



Work Area: SMM
Work Type: I&M
Originator Company: GEOCISA UK

## C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer: [Redacted]

### Monitoring Close-Out Report: Automated Total Station ATS 01 and 3D Targets read by ATS 01.

**CRL Document Number: C435-BFK-C2-RGN-M123-51610**

Supplier Document Number: N/A

Contract MDL reference C13.012

#### 1. Contractor Document Submittal History:

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	03-11-2015	[Redacted]	[Redacted]	[Redacted]	

#### 2a. Stakeholder Review Required? YES NO

Stakeholder submission required: LU  NR  DLR  RIL  LO  Other: \_\_\_\_\_ Purpose of submission: For no objection  For information

This document has been reviewed by the following individual for coordination, compliance, integration and acceptance and is acceptable for transmission to the above stakeholder for the above stated purpose.

Sign: \_\_\_\_\_ Role: \_\_\_\_\_ Name: \_\_\_\_\_ Date: \_\_\_\_\_  
 Sign: \_\_\_\_\_ Role: \_\_\_\_\_ Name: \_\_\_\_\_ Date: \_\_\_\_\_

#### 2b. Review by Stakeholder (if required):

Stakeholder Organisation	Job Title	Name	Signature	Date	Acceptance
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

compliance with their contractual obligations and does not constitute  
 ds or materials developed or selected by the designer/supplier.

#### 3. Acceptance by Crossrail:

[Redacted]
19/11/2015

## Contents

<b>A.</b>	<b>INTRODUCTION</b>	<b>3</b>
<b>B.</b>	<b>INSTRUMENTS</b>	<b>3</b>
<b>B.1</b>	DESCRIPTION OF THE INSTRUMENTS	3
<b>B.2</b>	LOCATION OF THE INSTRUMENTS	6
<b>C.</b>	<b>MOVEMENTS</b>	<b>6</b>
<b>C.1</b>	MOVEMENTS RESULTING FROM CONSTRUCTION ACTIVITIES	6
C.1.1	Relevant Crossrail (BFK) Works	6
C.1.2	Resulting Movements	7
<b>C.2</b>	TRIGGER BREACHES	8
<b>C.3</b>	SIGNIFICANT ISSUES WITH THE INSTRUMENTATION	12
<b>C.4</b>	RESIDUAL RISKS	12
<b>D.</b>	<b>CONCLUSIONS</b>	<b>12</b>

**APPENDIX A: DRAWINGS / PHOTOMONTAGES**

**APPENDIX B: GRAPHS.**



## A. INTRODUCTION

In line with the C122 – M&W Specification KX10 – Instrumentation & Monitoring C122-OVE-Z4-RSP-CR001-00007, this close out report aims to address the following points in relation to the instrumentation defined in Section B.

- Identify movements observed by the relevant instruments;
- Relate these movements to construction activities, where applicable.
- Identify trigger breaches that may have occurred.
- Demonstrate that the rate of change of the data is either in line with the required rate or such that residual risks are minimal.
- Identify any such residual risks should there be considered to be any.
- Based on the above points, this close out reports will provide justification for the decommissioning of the instruments.

## B. INSTRUMENTS

### B.1 Description of the Instruments

This Close-Out Report relates the Charterhouse Street West Area, consisting of 3D Targets read by ATS 01 and 1No. Automated Total Station (ATS 01) located in the Poultry Market. See table 1 below with details.

ATS 01 CODE	LOCATION	COORDINATES	
		X (m)	Y (m)
C435-AT00001	Poultry Market	82057.26	36449.75

PRISM CODE	LOCATION	COORDINATES	
		X (m)	Y (m)
C435-RP00101	47-50 CHARTERHOUSE STREET	81959.7062	36420.202
C435-RP00102	47-50 CHARTERHOUSE STREET	81959.5873	36420.1559
C435-RP00103	47-50 CHARTERHOUSE STREET	81967.2794	36424.2507
C435-RP00104	47-50 CHARTERHOUSE STREET	81966.4692	36423.8425
C435-RP00105	47-50 CHARTERHOUSE STREET	81974.9911	36428.1101
C435-RP00106	47-50 CHARTERHOUSE STREET	81974.7325	36427.9805
C435-RP00107	47-50 CHARTERHOUSE STREET	81984.7117	36432.7117
C435-RP00109	51-53 CHARTERHOUSE STREET	81987.2492	36433.583
C435-RP00110	51-53 CHARTERHOUSE STREET	81987.1178	36433.4581
C435-RP00111	51-53 CHARTERHOUSE STREET	81995.1301	36437.6596
C435-RP00112	51-53 CHARTERHOUSE STREET	81995.1868	36437.3119
C435-RP00113	51-53 CHARTERHOUSE STREET	82007.3989	36443.7616
C435-RP00114	51-53 CHARTERHOUSE STREET	82007.3837	36443.4347
C435-RP00115	51-53 CHARTERHOUSE STREET	82015.3336	36447.6157
C435-RP00116	51-53 CHARTERHOUSE STREET	82015.4078	36447.6231
C435-RP00117	55 CHARTERHOUSE STREET	82016.1595	36448.1819
C435-RP00118	55 CHARTERHOUSE STREET	82016.1558	36448.2092
C435-RP00119	55 CHARTERHOUSE STREET	82021.8644	36451.0539
C435-RP00120	55 CHARTERHOUSE STREET	82021.8032	36451.0514
C435-RP00121	55 CHARTERHOUSE STREET	82026.3162	36453.2795

C435-RP00122	55 CHARTERHOUSE STREET	82025.8736	36453.0701
C435-RP00123	57-61 CHARTERHOUSE STREET	82026.6719	36453.5609
C435-RP00124	57-61 CHARTERHOUSE STREET	82026.9679	36453.6906
C435-RP00125	57-61 CHARTERHOUSE STREET	82031.623	36456.0276
C435-RP00126	57-61 CHARTERHOUSE STREET	82031.6376	36456.0046
C435-RP00127	57-61 CHARTERHOUSE STREET	82037.4531	36458.9801
C435-RP00128	57-61 CHARTERHOUSE STREET	82037.472	36458.9747
C435-RP00129	57-61 CHARTERHOUSE STREET	82045.268	36462.8251
C435-RP00130	57-61 CHARTERHOUSE STREET	82045.2784	36462.8226
C435-RP00131	63 CHARTERHOUSE STREET	82045.6619	36462.9091
C435-RP00132	63 CHARTERHOUSE STREET	82045.7609	36462.9156
C435-RP00133	63 CHARTERHOUSE STREET	82050.8438	36465.4806
C435-RP00134	63 CHARTERHOUSE STREET	82051.2936	36465.6927
C435-RP00135	63 CHARTERHOUSE STREET	82055.1396	36467.5295
C435-RP00136	63 CHARTERHOUSE STREET	82054.7733	36467.3981
C435-RP00137	63 CHARTERHOUSE STREET	82058.1919	36469.1032
C435-RP00138	63 CHARTERHOUSE STREET	82057.8441	36468.9046
C435-RP00139	67-77 CHARTERHOUSE STREET	82074.0282	36477.2569
C435-RP00140	67-77 CHARTERHOUSE STREET	82074.0712	36477.2972
C435-RP00141	67-77 CHARTERHOUSE STREET	82081.9379	36481.3024
C435-RP00142	67-77 CHARTERHOUSE STREET	82081.8741	36481.2675
C435-RP00143	67-77 CHARTERHOUSE STREET	82090.3656	36485.6019
C435-RP00144	67-77 CHARTERHOUSE STREET	82089.9254	36485.4069
C435-RP00145	67-77 CHARTERHOUSE STREET	82098.3269	36489.6642
C435-RP00146	67-77 CHARTERHOUSE STREET	82098.3188	36489.645
C435-RP00147	77a CHARTERHOUSE STREET	82099.6691	36490.3245
C435-RP00148	77a CHARTERHOUSE STREET	82099.0372	36489.9389
C435-RP00149	77a CHARTERHOUSE STREET	82102.5775	36491.7866
C435-RP00150	77a CHARTERHOUSE STREET	82102.5269	36491.7654
C435-RP00151	77a CHARTERHOUSE STREET	82105.6256	36493.2607
C435-RP00152	77a CHARTERHOUSE STREET	82105.8838	36493.3943
C435-RP00153	77a CHARTERHOUSE STREET	82109.6091	36495.3349
C435-RP00154	77a CHARTERHOUSE STREET	82110.1457	36495.4233
C435-RP00155	79-83 CHARTERHOUSE STREET	82110.8512	36495.9002
C435-RP00156	79-83 CHARTERHOUSE STREET	82111.1517	36496.0313
C435-RP00157	79-83 CHARTERHOUSE STREET	82117.6499	36499.3535
C435-RP00158	79-83 CHARTERHOUSE STREET	82117.8032	36499.4205
C435-RP00159	79-83 CHARTERHOUSE STREET	82122.6196	36501.879
C435-RP00160	79-83 CHARTERHOUSE STREET	82122.4652	36501.7885
C435-RP00161	85 CHARTERHOUSE STREET	82123.2877	36502.1772
C435-RP00162	85 CHARTERHOUSE STREET	82123.1794	36502.1167
C435-RP00163	85 CHARTERHOUSE STREET	82130.1613	36505.6946
C435-RP00164	85 CHARTERHOUSE STREET	82130.2052	36505.7169
C435-RP00165	87 CHARTERHOUSE STREET	82130.9472	36506.1846

C435-RP00166	87 CHARTERHOUSE STREET	82130.8019	36506.1367
C435-RP00167	87 CHARTERHOUSE STREET	82135.5366	36508.5183
C435-RP00168	87 CHARTERHOUSE STREET	82135.602	36508.5477
C435-RP00169	87 CHARTERHOUSE STREET	82138.5417	36510.0533
C435-RP00170	87 CHARTERHOUSE STREET	82138.544	36510.3754
C435-RP00171	66-67 CHARTERHOUSE STREET	82067.1947	36490.2253
C435-RP00172	66-67 CHARTERHOUSE STREET	82067.0485	36490.4454
C435-RP00173	66-67 CHARTERHOUSE STREET	82073.67	36477.6071
C435-RP00174	66-67 CHARTERHOUSE STREET	82073.1967	36478.3746
C435-RP00175	85 CHARTERHOUSE STREET	82130.0089	36506.7376
C435-RP00199	63 CHARTERHOUSE STREET	82054.2455	36467.6284

Table 1: Details 3D Targets read by ATS 01 and ATS 01.

At the moment, this area monitored by these prisms is in a Post-Construction / Long Term basis with readings every six hours / three months, being the last one recorded on 16/09/2015.

These prisms read by ATS 01 and the ATS 01 itself are shown in the following documents:

Drawings:

- C122-OVE-C2-DDA-CR001\_Z-31531
- C122-OVE-C2-DDA-CR001\_Z-31532

Photomontages:

- C122-OVE-C2-DDJ-CR001\_Z-39667
- C122-OVE-C2-DDJ-CR001\_Z-30831
- C122-OVE-C2-DDJ-CR001\_Z-39650
- C122-OVE-C2-DDJ-CR001\_Z-39651
- C122-OVE-C2-DDJ-CR001\_Z-39654
- C122-OVE-C2-DDJ-CR001\_Z-39668
- C122-OVE-C2-DDJ-CR001\_Z-30803
- C122-OVE-C2-DDJ-CR001\_Z-30806
- C122-OVE-C2-DDJ-CR001\_Z-30809
- C122-OVE-C2-DDJ-CR001\_Z-39662
- C122-OVE-C2-DDJ-CR001\_Z-39665

Installation Reports:

- C435-BFK-C2-RGN-M123-50127
- C435-BFK-C2-RGN-M123-50027

## B.2 Location of the Instruments

As you can see from the Figure 1 below, the instruments described in Section B.1 are located in Charterhouse Street western area. A drawing showing the location of these devices can be found in the Appendix A.



Figure 1 – Map showing the Location of ATS 01 and 3D Targets read by ATS 01.

## C. MOVEMENTS

### C.1 Movements Resulting from Construction Activities

#### C.1.1 Relevant Crossrail (BFK) Works

The construction activities associated with these instruments are related to Crossrail tunnelling works. In all cases, these comprise of the passage of a TBMs (C300) and a platform tunnel enlargement.

ACTIVITY	START DATE	END DATE
Butcher's Ramp Shaft TAM Installation	25/06/2013	23/08/2013
Moorgate Spur Shaft No. 3 TAM Installation	19/07/2013	03/09/2013
Moorgate Spur Shaft No. 1 TAM Installation	08/07/2013	20/08/2013
Butcher's Ramp Shaft Pre-Treatment works	29/07/2013	16/08/2013
Moorgate Spur Shaft No. 3 Pre-Treatment works	10/08/2013	15/08/2013
Moorgate Spur Shaft No. 1 Pre-Treatment works	19/08/2013	15/09/2013
WB TBM passage	25/09/2013	04/10/2013
EB TBM passage	13/01/2014	17/01/2014
SCL-PTW enlargement	23/04/2014	29/08/2014
SCL-CP3b	28/05/2014	20/06/2014
SCL-PTE enlargement	27/07/2014	09/09/2014
SCL-CP4	17/09/2014	16/10/2014
SCL-PL2	29/04/2015	24/05/2015



### C.1.2 Resulting Movements

- 47-53 Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. During both WB and EB TBM passage, PTE, PTW and PL2 enlargement and CP3b cross passage excavation works no significant movement was observed on these 3D Targets. The only trend of movement historically recorded from these devices has been due to the temperature fluctuation, clearly seen in longitudinal and transversal displacement specially.
- 55 Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. During both WB and EB TBM passage, PTE and PTW enlargement and CP3b cross passage excavation works no significant movement was observed on these 3D Targets. The only trend of movement historically recorded from these devices has been due to the temperature fluctuation, clearly seen in all directions.
- 57-61 Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. During both WB and EB TBM passage, PTE and PTW enlargement and CP3b cross passage excavation works no significant movement was observed on these 3D Targets. The only trend of movement historically recorded from these devices has been due to the temperature fluctuation, clearly seen in all directions.
- 63 Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. During both WB and EB TBM passage, PTE and PTW enlargement works no significant movement was observed on these 3D Targets. The only trend of movement historically recorded from these devices has been due to the temperature fluctuation, clearly seen in all directions.
- 67-77 Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. WB TBM passage caused around 3mm settlement and the EB TBM around 1.5mm. SCL-PTW enlargement works caused a maximum settlement around 3mm and the PTE enlargement ones around 1.5mm. Almost 4mm heave recorded during Pre-Treatment works carried out from Moorgate Spur Shaft No.3. Historical trend of movement has been recorded from these devices as result of temperature fluctuation, clearly seen in longitudinal and transversal displacement specially.
- 77a Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. WB TBM passage caused around 6mm settlement and the EB TBM around 2.5mm. SCL-PTW enlargement works caused a maximum settlement around 7mm and the PTE enlargement ones around 3mm. Almost 4mm heave recorded during Pre-Treatment works carried out from Moorgate Spur Shaft No.3. Historical trend of movement has been recorded from these devices as result of temperature fluctuation, clearly seen in all directions.
- 79-83 Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. WB TBM passage caused around 6mm settlement and the EB TBM around 1.5mm. SCL-PTW enlargement works caused a maximum settlement around 8mm and the PTE enlargement ones around 3mm. SCL cross passage CP4 caused around 3mm of settlement recorded from these 3D Targets. Almost 4mm heave recorded during Pre-Treatment works carried out from Moorgate Spur Shaft No.3. Historical trend of movement has been recorded from these devices as result of temperature fluctuation, clearly seen in all directions.

- 85 Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. WB TBM passage caused around 7mm settlement and the EB TBM around 1.5mm. SCL-PTW enlargement works caused a maximum settlement around 13mm and the PTE enlargement ones around 3mm. SCL cross passage CP4 caused around 3mm of settlement recorded from these 3D Targets. Almost 4mm heave recorded during Pre-Treatment works carried out from Moorgate Spur Shaft No.1. Historical trend of movement has been recorded from these devices as result of temperature fluctuation, clearly seen in all directions.
- 87 Charterhouse Street:  
data for 3D Targets installed on the Charterhouse Street facade of this building is shown in Appendix B. WB TBM passage caused around 6mm settlement and the EB TBM around 1.5mm. SCL-PTW enlargement works caused a maximum settlement around 16mm and the PTE enlargement ones around 3mm. SCL cross passage CP4 caused around 3mm of settlement recorded from these 3D Targets. Almost 6mm heave recorded during Pre-Treatment works carried out from Moorgate Spur Shaft No.1. Historical trend of movement has been recorded from these devices as result of temperature fluctuation, clearly seen in all directions.

## C.2 Trigger Breaches

The Instrumentation and Monitoring Plan: Farringdon Station Ground Movement and Asset Protection C122-OVE-C2-RGN-M123-50013 outlines the triggers associated with the works. In this case, the right trigger values for these 3D Targets are the following ones taking into account they all are installed in buildings located Inside of the compensation grouting area:

- DEFAULT ALERT (in any direction): 10mm

No triggers have been defined for the Automated Total Stations (ATS).

C435-BFK-C2-RGN-M123-51610

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
47-50 CHARTERHOUSE STREET	C435-RP00101	AUTOMATIC RP	Settlement	16/09/2015 06 00	2.5	Clear	Clear
	C435-RP00102	AUTOMATIC RP	Settlement	16/09/2015 06 00	1.7	Clear	Clear
	C435-RP00103	AUTOMATIC RP	Settlement	16/09/2015 06 00	2.1	Clear	Clear
	C435-RP00104	AUTOMATIC RP	Settlement	16/09/2015 06 00	0.8	Clear	Clear
	C435-RP00105	AUTOMATIC RP	Settlement	16/09/2015 06 00	0.6	Clear	Clear
	C435-RP00106	AUTOMATIC RP	Settlement	16/09/2015 06 00	0.6	Clear	Clear
51-53 CHARTERHOUSE STREET	C435-RP00107	AUTOMATIC RP	Settlement	24/04/2014 10 00	0.2	Clear	Clear
	C435-RP00109	AUTOMATIC RP	Settlement	16/09/2015 06 00	2	Clear	Clear
	C435-RP00110	AUTOMATIC RP	Settlement	16/09/2015 06 00	2.1	Clear	Clear
55 CHARTERHOUSE STREET	C435-RP00111	AUTOMATIC RP	Settlement	16/09/2015 06 00	2.1	Clear	Clear
	C435-RP00112	AUTOMATIC RP	Settlement	16/09/2015 06 00	1.9	Clear	Clear
	C435-RP00113	AUTOMATIC RP	Settlement	16/09/2015 06 00	1.1	Clear	Clear
	C435-RP00114	AUTOMATIC RP	Settlement	16/09/2015 06 00	1	Clear	Clear
	C435-RP00115	AUTOMATIC RP	Settlement	16/09/2015 06 00	0.6	Clear	Clear
	C435-RP00116	AUTOMATIC RP	Settlement	16/09/2015 06 00	0	Clear	Clear
57-61 CHARTERHOUSE STREET	C435-RP00117	AUTOMATIC RP	Settlement	16/09/2015 06 00	-0.5	Clear	Clear
	C435-RP00118	AUTOMATIC RP	Settlement	16/09/2015 06 00	-0.2	Clear	Clear
	C435-RP00119	AUTOMATIC RP	Settlement	16/09/2015 06 00	-0.4	Clear	Clear
	C435-RP00120	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1	Clear	Clear
	C435-RP00121	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1	Clear	Clear
	C435-RP00122	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.3	Clear	Clear
63 CHARTERHOUSE STREET	C435-RP00123	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.1	Clear	Clear
	C435-RP00124	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.5	Clear	Clear
	C435-RP00125	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.6	Clear	Clear
	C435-RP00126	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.8	Clear	Clear
	C435-RP00127	AUTOMATIC RP	Settlement	16/09/2015 06 00	-0.8	Clear	Clear
	C435-RP00128	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.1	Clear	Clear
67-77 CHARTERHOUSE STREET	C435-RP00129	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.6	Clear	Clear
	C435-RP00130	AUTOMATIC RP	Settlement	16/09/2015 06 00	-2	Clear	Clear
	C435-RP00131	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.5	Clear	Clear
	C435-RP00132	AUTOMATIC RP	Settlement	16/09/2015 06 00	-2.2	Clear	Clear
	C435-RP00133	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.4	Clear	Clear
	C435-RP00134	AUTOMATIC RP	Settlement	16/09/2015 06 00	-2	Clear	Clear
77a CHARTERHOUSE STREET	C435-RP00135	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.5	Clear	Clear
	C435-RP00136	AUTOMATIC RP	Settlement	16/09/2015 06 00	-1.4	Clear	Clear
	C435-RP00137	AUTOMATIC RP	Settlement	16/09/2015 06 00	-0.7	Clear	Clear
	C435-RP00138	AUTOMATIC RP	Settlement	16/09/2015 06 00	-3.2	Clear	Clear
	C435-RP00139	AUTOMATIC RP	Settlement	16/09/2015 06 00	-3.1	Clear	Clear
	C435-RP00140	AUTOMATIC RP	Settlement	16/09/2015 06 00	-3.7	Clear	Clear
79-83 CHARTERHOUSE STREET	C435-RP00141	AUTOMATIC RP	Settlement	16/09/2015 06 00	-2.3	Clear	Clear
	C435-RP00142	AUTOMATIC RP	Settlement	16/09/2015 06 00	-2.8	Clear	Clear
	C435-RP00143	AUTOMATIC RP	Settlement	16/09/2015 06 00	-4.6	Clear	Clear
	C435-RP00144	AUTOMATIC RP	Settlement	16/09/2015 06 00	-3.8	Clear	Clear
	C435-RP00145	AUTOMATIC RP	Settlement	16/09/2015 06 00	-9.7	Default alert	Clear
	C435-RP00146	AUTOMATIC RP	Settlement	16/09/2015 06 00	-11.2	Default alert	Default alert
85 CHARTERHOUSE STREET	C435-RP00147	AUTOMATIC RP	Settlement	16/09/2015 06 00	-10.1	Default alert	Default alert
	C435-RP00148	AUTOMATIC RP	Settlement	16/09/2015 06 00	-9.7	Default alert	Clear
	C435-RP00149	AUTOMATIC RP	Settlement	16/09/2015 06 00	-11.2	Default alert	Default alert
	C435-RP00150	AUTOMATIC RP	Settlement	16/09/2015 06 00	-11.1	Default alert	Default alert
	C435-RP00151	AUTOMATIC RP	Settlement	16/09/2015 06 00	-12	Default alert	Default alert
	C435-RP00152	AUTOMATIC RP	Settlement	16/09/2015 06 00	-12.2	Default alert	Default alert
87 CHARTERHOUSE STREET	C435-RP00153	AUTOMATIC RP	Settlement	16/09/2015 06 00	-13.3	Default alert	Default alert
	C435-RP00154	AUTOMATIC RP	Settlement	16/09/2015 06 00	-14.1	Default alert	Default alert
	C435-RP00155	AUTOMATIC RP	Settlement	16/09/2015 06 00	-13.6	Default alert	Default alert
	C435-RP00156	AUTOMATIC RP	Settlement	16/09/2015 06 00	-14	Default alert	Default alert
	C435-RP00157	AUTOMATIC RP	Settlement	16/09/2015 06 00	-16.5	Default alert	Default alert
	C435-RP00158	AUTOMATIC RP	Settlement	16/09/2015 06 00	-17.2	Default alert	Default alert
87 CHARTERHOUSE STREET	C435-RP00159	AUTOMATIC RP	Settlement	16/09/2015 06 00	-19.4	Default alert	Default alert
	C435-RP00160	AUTOMATIC RP	Settlement	16/09/2015 06 00	-19.8	Default alert	Default alert
	C435-RP00161	AUTOMATIC RP	Settlement	16/09/2015 06 00	-19.3	Default alert	Default alert
	C435-RP00162	AUTOMATIC RP	Settlement	16/09/2015 06 00	-19.4	Default alert	Default alert
	C435-RP00163	AUTOMATIC RP	Settlement	16/09/2015 06 00	-23.9	Default alert	Default alert
	C435-RP00164	AUTOMATIC RP	Settlement	16/09/2015 06 00	-23.4	Default alert	Default alert
66-67 CHARTERHOUSE STREET	C435-RP00165	AUTOMATIC RP	Settlement	16/09/2015 06 00	-24.3	Default alert	Default alert
	C435-RP00166	AUTOMATIC RP	Settlement	16/09/2015 06 00	-25.2	Default alert	Default alert
	C435-RP00167	AUTOMATIC RP	Settlement	16/09/2015 06 00	-26.4	Default alert	Default alert
	C435-RP00168	AUTOMATIC RP	Settlement	16/09/2015 06 00	-26.9	Default alert	Default alert
	C435-RP00169	AUTOMATIC RP	Settlement	16/09/2015 06 00	-27.2	Default alert	Default alert
	C435-RP00170	AUTOMATIC RP	Settlement	16/09/2015 06 00	-27.6	Default alert	Default alert
87 CHARTERHOUSE STREET	C435-RP00171	AUTOMATIC RP	Settlement	16/09/2015 06 00	0.5	Clear	Clear
	C435-RP00172	AUTOMATIC RP	Settlement	16/09/2015 06 00	-2.5	Clear	Clear
	C435-RP00173	AUTOMATIC RP	Settlement	16/09/2015 06 00	-3.1	Clear	Clear
	C435-RP00174	AUTOMATIC RP	Settlement	16/09/2015 06 00	-4	Clear	Clear
87 CHARTERHOUSE STREET	C435-RP00175	AUTOMATIC RP	Settlement	16/09/2015 06 00	-25.3	Default alert	Default alert



C435-BFK-C2-RGN-M123-51610

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
AUTOMATIC 3D-TARGETS / READ BY ATS 01 (Poultry MA)	C435-RP00101	AUTOMATIC RP	Transversal	16/09/2015 06 00	-1.8	Clear	Clear
	C435-RP00102	AUTOMATIC RP	Transversal	16/09/2015 06 00	-2.8	Clear	Clear
47-50 CHARTERHOUSE STREET	C435-RP00103	AUTOMATIC RP	Transversal	16/09/2015 06 00	-3	Clear	Clear
	C435-RP00104	AUTOMATIC RP	Transversal	16/09/2015 06 00	-3.2	Clear	Clear
	C435-RP00105	AUTOMATIC RP	Transversal	16/09/2015 06 00	-3.3	Clear	Clear
	C435-RP00106	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4.3	Clear	Clear
	C435-RP00107	AUTOMATIC RP	Transversal	24/04/2014 10 00	-2.3	Clear	Clear
51-53 CHARTERHOUSE STREET	C435-RP00109	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4.7	Clear	Clear
	C435-RP00110	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.8	Clear	Clear
55 CHARTERHOUSE STREET	C435-RP00111	AUTOMATIC RP	Transversal	16/09/2015 06 00	-5.1	Clear	Clear
	C435-RP00112	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.9	Clear	Clear
	C435-RP00113	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.3	Clear	Clear
	C435-RP00114	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.2	Clear	Clear
	C435-RP00115	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.7	Clear	Clear
	C435-RP00116	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.9	Clear	Clear
	C435-RP00117	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.8	Clear	Clear
57-61 CHARTERHOUSE STREET	C435-RP00118	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.6	Clear	Clear
	C435-RP00119	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.5	Clear	Clear
	C435-RP00120	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.9	Default alert	Default alert
	C435-RP00121	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.4	Clear	Clear
	C435-RP00122	AUTOMATIC RP	Transversal	16/09/2015 06 00	-11.7	Default alert	Default alert
63 CHARTERHOUSE STREET	C435-RP00123	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.2	Clear	Clear
	C435-RP00124	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.7	Default alert	Default alert
	C435-RP00125	AUTOMATIC RP	Transversal	16/09/2015 06 00	-7.7	Clear	Clear
	C435-RP00126	AUTOMATIC RP	Transversal	16/09/2015 06 00	-9.9	Default alert	Clear
	C435-RP00127	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.1	Clear	Clear
	C435-RP00128	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.2	Clear	Clear
	C435-RP00129	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4.7	Clear	Clear
67-77 CHARTERHOUSE STREET	C435-RP00130	AUTOMATIC RP	Transversal	16/09/2015 06 00	-5.9	Clear	Clear
	C435-RP00131	AUTOMATIC RP	Transversal	16/09/2015 06 00	-5	Clear	Clear
	C435-RP00132	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6	Clear	Clear
	C435-RP00133	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4.5	Clear	Clear
	C435-RP00134	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4.8	Clear	Clear
	C435-RP00135	AUTOMATIC RP	Transversal	16/09/2015 06 00	-0.8	Clear	Clear
	C435-RP00136	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4.5	Clear	Clear
	C435-RP00137	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4	Clear	Clear
	C435-RP00138	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4	Clear	Clear
	C435-RP00139	AUTOMATIC RP	Transversal	16/09/2015 06 00	-5	Clear	Clear
77a CHARTERHOUSE STREET	C435-RP00140	AUTOMATIC RP	Transversal	16/09/2015 06 00	-5.3	Clear	Clear
	C435-RP00141	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6	Clear	Clear
	C435-RP00142	AUTOMATIC RP	Transversal	16/09/2015 06 00	-7.8	Clear	Clear
	C435-RP00143	AUTOMATIC RP	Transversal	16/09/2015 06 00	-9.2	Default alert	Clear
	C435-RP00144	AUTOMATIC RP	Transversal	16/09/2015 06 00	-11.5	Default alert	Default alert
	C435-RP00145	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.6	Default alert	Default alert
	C435-RP00146	AUTOMATIC RP	Transversal	16/09/2015 06 00	-13.5	Default alert	Default alert
	C435-RP00147	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.3	Default alert	Default alert
79-83 CHARTERHOUSE STREET	C435-RP00148	AUTOMATIC RP	Transversal	16/09/2015 06 00	-14.5	Default alert	Default alert
	C435-RP00149	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.3	Default alert	Default alert
	C435-RP00150	AUTOMATIC RP	Transversal	16/09/2015 06 00	-15.9	Default alert	Default alert
	C435-RP00151	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.9	Default alert	Default alert
	C435-RP00152	AUTOMATIC RP	Transversal	16/09/2015 06 00	-16.3	Default alert	Default alert
	C435-RP00153	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.6	Default alert	Default alert
	C435-RP00154	AUTOMATIC RP	Transversal	16/09/2015 06 00	-18.5	Default alert	Default alert
	C435-RP00155	AUTOMATIC RP	Transversal	16/09/2015 06 00	-12.1	Default alert	Default alert
85 CHARTERHOUSE STREET	C435-RP00156	AUTOMATIC RP	Transversal	16/09/2015 06 00	-17.4	Default alert	Default alert
	C435-RP00157	AUTOMATIC RP	Transversal	16/09/2015 06 00	-11.8	Default alert	Default alert
	C435-RP00158	AUTOMATIC RP	Transversal	16/09/2015 06 00	-16.5	Default alert	Default alert
	C435-RP00159	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.2	Default alert	Default alert
	C435-RP00160	AUTOMATIC RP	Transversal	16/09/2015 06 00	-15.7	Default alert	Default alert
87 CHARTERHOUSE STREET	C435-RP00161	AUTOMATIC RP	Transversal	16/09/2015 06 00	-9.5	Default alert	Clear
	C435-RP00162	AUTOMATIC RP	Transversal	16/09/2015 06 00	-12.8	Default alert	Default alert
	C435-RP00163	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.4	Default alert	Clear
	C435-RP00164	AUTOMATIC RP	Transversal	16/09/2015 06 00	-9.5	Default alert	Clear
	C435-RP00165	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.1	Default alert	Clear
	C435-RP00166	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.8	Default alert	Clear
	C435-RP00167	AUTOMATIC RP	Transversal	16/09/2015 06 00	-5.5	Default alert	Clear
66-67 CHARTERHOUSE STREET	C435-RP00168	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.8	Default alert	Clear
	C435-RP00169	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4.4	Default alert	Clear
	C435-RP00170	AUTOMATIC RP	Transversal	16/09/2015 06 00	-6.3	Default alert	Clear
	C435-RP00171	AUTOMATIC RP	Transversal	16/09/2015 06 00	-2.3	Clear	Clear
	C435-RP00172	AUTOMATIC RP	Transversal	16/09/2015 06 00	-4.8	Clear	Clear
87 CHARTERHOUSE STREET	C435-RP00173	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.1	Clear	Clear
	C435-RP00174	AUTOMATIC RP	Transversal	16/09/2015 06 00	-10.8	Default alert	Default alert
	C435-RP00175	AUTOMATIC RP	Transversal	16/09/2015 06 00	-8.7	Default alert	Clear

C435-BFK-C2-RGN-M123-51610

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL		
						WORST HISTORICAL STATUS	CURRENT STATUS	
AUTOMATIC 3D-TARGETS / READ BY ATS 01 (Poultry M)	C435-RP00101	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.7	Clear	Clear	
	C435-RP00102	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	4.2	Clear	Clear	
	47-50 CHARTERHOUSE STREET	C435-RP00103	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.2	Clear	Clear
		C435-RP00104	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.7	Clear	Clear
		C435-RP00105	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.7	Clear	Clear
		C435-RP00106	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.9	Clear	Clear
51-53 CHARTERHOUSE STREET	C435-RP00107	AUTOMATIC RP	Longitudinal	24/04/2014 10 00	2.3	Clear	Clear	
	C435-RP00109	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.7	Clear	Clear	
	C435-RP00110	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.9	Clear	Clear	
55 CHARTERHOUSE STREET	C435-RP00111	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.2	Clear	Clear	
	C435-RP00112	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3	Clear	Clear	
	C435-RP00113	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.7	Clear	Clear	
	C435-RP00114	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.3	Clear	Clear	
	C435-RP00115	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.3	Clear	Clear	
	C435-RP00116	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.7	Clear	Clear	
	C435-RP00117	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	-0.4	Clear	Clear	
	C435-RP00118	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.6	Clear	Clear	
	C435-RP00119	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.2	Clear	Clear	
	C435-RP00120	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.8	Clear	Clear	
	C435-RP00121	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.2	Clear	Clear	
57-61 CHARTERHOUSE STREET	C435-RP00122	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.5	Clear	Clear	
	C435-RP00123	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.2	Clear	Clear	
	C435-RP00124	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.5	Clear	Clear	
	C435-RP00125	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.1	Clear	Clear	
	C435-RP00126	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.2	Clear	Clear	
	C435-RP00127	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.9	Clear	Clear	
	C435-RP00128	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.4	Clear	Clear	
	C435-RP00129	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.6	Clear	Clear	
63 CHARTERHOUSE STREET	C435-RP00130	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.5	Clear	Clear	
	C435-RP00131	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.4	Clear	Clear	
	C435-RP00132	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.6	Clear	Clear	
	C435-RP00133	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	1.4	Clear	Clear	
	C435-RP00134	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.5	Clear	Clear	
	C435-RP00135	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.8	Clear	Clear	
	C435-RP00136	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.1	Clear	Clear	
	C435-RP00137	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.5	Clear	Clear	
	C435-RP00138	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	0.8	Clear	Clear	
	C435-RP00139	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	8.2	Default alert	Clear	
	C435-RP00140	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	11.1	Default alert	Default alert	
	C435-RP00141	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	7.4	Default alert	Clear	
	C435-RP00142	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	10.4	Default alert	Default alert	
77a CHARTERHOUSE STREET	C435-RP00143	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	6.3	Default alert	Clear	
	C435-RP00144	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	9.1	Default alert	Clear	
	C435-RP00145	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	6.2	Default alert	Clear	
	C435-RP00146	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	7.9	Default alert	Clear	
	C435-RP00147	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	6	Default alert	Clear	
	C435-RP00148	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	8.6	Default alert	Clear	
	C435-RP00149	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	5.3	Default alert	Clear	
79-83 CHARTERHOUSE STREET	C435-RP00150	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	8.6	Default alert	Clear	
	C435-RP00151	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	5.1	Default alert	Clear	
	C435-RP00152	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	8.9	Default alert	Clear	
	C435-RP00153	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	4.7	Default alert	Clear	
	C435-RP00154	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	8.7	Default alert	Clear	
	C435-RP00155	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	5.1	Clear	Clear	
	C435-RP00156	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	7.6	Default alert	Clear	
85 CHARTERHOUSE STREET	C435-RP00157	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	4.2	Clear	Clear	
	C435-RP00158	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	6.8	Default alert	Clear	
	C435-RP00159	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.2	Clear	Clear	
	C435-RP00160	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	6	Clear	Clear	
87 CHARTERHOUSE STREET	C435-RP00161	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.1	Clear	Clear	
	C435-RP00162	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	4.4	Clear	Clear	
	C435-RP00163	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.5	Clear	Clear	
	C435-RP00164	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.6	Clear	Clear	
	C435-RP00165	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.2	Clear	Clear	
	C435-RP00166	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.9	Clear	Clear	
	C435-RP00167	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.8	Clear	Clear	
66-67 CHARTERHOUSE STREET	C435-RP00168	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.9	Clear	Clear	
	C435-RP00169	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	2.6	Clear	Clear	
	C435-RP00170	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	3.6	Clear	Clear	
	C435-RP00171	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	-5.5	Clear	Clear	
87 CHARTERHOUSE STREET	C435-RP00172	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	-1.6	Clear	Clear	
	C435-RP00173	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	-5	Clear	Clear	
	C435-RP00174	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	-4.6	Clear	Clear	
	C435-RP00175	AUTOMATIC RP	Longitudinal	16/09/2015 06 00	6.2	Clear	Clear	

### **C.3 Significant Issues with the Instrumentation**

- 3D Target C435-RP00107 was covered by scaffolding and knocked on 24/04/2014, being not facing to any ATS since then.

### **C.4 Residual Risks**

The rates of residual settlement for these 3D Targets have been determined and in all cases these rates are less than 2mm/year.

## **D. CONCLUSIONS**

Following the WB and EB TBMs passage, as well as the SCL enlargement of PTW, PTE and PL2 and the cross passages CP3b and CP4 and Compensation Grouting works carried out from the Butcher's Ramp, Moorgate Spur No.1 and No.3 shafts, a maximum measured settlement of 27.6mm has been recorded in the 87 Charterhouse Street building.

On the other hand, the maximum horizontal movement in longitudinal and transversal directions has being +11.1mm in the 67-77 Charterhouse Street building and -18.5mm in 77a Charterhouse Street for these 3D Targets.

At the same time, all these movements recorded in all directions have been potentially affected by the temperature fluctuation recorded from the ATS 01 along these years, being these series included as an exception in all graphs as a clear behaviour comparison.

After the works, all devices do not show any significant movement, therefore these devices are considered stabilized.





Learning Legacy Document

**Appendix A: Drawings / Photomontages**






	PRIMS 3D
	TOTAL STATION

Rev.	Date	Description	By	Chkd	App	Auth
	16-04-2013					

Notes:




**GEOCISA UK**  
 C/ Los Llanos de Jerez 10-12  
 28823- MADRID  
 www.geocisa.com

Contract :	C435 I&M FARRINGTON STATION
Originator :	GEOCISA
Location :	CROSSRA L GENERAL
Title :	3D PRIMS ATS1
By :	
Chk :	
App :	
Scale :	@ A3
Drg No :	C435-BFK-C2-RGN-M123-50027-IR-RP-ATS01
Rev :	
Suit :	
Auth :	





**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	4	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	13	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box with screw fixings.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

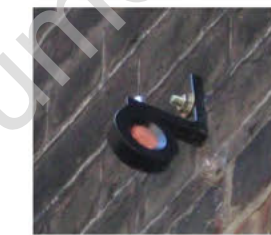
**Legend**



Geodetic Prism



BRE Levelling Stud



**Geodetic Prism:**

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.

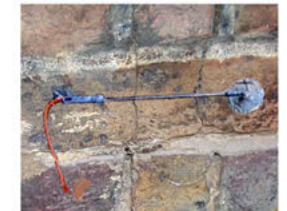


**BRE Levelling Stud:**

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.



Vibrating Wire Crackmeter

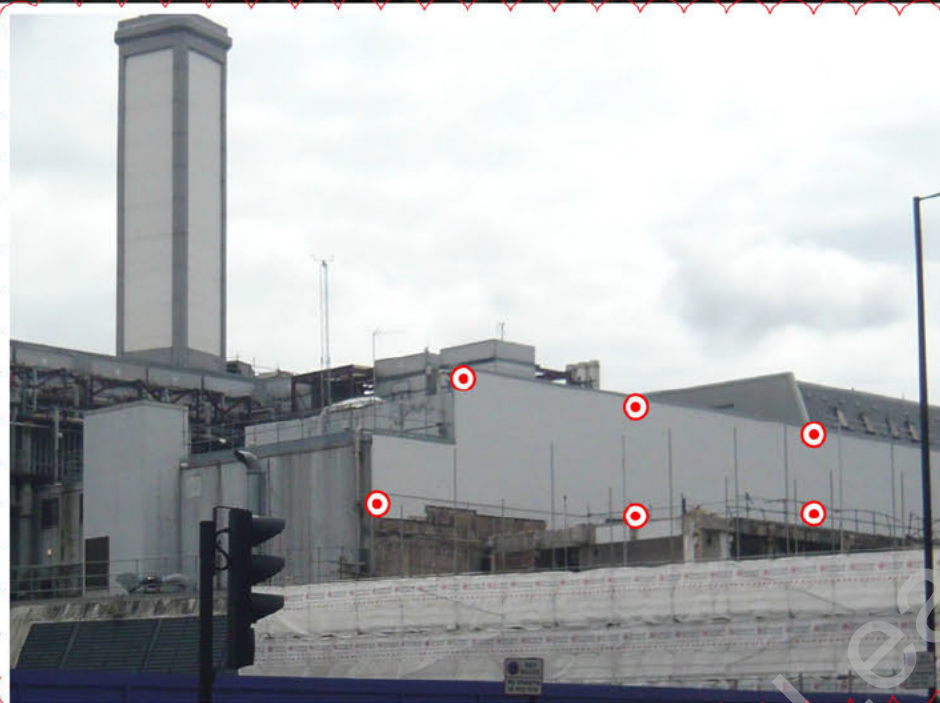


**Vibrating Wire Crackmeter:**

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

**Safety, Health and Environmental Information**

- Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
- Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
- Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:
  - Working at height - e.g. installing geodetic prisms at high level on buildings;
  - Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.



**Notes:**

- Drawing issued as designer's recommendations for use by contractor.
- Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
- Invar scales to be located at suitable survey tripod height to allow direct reading.
- Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

**Notes:**

Rev.	Date	Description	By	Chkd	App	Auth
P01	29/06/2011	Issued as per note 1	MK	AS	RM	
P02	21/07/2011	Reissued as per note 1	MK	JA	RM	
C01	11/11/2011	Issued as Fit for construction	MK	JA	RM	IT



**Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ  
 www.crossrail.co.uk

Scale : NTS @ A3

Contract : Bored Tunnels (Alignment and Track)

Originator : Ove Arup & Partners Limited

Location : Crossrail General

Title : Proposed Building Instrumentation  
 Farringdon Station  
 C122-28403 47-50 Charterhouse Street

Drg No : C122-OVE-C2-DDJ-CR001\_Z-39667

By : M.KNIGHT

Chk : J.APTED

App : R.MCCRAE

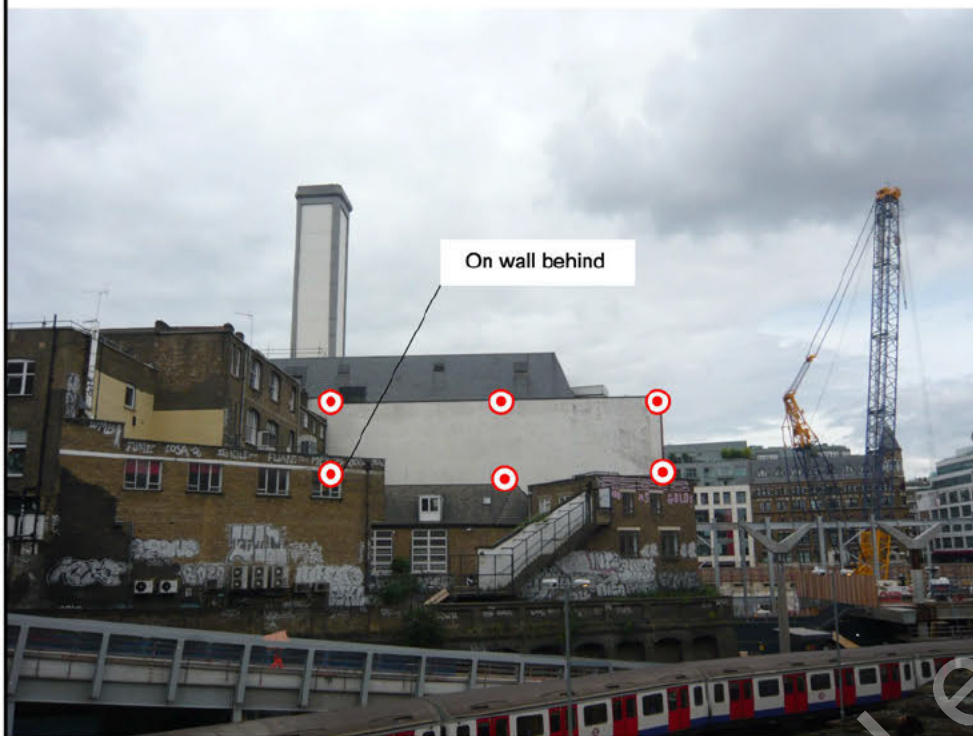
Auth : I.THOMSON

Rev : C01 Suit : A





This drawing to be read in conjunction with C122-OVE-C2-DDJ-CR001\_Z-39603



On wall behind

- Notes:**
- 1) Drawing issued as designer's recommendations for use by contractor.
  - 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
  - 3) Invar scales to be located at suitable survey tripod height to allow direct reading.
  - 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.
  - 5) Vibrating Wire Crackmeters to be installed at selected cracks encountered on site, with the agreement of the Supervisor, at the time of installation.

**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details by C430	Making good strategy by C435
BRE Levelling Studs	4	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	14	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. Brackets not to be fixed to decorative brick work/stone work. Contractor to contact Crossrail heritage for clarification if required.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.

**Internal Monitoring Instrumentation**  
Internal monitoring not required

**Legend**

- Geodetic Prism
- BRE Levelling Stud



**Geodetic Prism:**  
Geodetic prisms are supported on brackets. They are read remotely using Total Stations



**BRE Levelling Stud:**  
Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.

**Safety, Health and Environmental Information**

1. Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
2. Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
3. Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:
  - (a) Working at height - e.g. installing geodetic prisms at high level on buildings;
  - (b) Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.

Rev.	Date	Description	By	Chkd	App	Auth
P01	22/07/2011	Issued as per note 1	MK	JA	RM	
C01	11/11/2011	Issued as Fit for construction	MK	JA	RM	IT

Notes:

**Crossrail Limited**  
25 Canada Square  
Canary Wharf  
London  
E14 5LQ  
www.crossrail.co.uk

Contract : Bored Tunnels (Alignment and Track)	
Originator : Ove Arup & Partners Limited	
Location : Crossrail General	
Title : Proposed Building Instrumentation Farringdon Station 51-53 Charterhouse Street MDC3_00032 2 of 2	By :
Scale : NTS @ A3	Chk :
Drg No : C122-OVE-C2-DDJ-CR001_Z-30831	App :
Rev : C01	Suit : A
Auth :	





**Notes:**

- 1) Drawing issued as designer's recommendations for use by contractor.
- 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
- 3) Invar scales to be located at suitable survey tripod height to allow direct reading.
- 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

**External Monitoring Instrumentation**

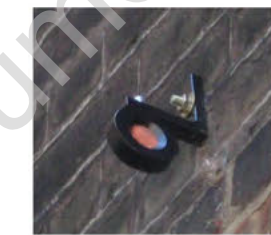
Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	3	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	6	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box with screw fixings.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

**Legend**

- Geodetic Prism
- BRE Levelling Stud



**Geodetic Prism:**

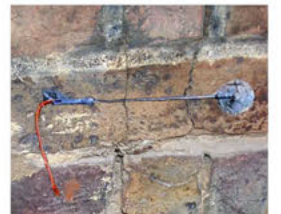
Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.



**BRE Levelling Stud:**

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.

✂ **Vibrating Wire Crackmeter**



**Vibrating Wire Crackmeter:**

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

This drawing to be read in conjunction with C122-OVE-C2-DDJ-CR001\_Z-30813 (2 of 3) and 30814 (3 of 3)

**Safety, Health and Environmental Information**

1. Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
2. Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
3. Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:
  - (a) Working at height - e.g. installing geodetic prisms at high level on buildings;
  - (b) Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.

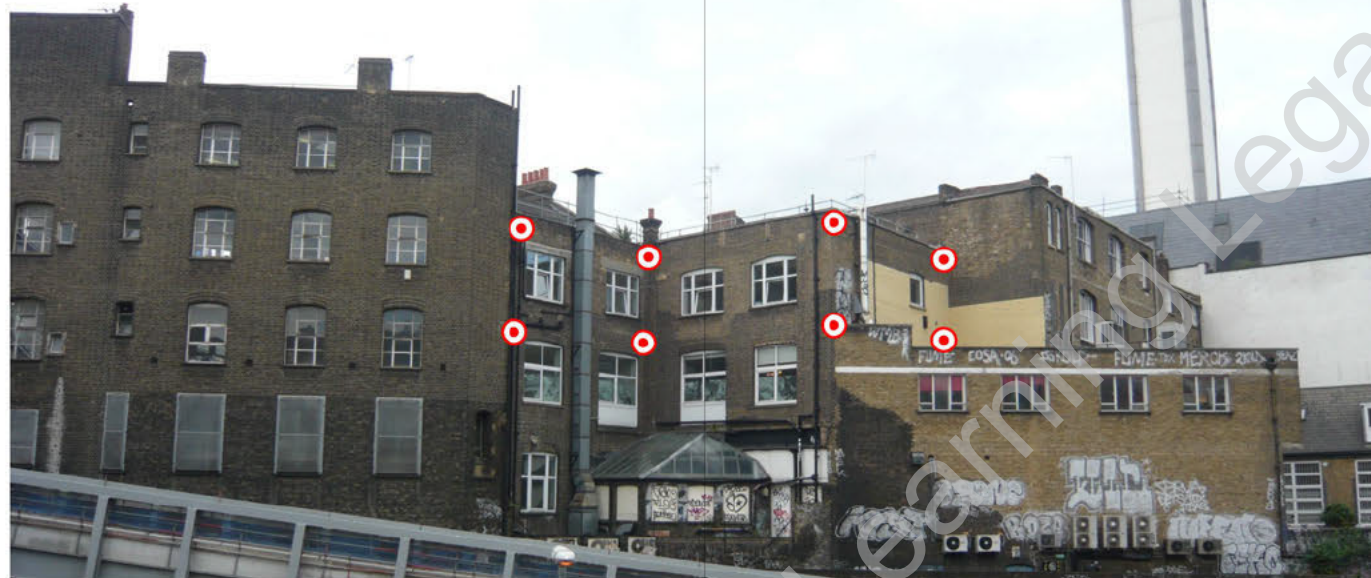
Rev.	Date	Description	By	Chkd	App	Auth
P01	29/06/2011	Issued as per note 1	MK	AS	RM	
P02	14/07/2011	Reissued as per note 1	MK	AS	RM	
C01	11/11/2011	Issued as Fit for construction	MK	AS	RM	IT

Notes:

**Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ  
 www.crossrail.co.uk

Contract : Bored Tunnels (Alignment and Track)	
Originator : Ove Arup & Partners Limited	
Location : Crossrail General	
Title : Proposed Building Instrumentation Farringdon Station MDC3_00400 55 Charterhouse Street 1 of 3	By : M.KNIGHT
	Chk : A.STENNING
	App : R.MCCRAE
Scale : NTS @ A3	Auth : I.THOMSON
Drg No : C122-OVE-C2-DDJ-CR001_Z-39650	Rev: C01 Suit: A





- Notes:**
- 1) Drawing issued as designer's recommendations for use by contractor.
  - 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
  - 3) Invar scales to be located at suitable survey tripod height to allow direct reading.
  - 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

**External Monitoring Instrumentation**

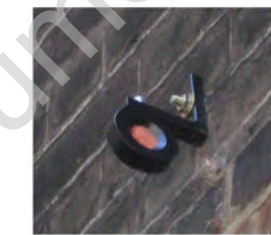
Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	4	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	16	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box with screw fixings.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

**Legend**

- Geodetic Prism
- BRE Levelling Stud



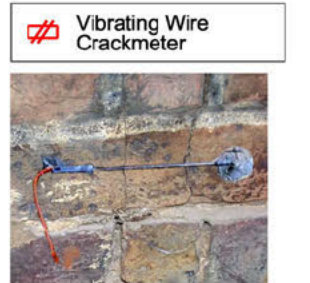
**Geodetic Prism:**

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.



**BRE Levelling Stud:**

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.



**Vibrating Wire Crackmeter:**

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

**Safety, Health and Environmental Information**

1. Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
2. Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
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  - (b) Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.

Rev.	Date	Description	By	Chkd	App	Auth
P01	29/06/2011	Issued as per note 1	MK	AS	RM	
P02	21/07/2011	Reissued as per note 1	MK	JA	RM	
C01	11/11/2011	Issued as Fit for construction	MK	JA	RM	IT

Notes:

**Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ  
 www.crossrail.co.uk

Contract : Bored Tunnels (Alignment and Track)	
Originator : Ove Arup & Partners Limited	
Location : Crossrail General	
Title : Proposed Building Instrumentation Farringdon Station MDC3_00401 57-61 Charterhouse Street	By : <span style="background-color: black; color: black;">XXXXXXXXXX</span>
Drg No : C122-OVE-C2-DDJ-CR001_Z-39651	Chk : <span style="background-color: black; color: black;">XXXXXXXXXX</span>
Rev : C01	Suit : A
Auth : <span style="background-color: black; color: black;">XXXXXXXXXX</span>	





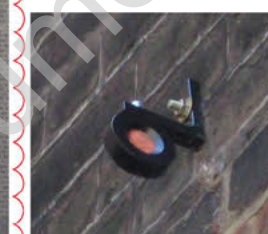
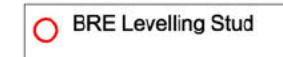
**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	4	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	14	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box with screw fixings.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

**Legend**



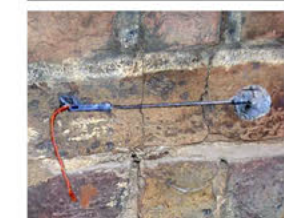
**Geodetic Prism:**

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.



**BRE Levelling Stud:**

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.



**Vibrating Wire Crackmeter:**

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

**Notes:**

- 1) Drawing issued as designer's recommendations for use by contractor.
- 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
- 3) Invar scales to be located at suitable survey tripod height to allow direct reading.
- 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

**Safety, Health and Environmental Information**

1. Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
2. Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
3. Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:
  - (a) Working at height - e.g. installing geodetic prisms at high level on buildings;
  - (b) Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.

Rev.	Date	Description	By	Chkd	App	Auth
P01	29/06/2011	Issued as per note 1	MK	AS	RM	
P02	14/07/2011	Reissued as per note 1	MK	AS	RM	

**Notes:**



**Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ

© Crossrail

[www.crossrail.co.uk](http://www.crossrail.co.uk)

Scale : NTS @ A3

Contract : Bored Tunnels (Alignment and Track)

Originator : Ove Arup & Partners Limited

Location : Crossrail General

Title : Proposed Building Instrumentation  
 Farringdon Station  
 MDC3\_00404 63 Charterhouse Street

Drg No : C122-OVE-C2-DDJ-CR001\_Z-39654

By : M.KNIGHT

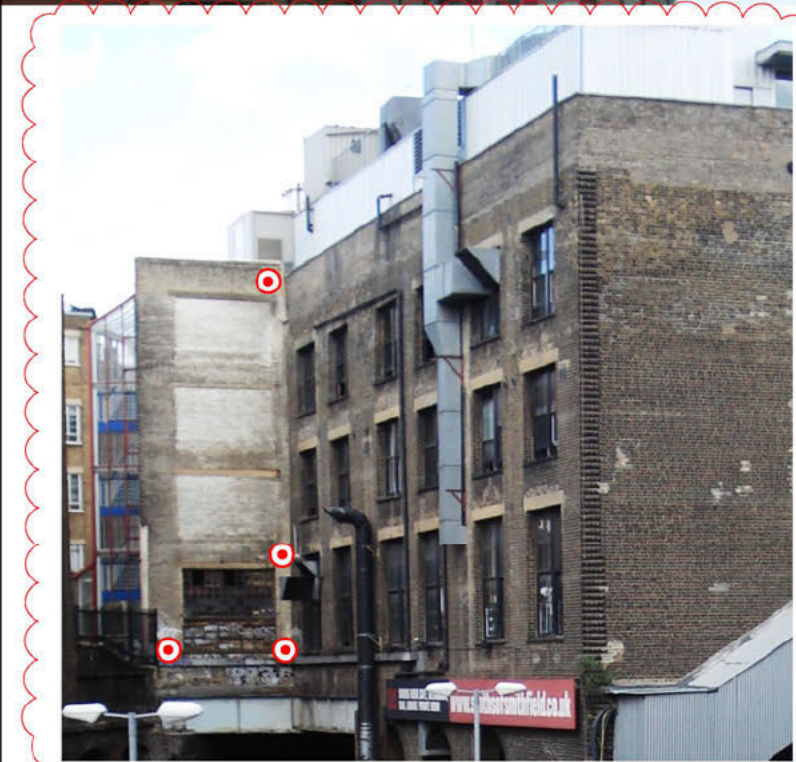
Chk : A.STENNING

App : R.MCCRAE

Rev : P02 Suit : S4

Auth : ---





- Notes:**
- 1) Drawing issued as designer's recommendations for use by contractor.
  - 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
  - 3) Invar scales to be located at suitable survey tripod height to allow direct reading.
  - 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	4	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	18	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box with screw fixings.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

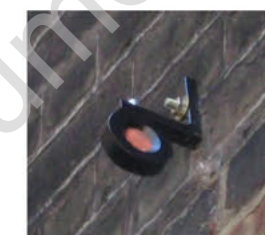
**Legend**



Geodetic Prism



BRE Levelling Stud



**Geodetic Prism:**

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.



**BRE Levelling Stud:**

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.



Vibrating Wire Crackmeter



**Vibrating Wire Crackmeter:**

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

**Safety, Health and Environmental Information**

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2. Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
3. Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:
  - (a) Working at height - e.g. installing geodetic prisms at high level on buildings;
  - (b) Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.

Rev.	Date	Description	By	Chkd	App	Auth
P01	29/06/2011	Issued as per note 1	MK	AS	RM	
P02	21/07/2011	Reissued as per note 1	MK	JA	RM	
C01	11/11/2011	Issued as Fit for construction	MK	JA	RM	IT

Notes:


**Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ  
 www.crossrail.co.uk

Contract : Bored Tunnels (Alignment and Track)	By : [Redacted]
Originator : Ove Arup & Partners Limited	Chk : [Redacted]
Location : Crossrail General	App : [Redacted]
Title : Proposed Building Instrumentation Farringdon Station C122_28407 77a Charterhouse Street	Auth : [Redacted]
Scale : NTS @ A3	Rev: C01 Suit: A
Drg No : C122-OVE-C2-DDJ-CR001_Z-39668	





- Notes:**
- 1) Drawing issued as designer's recommendations for use by contractor.
  - 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
  - 3) Invar scales to be located at suitable survey tripod height to allow direct reading.
  - 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	3	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	6	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

**Legend**

- Geodetic Prism
- BRE Levelling Stud



**Geodetic Prism:**

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.



**BRE Levelling Stud:**

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.

**Vibrating Wire Crackmeter**



**Vibrating Wire Crackmeter:**

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

**Safety, Health and Environmental Information**

1. Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
2. Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
3. Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:
  - (a) Working at height - e.g. installing geodetic prisms at high level on buildings;
  - (b) Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.

Rev.	Date	Description	By	Chkd	App	Auth
P01	07/07/2011	Issued as per note 1	MK	HJ	RM	
P02	14/07/2011	Reissued as per note 1	MK	AS	RM	
C01	11/11/2011	Issued as Fit for construction	MK	AS	RM	IT

Notes:

**Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ  
 www.crossrail.co.uk

Contract : Bored Tunnels (Alignment and Track)	
Originator : Ove Arup & Partners Limited	
Location : Crossrail General	
Title : Proposed Building Instrumentation Farringdon Station MDC300010 79-83 Charterhouse Street 1 of 2	By : M.KNIGHT
	Chk : A.STENNING
	App : R.MCCRAE
Scale : NTS @ A3	Auth : I.THOMSON
Drg No : C122-OVE-C2-DDJ-CR001_Z-30803	Rev : C01 Suit : A





**Notes:**

- 1) Drawing issued as designer's recommendations for use by contractor.
- 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
- 3) Invar scales to be located at suitable survey tripod height to allow direct reading.
- 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

Rev.	Date	Description	By	Chkd	App	Auth
P01	06/07/2011	Issued as per note 1	MK	HJ	RM	
C01	11/11/2011	Issued as Fit for construction	MK	HJ	RM	IT

Notes:

 **Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ  
 www.crossrail.co.uk

Contract : Bored Tunnels (Alignment and Track)	
Originator : Ove Arup & Partners Limited	
Location : Crossrail General	
Title : Proposed Building Instrumentation Farringdon Station MDC3-00019 85 Charterhouse Street	By : [Redacted]
Scale : NTS @ A3	Chk : [Redacted]
Drg No : C122-OVE-C2-DDJ-CR001_Z-30806	App : [Redacted]
Rev : C01	Suit : A
	Auth : [Redacted]

**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	2	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	4	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box with screw fixings.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

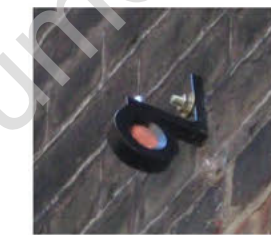
**Legend**



Geodetic Prism



BRE Levelling Stud



Geodetic Prism:

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.



BRE Levelling Stud:

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.



Vibrating Wire Crackmeter



Vibrating Wire Crackmeter:

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

**Safety, Health and Environmental Information**

1. Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
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**Notes:**

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- 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
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- 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	3	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	6	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box with screw fixings.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

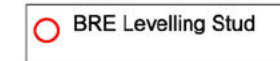
**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

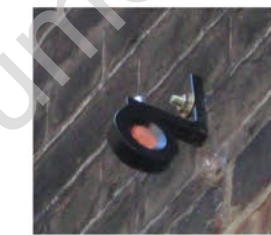
**Legend**



Geodetic Prism



BRE Levelling Stud



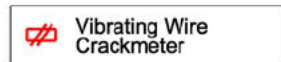
**Geodetic Prism:**

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.

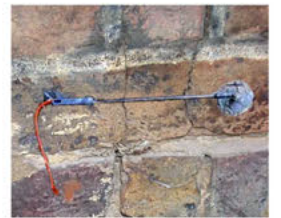


**BRE Levelling Stud:**

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.



Vibrating Wire Crackmeter



**Vibrating Wire Crackmeter:**

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

**Safety, Health and Environmental Information**

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2. Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
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Rev.	Date	Description	By	Chkd	App	Auth
P01	06/07/2011	Issued as per note 1	MK	HJ	RM	
C01	11/11/2011	Issued as Fit for construction	MK	HJ	RM	IT

Notes:


**Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ  
 www.crossrail.co.uk

Contract : Bored Tunnels (Alignment and Track)	
Originator : Ove Arup & Partners Limited	
Location : Crossrail General	
Title : Proposed Building Instrumentation Farringdon Station MDC3-00022 87 Charterhouse Street 1 of 2	By : M.KNIGHT
	Chk : H.JUNG
	App : R.MCCRAE
Scale : NTS @ A3	Auth : I.THOMSON
Drg No : C122-OVE-C2-DDJ-CR001_Z-30809	Rev : C01 Suit : A





Geodetic prism at top of building column.

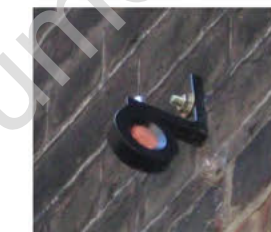
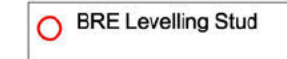
External Monitoring Instrumentation

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
BRE Levelling Studs	4	1	Studs are screwed into slightly recessed 13mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin.	Protruding studs will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Geodetic Prisms	8	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing area made good with materials to match the existing façade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box with screw fixings.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

Internal Monitoring Instrumentation

Requirement for internal monitoring to be confirmed.

Legend



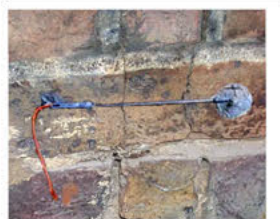
Geodetic Prism:

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.



BRE Levelling Stud:

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed onto stud.



Vibrating Wire Crackmeter:

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the façade.

- Notes:
- 1) Drawing issued as designer's recommendations for use by contractor.
  - 2) Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
  - 3) Invar scales to be located at suitable survey tripod height to allow direct reading.
  - 4) Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

Safety, Health and Environmental Information

1. Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
2. Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
3. Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:
  - (a) Working at height - e.g. installing geodetic prisms at high level on buildings;
  - (b) Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.

Copy Approved for Design - Created: 11-NOV-2011

Rev.	Date	Description	By	Chkd	App	Auth
P01	29/06/2011	Issued as per note 1	MK	AS	RM	
C01	11/11/2011	Issued as Fit for construction	MK	AS	RM	IT

Notes:

Crossrail Limited  
25 Canada Square  
Canary Wharf  
London  
E14 5LQ  
www.crossrail.co.uk

Contract : Bored Tunnels (Alignment and Track)	By : [Redacted]
Originator : Ove Arup & Partners Limited	Chk : [Redacted]
Location : Crossrail General	App : [Redacted]
Title : Proposed Building Instrumentation Farringdon Station MDC3-0009 67-77 Charterhouse Street 1 of 4	Auth : [Redacted]
Scale : NTS @ A3	Rev: C01 Suit: A
Drg No : C122-OVE-C2-DDJ-CR001_Z-39662	





- Notes:**
- Drawing issued as designer's recommendations for use by contractor.
  - Monitoring positions shown are approximate. Adjustments may be necessary by contractor depending on "as found" conditions at time of installation.
  - Inver scales to be located at suitable survey tripod height to allow direct reading.
  - Prisms and BRE sockets on same horizontal alignment to be installed at same level where possible.

**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details	Making good strategy
Geodetic Prisms	4	1	Brackets screwed into slightly recessed shell anchor fixings approximately 10mm in diameter. Inserted into drill holes and expanded to stabilise.	Prism brackets will be removed, and recessed fixing areas made good with materials to match the existing facade finish.
Vibrating Wire Crackmeters	TBC on site	TBC on site	Attached by screws with moveable ball joints into slightly recessed shell anchor fixings approximately 10mm in diameter. Inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box.	Crackmeter and transmitter box will be removed, and recessed fixing areas made good with materials to match the existing facade finish.

**Internal Monitoring Instrumentation**

Requirement for internal monitoring to be confirmed.

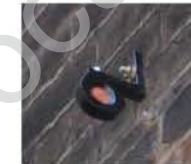
**Legend**



Geodetic Prism



Vibrating Wire Crackmeter



**Geodetic Prism:**

Geodetic prisms are supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.



**Vibrating Wire Crackmeter:**

Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box located on the facade.

**Safety, Health and Environmental Information**

- Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.
- Before installing instrumentation, contractor to carry out site inspection to assess proposed positions and location-specific risks to be avoided or controlled.
- Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:
  - (a) Working at height - e.g. installing geodetic prisms at high level on buildings;
  - (b) Near railways - risk of train drivers mistaking retro reflective prisms for signals. Prisms to be sited to avoid this risk.

Rev.	Date	Description	By	Chkd	App	Auth
P01	30/06/2011	Issued as per note 1	MK	AS	RM	
C01	11/11/2011	Issued as Fk for construction	MK	AS	RM	IT

**Notes:**

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**Crossrail Limited**  
 25 Canada Square  
 Canary Wharf  
 London  
 E14 5LQ  
 www.crossrail.co.uk

<b>Contract:</b> Bored Tunnels (Alignment and Track)	
<b>Originator:</b> Ove Arup & Partners Limited	
<b>Location:</b> Crossrail General	
<b>Title:</b> Proposed Building Instrumentation Farringdon Station MDC3-0008 67-77 Charterhouse Street 4 of 4	<b>By:</b> M.KNIGHT <b>Chk:</b> A.STENNING <b>App:</b> R.MCCRAE
<b>Scale:</b> NTS @ A3	<b>Auth:</b> I.THOMSON
<b>Contract:</b> Bored Tunnels (Alignment and Track)	<b>Rev:</b> C01 <b>Suit:</b> A
<b>Originator:</b> Ove Arup & Partners Limited	<b>App:</b> R.MCCRAE
<b>Location:</b> Crossrail General	<b>Auth:</b> I.THOMSON
<b>Title:</b> Proposed Building Instrumentation Farringdon Station MDC3-0008 67-77 Charterhouse Street 4 of 4	<b>Rev:</b> C01 <b>Suit:</b> A
<b>Scale:</b> NTS @ A3	<b>App:</b> R.MCCRAE
<b>Contract:</b> Bored Tunnels (Alignment and Track)	<b>Auth:</b> I.THOMSON
<b>Originator:</b> Ove Arup & Partners Limited	
<b>Location:</b> Crossrail General	
<b>Title:</b> Proposed Building Instrumentation Farringdon Station MDC3-0008 67-77 Charterhouse Street 4 of 4	
<b>Scale:</b> NTS @ A3	
<b>Contract:</b> Bored Tunnels (Alignment and Track)	
<b>Originator:</b> Ove Arup & Partners Limited	
<b>Location:</b> Crossrail General	
<b>Title:</b> Proposed Building Instrumentation Farringdon Station MDC3-0008 67-77 Charterhouse Street 4 of 4	
<b>Scale:</b> NTS @ A3	
<b>Contract:</b> Bored Tunnels (Alignment and Track)	
<b>Originator:</b> Ove Arup & Partners Limited	
<b>Location:</b> Crossrail General	
<b>Title:</b> Proposed Building Instrumentation Farringdon Station MDC3-0008 67-77 Charterhouse Street 4 of 4	
<b>Scale:</b> NTS @ A3	
<b>Contract:</b> Bored Tunnels (Alignment and Track)	
<b>Originator:</b> Ove Arup & Partners Limited	
<b>Location:</b> Crossrail General	
<b>Title:</b> Proposed Building Instrumentation Farringdon Station MDC3-0008 67-77 Charterhouse Street 4 of 4	
<b>Scale:</b> NTS @ A3	



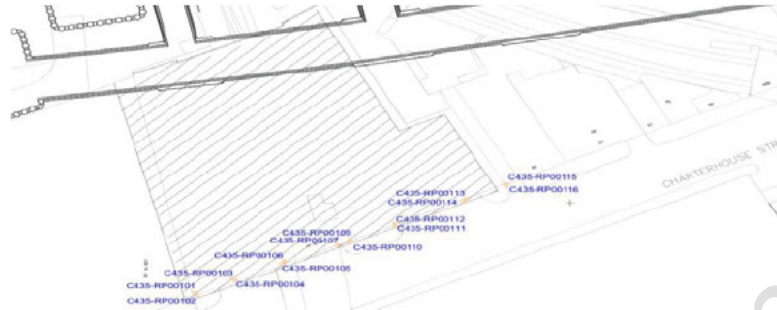
Learning Legacy Document

**Appendix B: Graphs**

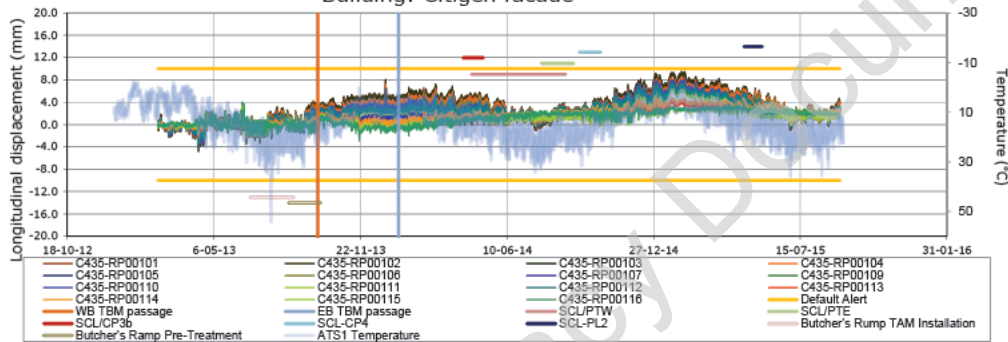


**GEOCISA UK**

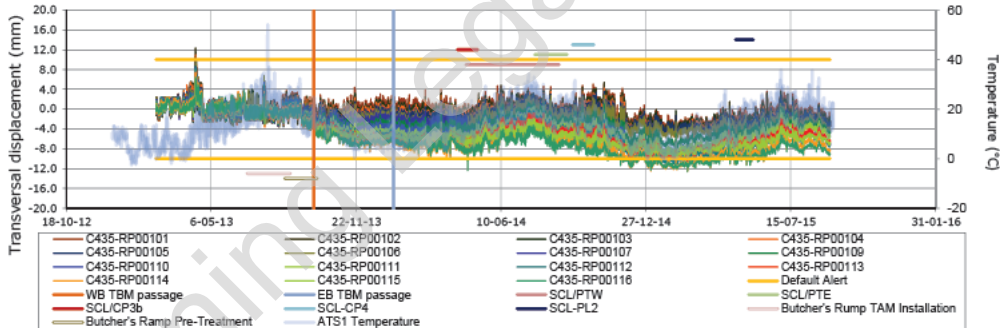
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 AREA Farringdon Station  
 DEVICE 3D Target



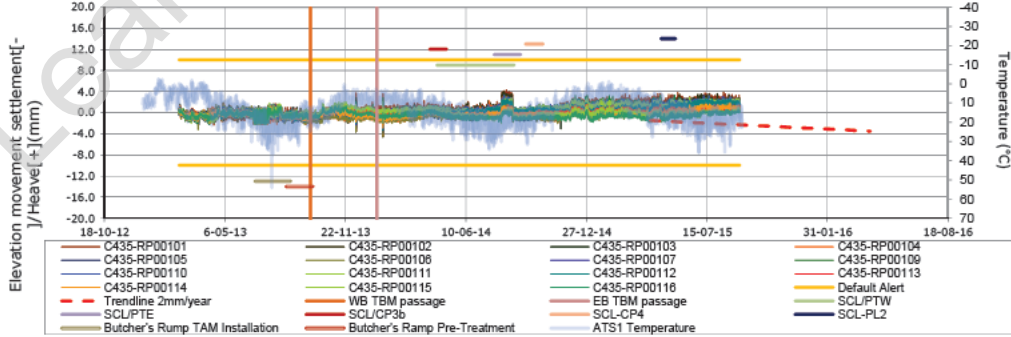
Building: Citigen facade



Building: Citigen facade



Building: Citigen facade



**REMARKS**  
 2mm heave recorded on 08/08/2014 not real and amended applying a posterior offset on 26/08/2014

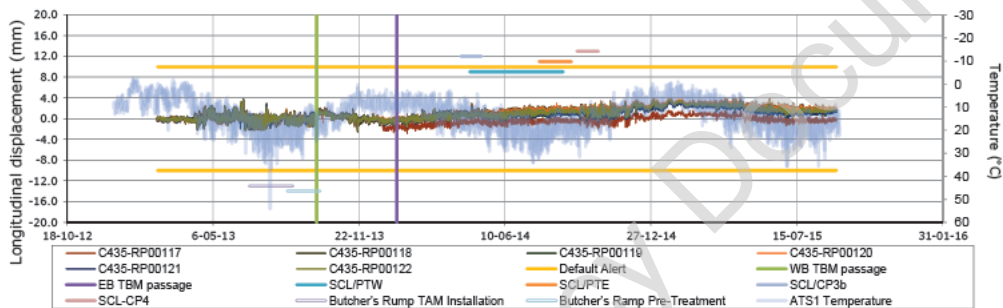


**GEOCISA UK**

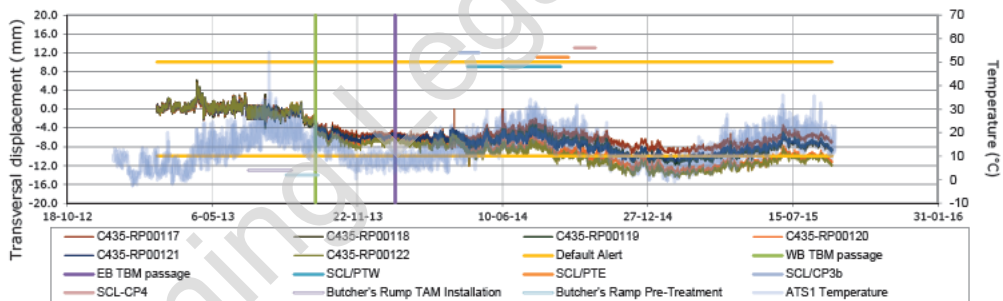
REPORT Automatic Prisms  
 AREA Farringdon Station  
 DEVICE 3D Target



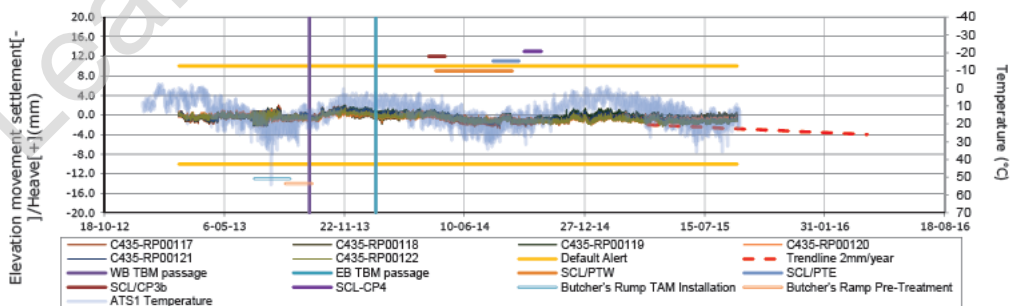
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Building: 55 CHARTERHOUSE STREET FACADE



Building: 55 CHARTERHOUSE STREET FACADE



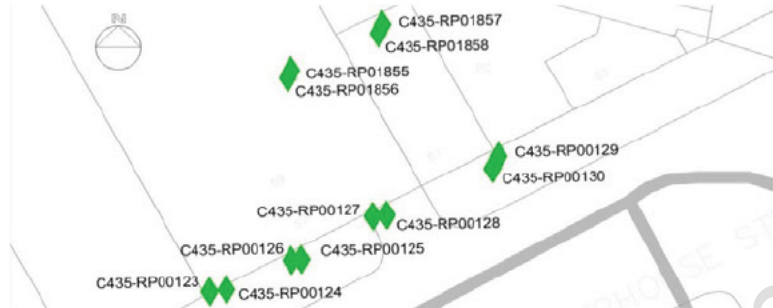
REMARKS



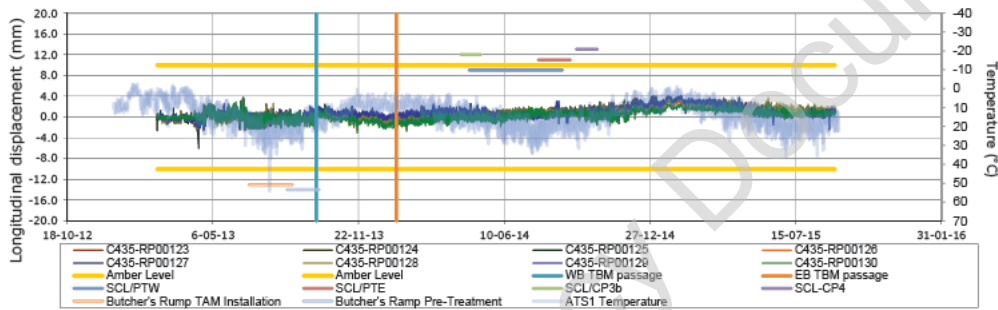


**GEOCISA UK**

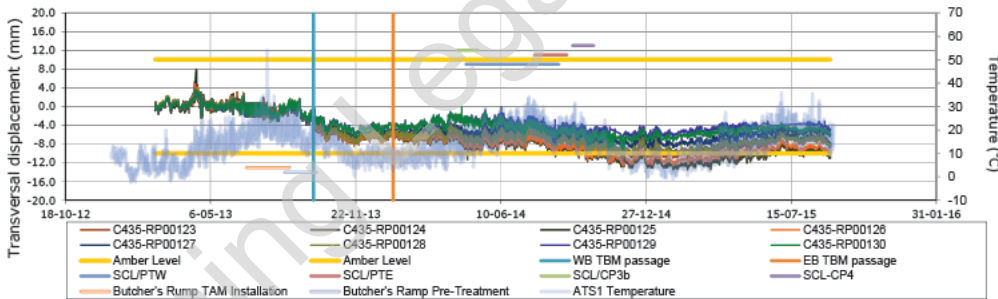
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 AREA Farringdon Station  
 DEVICE 3D Target



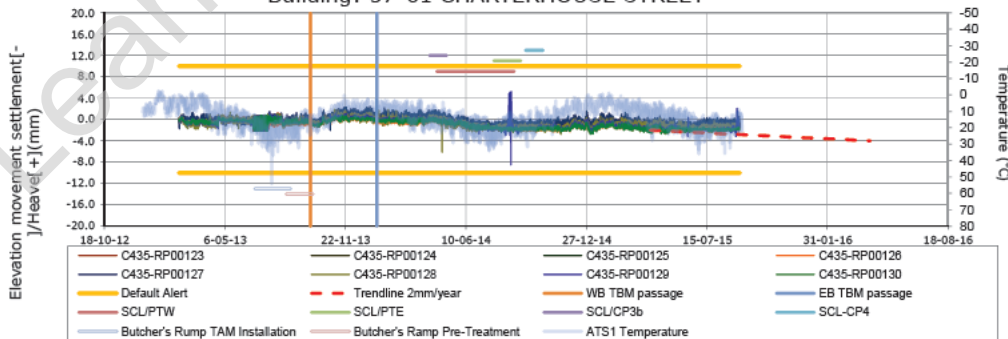
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Building: 57-61 CHARTERHOUSE STREET



Building: 57-61 CHARTERHOUSE STREET

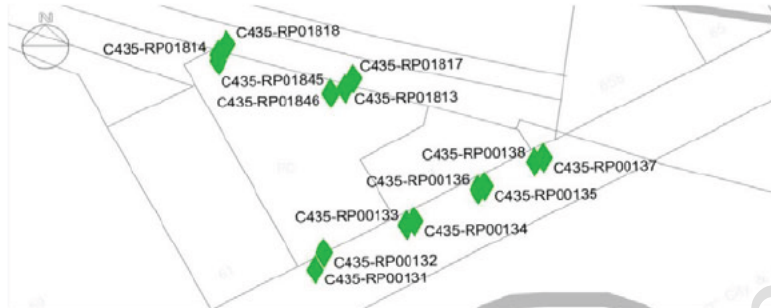


**REMARKS**  
 These prisms are read by 2 different ATS with different references (ATS N.1 and N.17)  
 01-10-2013: Settlement due to TBM passage  
 These prisms are read by 2 different ATS with different references (ATS N.1 and N.14)  
 02-10-2013: Settlement due to TBM passage

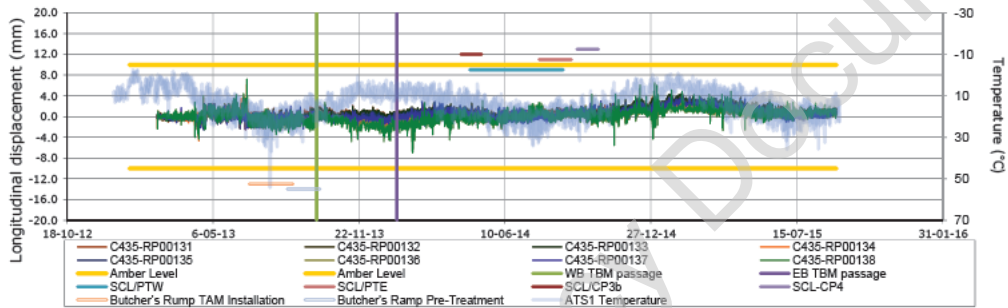


**GEOCISA UK**

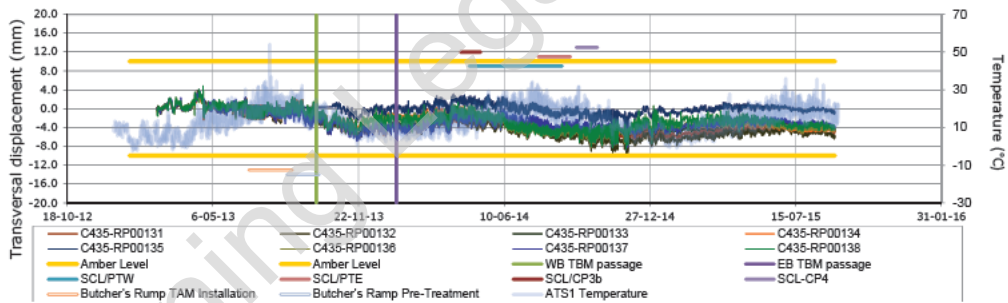
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 AREA Farringdon Station  
 DEVICE 3D Target



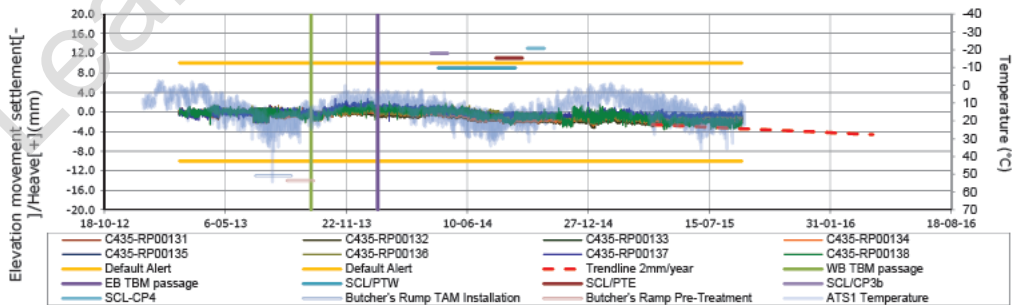
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Building: 63 CHARTERHOUSE STREET



Building: 63 CHARTERHOUSE STREET



**REMARKS**

01-10-2013: Settlement due to TBM passage

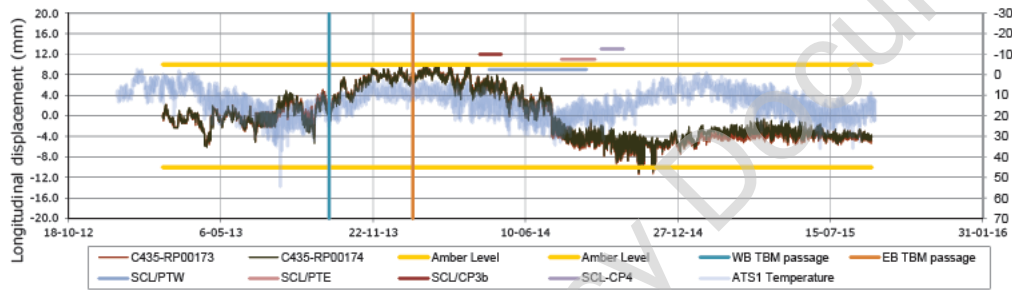
02-10-2013: Settlement due to TBM passage



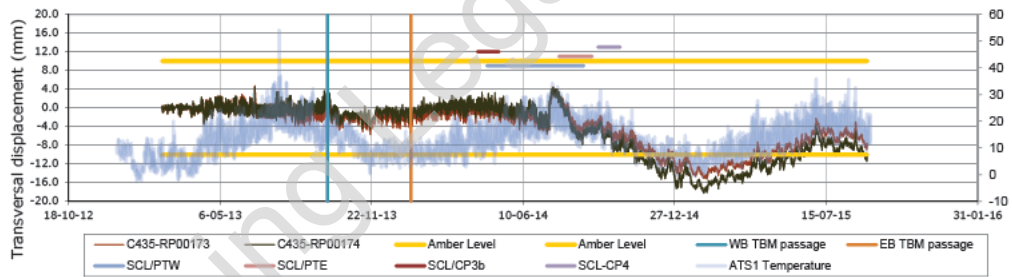
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 AREA Farringdon Station  
 DEVICE 3D Target



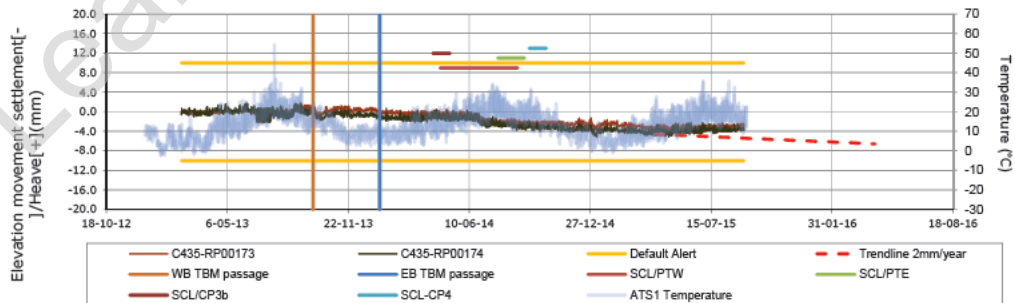
Building: 67-77 CHARTERHOUSE STREET



Building: 67-77 CHARTERHOUSE STREET



Building: 67-77 CHARTERHOUSE STREET



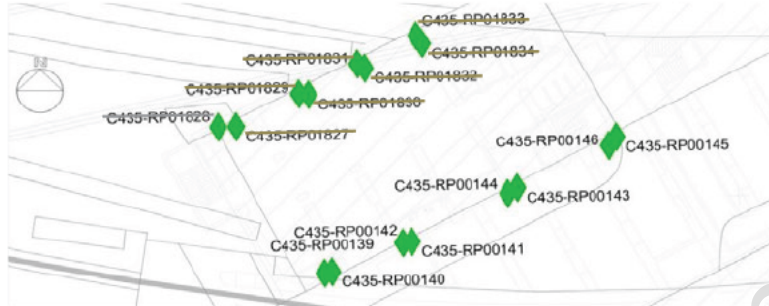
**REMARKS**

These prisms are read by 2 different ATS with different references (ATS N.1 and N.17)  
 01-10-2013: Settlement due to TBM passage  
 These prisms are read by 2 different ATS with different references (ATS N.1 and N.14)  
 02-10-2013: Settlement due to TBM passage

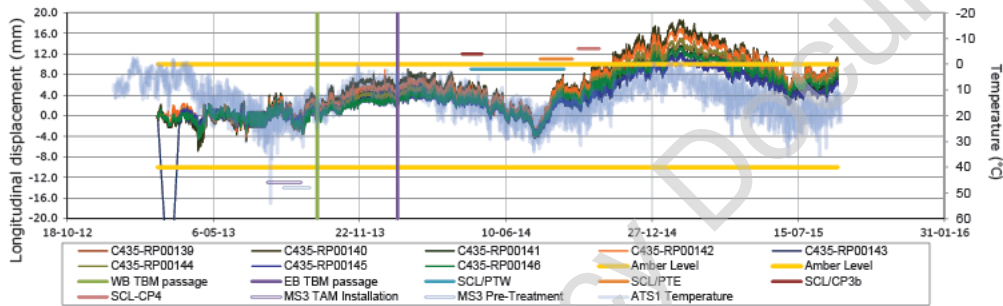


**GEOCISA UK**

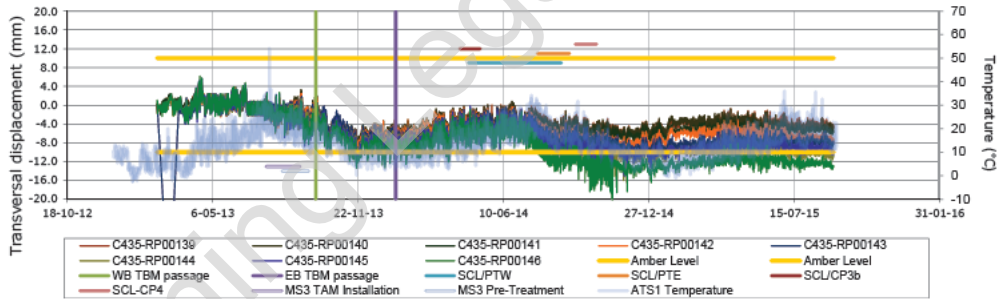
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 AREA Farringdon Station  
 DEVICE 3D Target



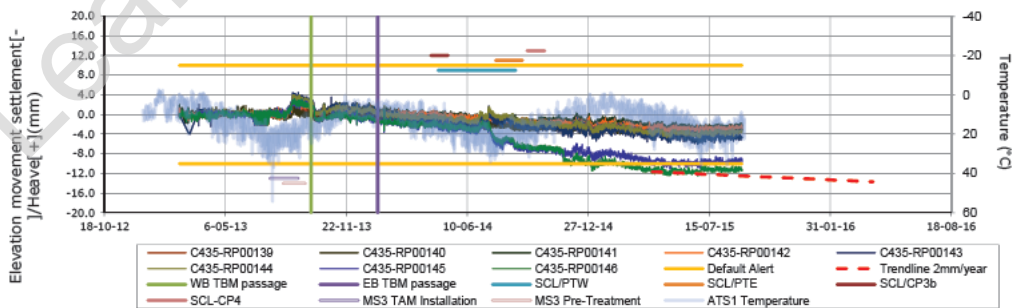
Building: 67-77 CHARTERHOUSE STREET



Building: 67-77 CHARTERHOUSE STREET



Building: 67-77 CHARTERHOUSE STREET

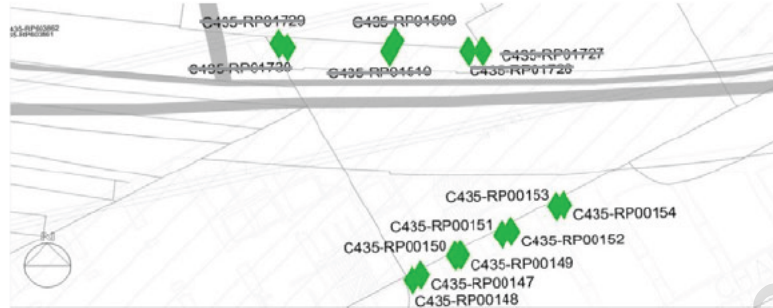


REMARKS

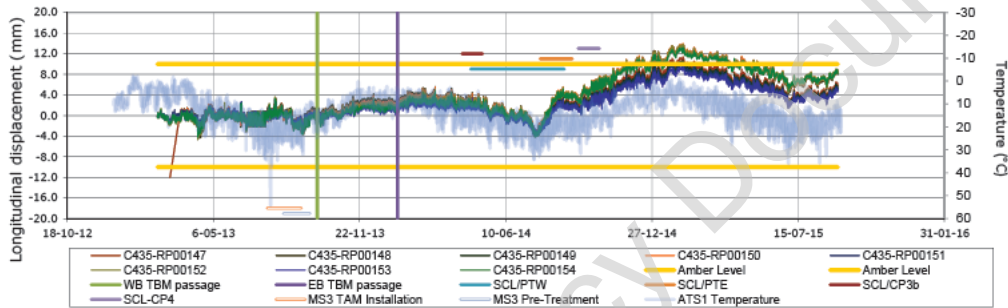


**GEOCISA UK**

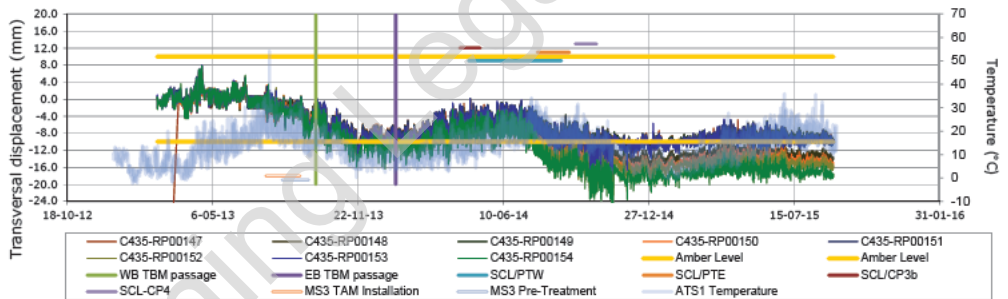
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 AREA Farringdon Station  
 DEVICE 3D Target



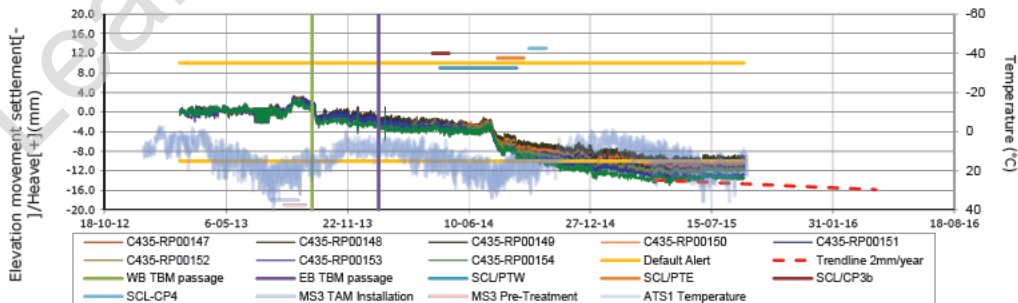
Building: 77a CHARTERHOUSE STREET



Building: 77a CHARTERHOUSE STREET



Building: 77a CHARTERHOUSE STREET

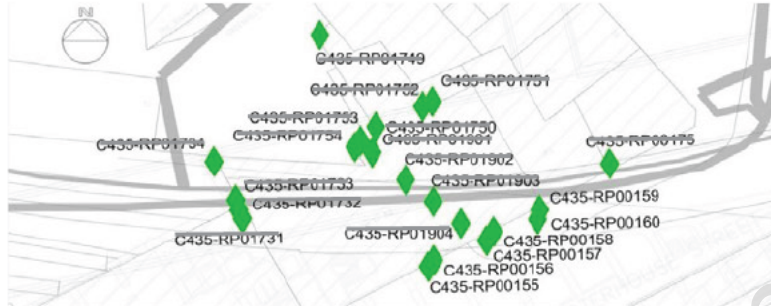


REMARKS

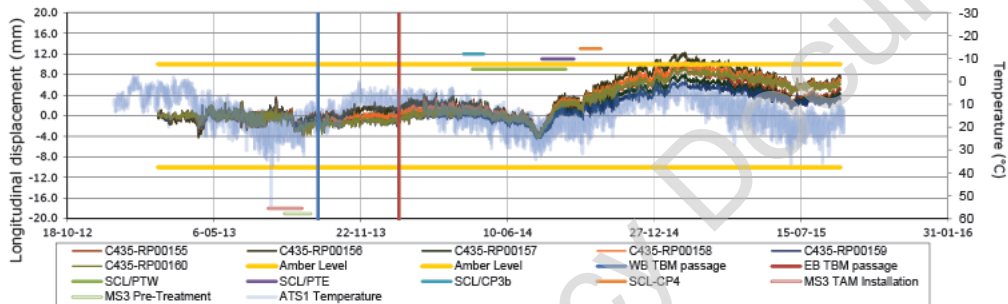


**GEOCISA UK**

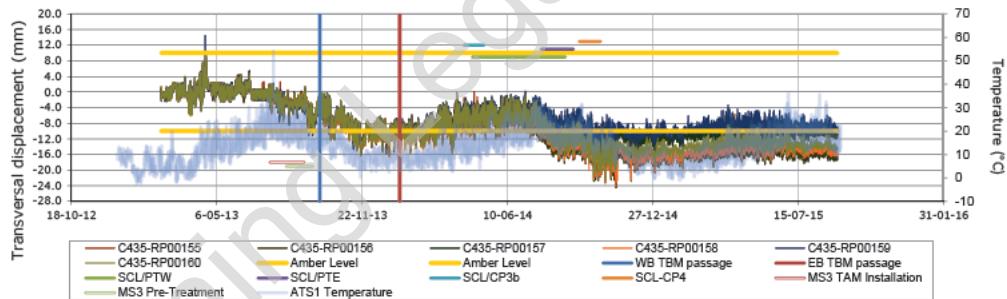
REPORT Automatic Prisms  
 AREA Farrington Station  
 DEVICE 3D Target



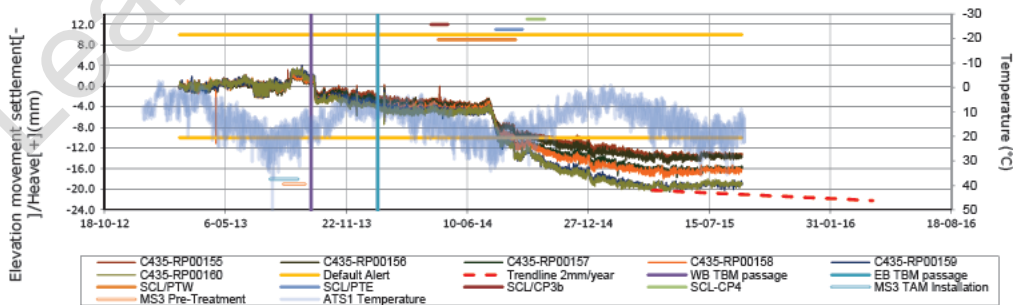
Building: 79-83 CHARTERHOUSE STREET



Building: 79-83 CHARTERHOUSE STREET



Building: 79-83 CHARTERHOUSE STREET



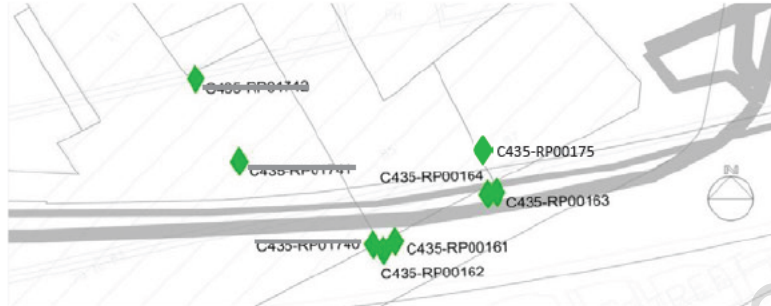
**REMARKS**  
 These prisms are read by 2 different ATS with different references (ATS N.1 and N.17)  
 01-10-2013: Settlement due to TBM passage



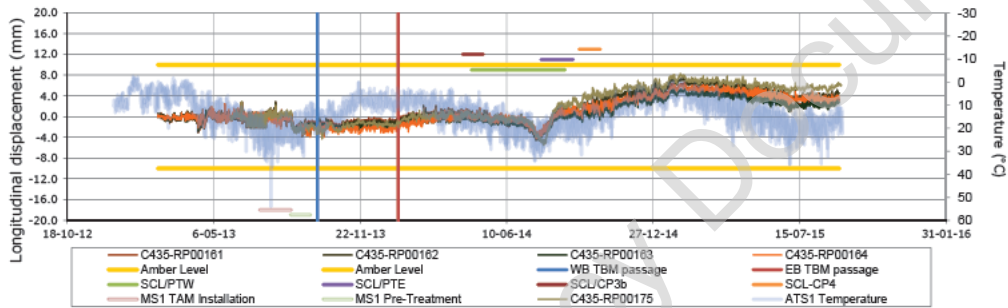


**GEOCISA UK**

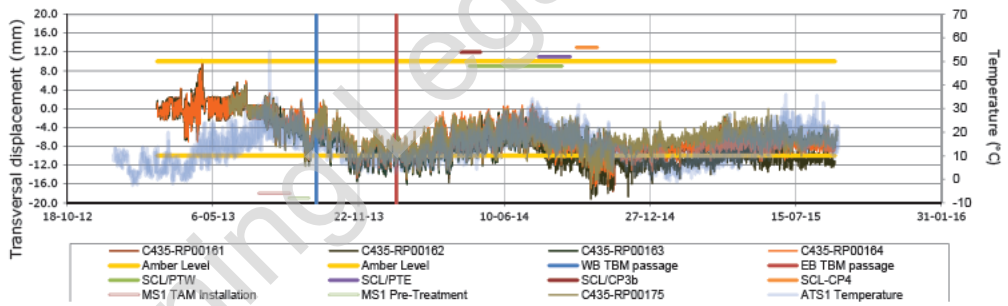
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 AREA Farringdon Station  
 DEVICE 3D Target



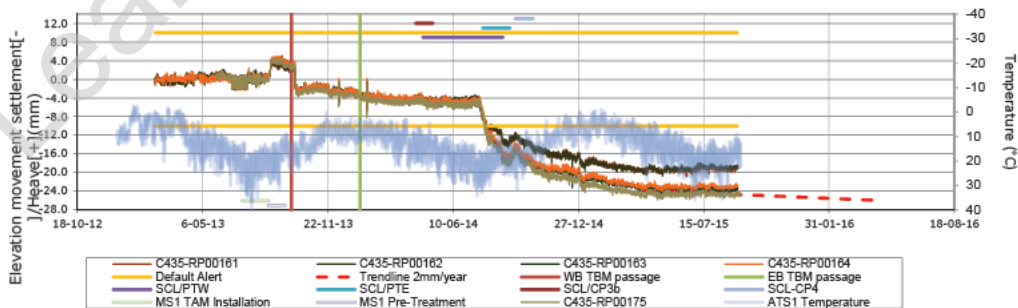
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Building: 85 CHARTERHOUSE STREET



Building: 85 CHARTERHOUSE STREET



**REMARKS**

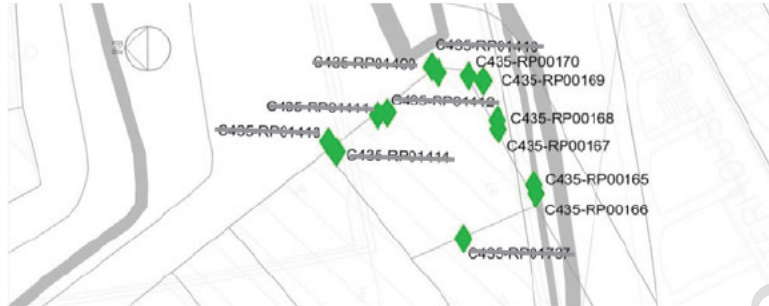
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 01-10-2013: Settlement due to TBM passage



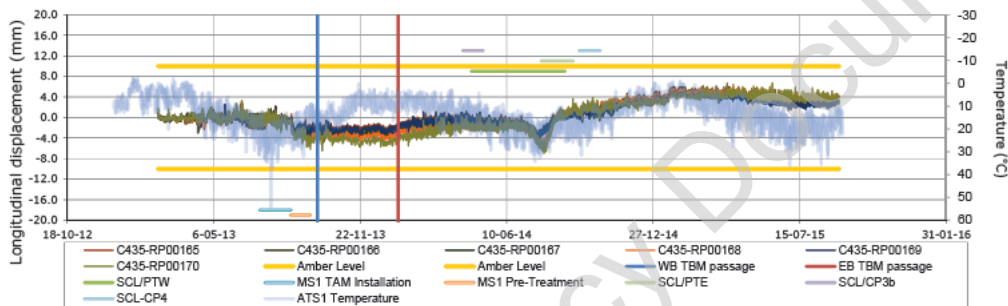


**GEOCISA UK**

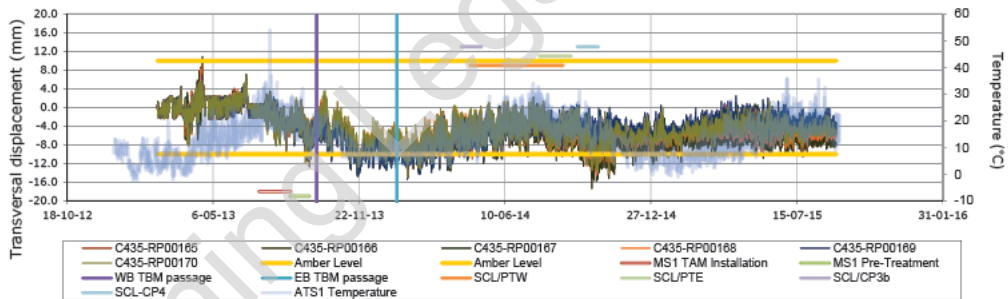
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 DEVICE 3D Target



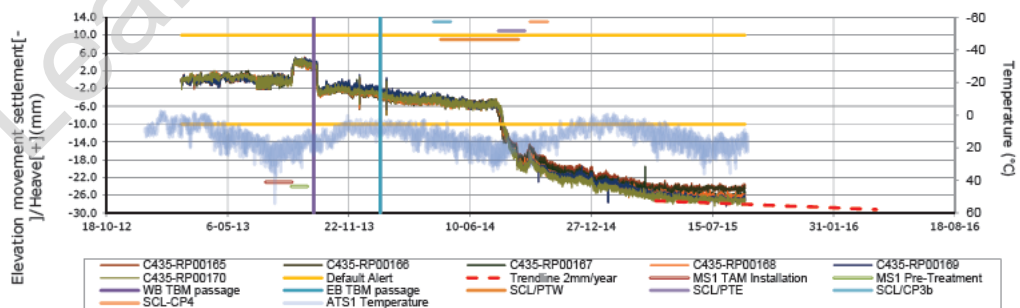
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Building: 87 CHARTERHOUSE STREET



Building: 87 CHARTERHOUSE STREET



REMARKS