flexibility to deflect with ground movements. Cadent Gas have confirmed that they would not require any assessments for such types of pipes.

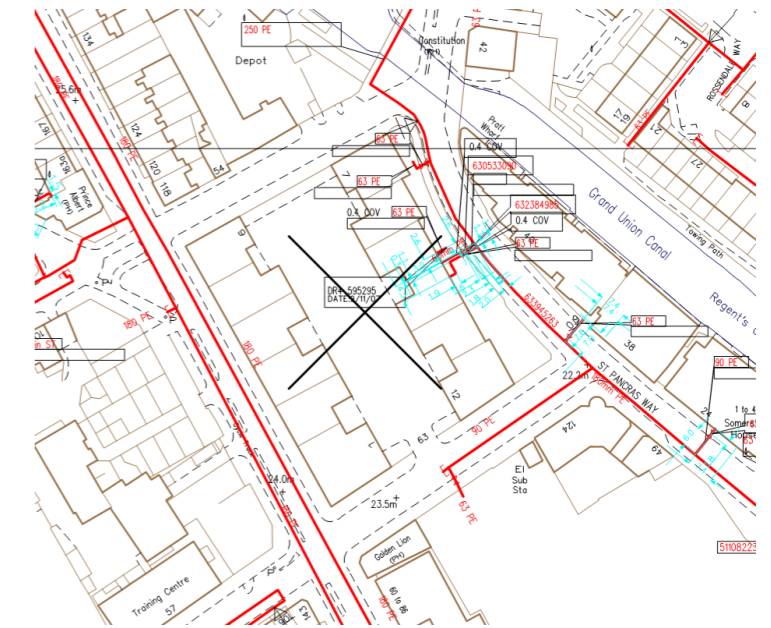


Figure A6. Cadent Gas asset map

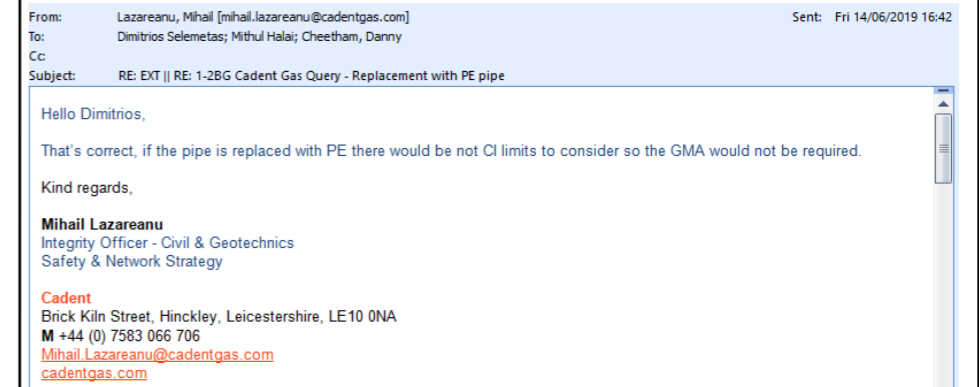


Figure A7. Cadent Gas email correspondence



PROJECT	ST PANCRAS CAMPUS	TITLE	UTILITY INFORMATION
DATE	06/12/2019	SCALE	N/A
DRAWN	MH	CAD FILENAME	-
CHECKED	-	STATUS	-
PROJECT No.	4409	DRAWING No.	-
REV	P1		

RESULTS

The wall installation and excavation effect have been modelled using the empirical curves from CIRIA C760 that is accepted industry wide to provide conservative estimates of ground movements. These have been modelled using XDisp and presented below.

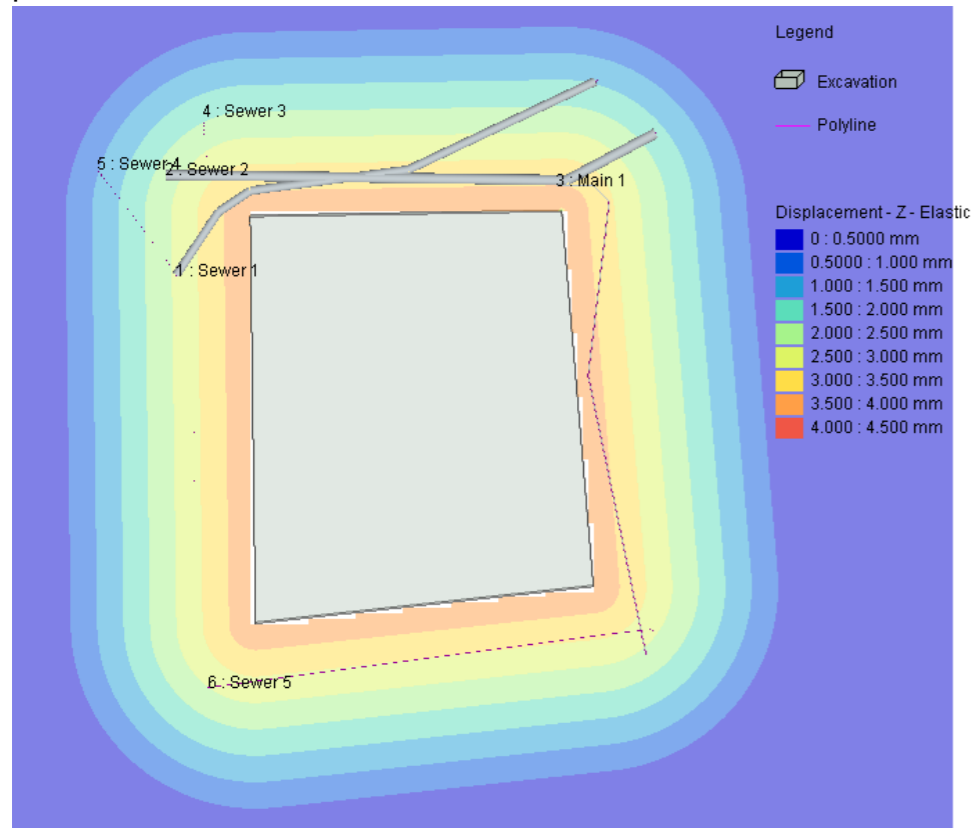


Figure B1. Greenfield ground movements due to wall installation

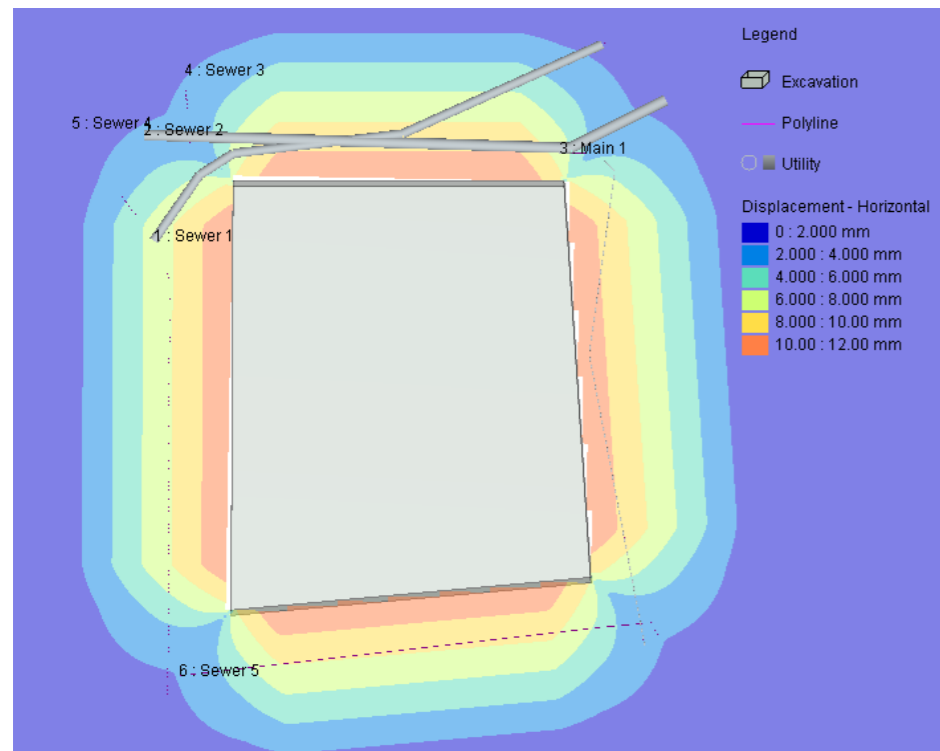


Figure B2. Greenfield ground movements due to excavation

Subsequently, wall installation and excavation effects have been combined to provide ground displacements as below.

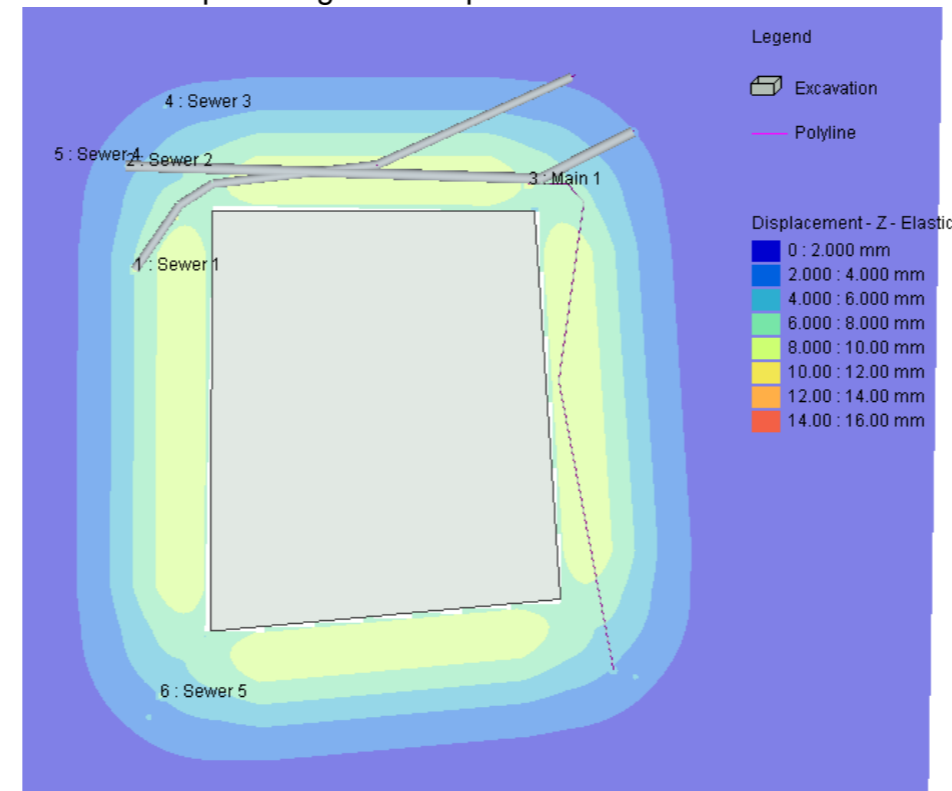


Figure B3. Greenfield ground movements due to wall installation+excavation

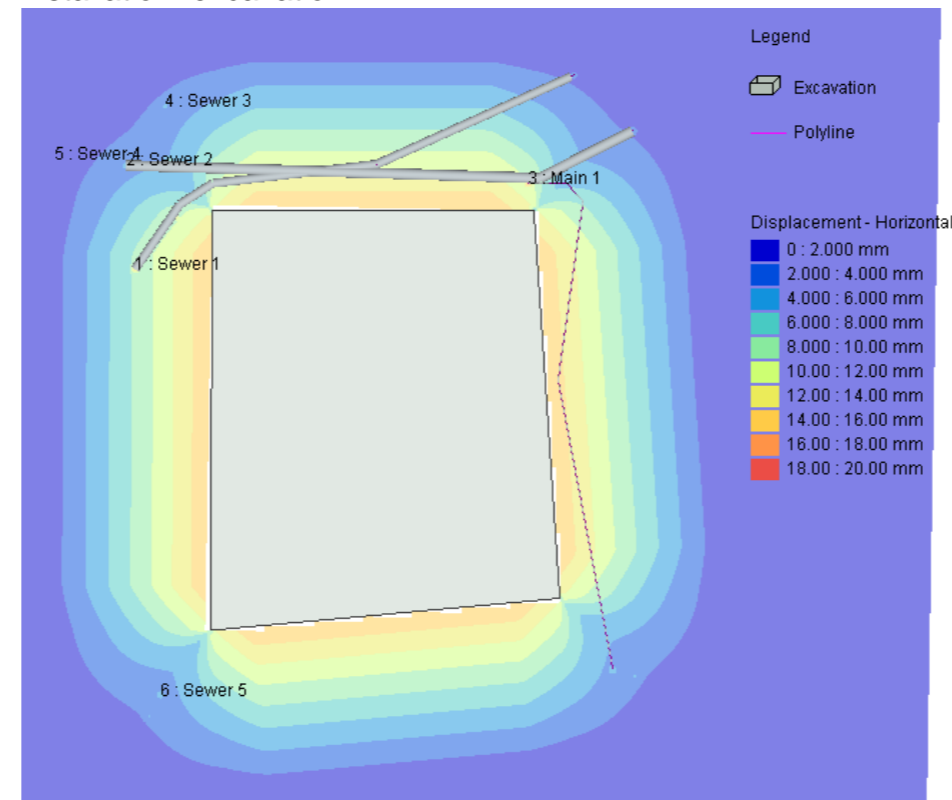


Figure B4. Greenfield ground movements due to wall installation+excavation

The table below summarises the assessment criteria results using XDisp. These have been shown to be within the limits.

Asset	Material	Internal diameter (mm)	Maximum tensile Strain (µε)	Maximum allowed tensile strain (µε)	Maximum compressive strain (µε)	Maximum allowed compressive strain (µε)	Maximum rotation (deg)	Maximum allowed rotation (deg)	Maximum pullout (mm)	Maximum allowed pullout (mm)
Sewer 1	Masonry	1219	110	500	691	-	-	-	-	-
Sewer 2	Masonry	1548	150	500	264	-	-	-	-	-
Sewer 3	Masonry	1372x864	212	500	554	-	-	-	-	-
Sewer 4	Masonry	1930x1829	400	500	344	-	-	-	-	-
Sewer 5	Masonry	1372x762	281	500	400	-	-	-	-	-
Water Main 1	Cast Iron	102	25	100	77	1200	0.01	0.1	0.04	3

Table B1. Result summary for affected Thames Water assets based on wall installation + excavation effects



PROJECT	ST PANCRAS CAMPUS	TITLE	GROUND MOVEMENT ASSESSMENT RESULTS		
DATE	06/12/2019	SCALE	N/A	CAD FILENAME	-
DRAWN	MH	CHECKED	-	PROJECT No.	4409
				DRAWING No.	-
				REV	P1

RESULTS

Loading has been modelled in PDisp using London Clay stiffness parameters of $E_u=400C_u$ and $E'=320C_u$. A 130kPa load has been applied to model the building and raft with the formation level on London Clay. Undrained (short-term) and drained (long-term) soil conditions have both been modelled and subsequently summed to wall installation and excavation related ground movements.

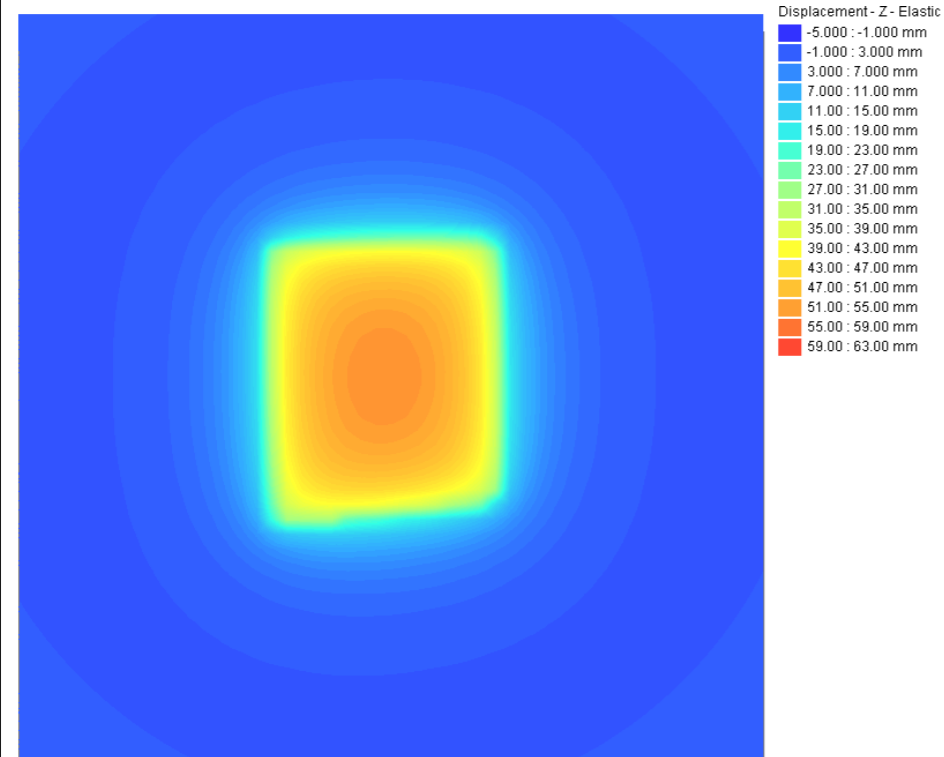


Figure C1. Greenfield ground movements due to loading (undrained soil parameters)

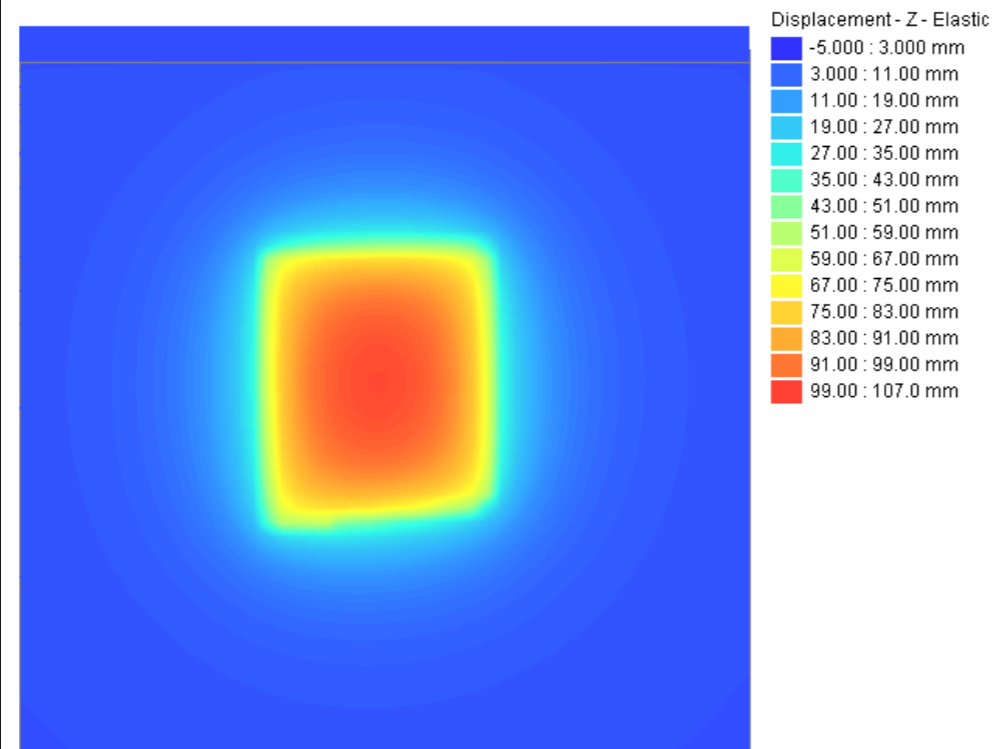


Figure C2. Greenfield ground movements due to loading (drained soil parameters)

The tables below provide the results from combined greenfield ground movements due to wall installation, excavation, and loading.

Asset	Material	Internal diameter (mm)	Maximum tensile Strain ($\mu\epsilon$)	Maximum allowed tensile strain ($\mu\epsilon$)	Maximum compressive strain ($\mu\epsilon$)	Maximum allowed compressive strain ($\mu\epsilon$)	Maximum rotation (deg)	Maximum allowed rotation (deg)	Maximum pullout (mm)	Maximum allowed pullout (mm)
Sewer 1	Masonry	1219	146	500	723	-	-	-	-	-
Sewer 2	Masonry	1548	165	500	274	-	-	-	-	-
Sewer 3	Masonry	1372x864	226	500	537	-	-	-	-	-
Sewer 4	Masonry	1930x1829	441	500	345	-	-	-	-	-
Sewer 5	Masonry	1372x762	278	500	429	-	-	-	-	-
Water Main 1	Cast Iron	102	26	100	79	1200	0.01	0.1	0.04	3

Table C1. Result summary for affected Thames Water assets based on wall installation + excavation + loading (undrained)

Asset	Material	Internal diameter (mm)	Maximum tensile Strain ($\mu\epsilon$)	Maximum allowed tensile strain ($\mu\epsilon$)	Maximum compressive strain ($\mu\epsilon$)	Maximum allowed compressive strain ($\mu\epsilon$)	Maximum rotation (deg)	Maximum allowed rotation (deg)	Maximum pullout (mm)	Maximum allowed pullout (mm)
Sewer 1	Masonry	1219	178	500	739	-	-	-	-	-
Sewer 2	Masonry	1548	229	500	274	-	-	-	-	-
Sewer 3	Masonry	1372x864	236	500	537	-	-	-	-	-
Sewer 4	Masonry	1930x1829	432	500	349	-	-	-	-	-
Sewer 5	Masonry	1372x762	300	500	429	-	-	-	-	-
Water Main 1	Cast Iron	102	26	100	79	1200	0.013	0.1	0.043	3

Table C2. Result summary for affected Thames Water assets based on wall installation + excavation + loading (drained)



PROJECT	ST PANCRAS CAMPUS	TITLE	GROUND MOVEMENT ASSESSMENT RESULTS		
DATE	06/12/2019	SCALE	N/A	CAD FILENAME	-
DRAWN	MH	CHECKED	-	PROJECT No.	4409
				DRAWING No.	-
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