



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 at 20 Farringdon Road (ATS 51) and 3D Targets read by ATS 51. CRL Document Number: C435-BFK-C2-RGN-M123-51050

Supplier Document Number: N/A

Contract MDL reference C14.022

### 1. Contractor Document Submittal History:

Revision:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
2.0	26-05-2014	[REDACTED]	[REDACTED]	[REDACTED]	For acceptance
3.0	29-07-2015	[REDACTED]	[REDACTED]	[REDACTED]	For acceptance
4.0	09-11-2015	[REDACTED]	[REDACTED]	[REDACTED]	For acceptance

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

Stakeholder submission required: LU  NR  DLR  RfL  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"/>
				18/12/2015	<input type="checkbox"/>

### 3. Acceptance by Crossrail:

## 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	5
<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	6
<b>C.2</b>	TRIGGER BREACHES	7
<b>C.3</b>	SIGNIFICANT ISSUES WITH THE INSTRUMENTATION	8
<b>C.4</b>	RESIDUAL RISKS	8
<b>D.</b>	<b>CONCLUSIONS</b>	<b>8</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 Farringdon Road Area, consisting of 63No. 3D Targets read by ATS 51 and 1No. Automated Total Station (ATS 51) located in the Farringdon Road. See table 1 below with details.

ATS 51 CODE	LOCATION	COORDINATES	
		X	Y
C435-AT00051	20 Farringdon Road	81885.98	36531.22

PRISM CODE	LOCATION	COORDINATES	
		X	Y
C430-RP52402	Farringdon Road – Rider Main	81868.132	36547.679
C430-RP52408	Farringdon Road – Rider Main	81879.086	36496.496
C430-RP52409	Farringdon Road – Rider Main	81879.887	36492.553
C430-RP52410	Farringdon Road – Rider Main	81880.686	36488.641
C430-RP52411	Farringdon Road – Rider Main	81881.44	36484.741
C430-RP52412	Farringdon Road – Rider Main	81882.257	36480.797
C430-RP52413	Farringdon Road – Rider Main	81883.061	36476.859
C430-RP52414	Farringdon Road – Rider Main	81883.804	36473.008
C430-RP52415	Farringdon Road – Rider Main	81884.632	36469.05
C430-RP52416	Farringdon Road – Rider Main	81885.448	36465.124
C430-RP52417	Farringdon Road – Rider Main	81886.245	36461.207
C430-RP52418	Farringdon Road – Rider Main	81887.042	36457.282
C430-RP52419	Farringdon Road – Rider Main	81887.837	36453.448
C430-RP52420	Farringdon Road – Rider Main	81888.646	36449.447
C430-RP52421	Farringdon Road – Rider Main	81889.446	36445.505
C430-RP52422	Farringdon Road – Rider Main	81890.231	36441.569
C430-RP52423	Farringdon Road – Rider Main	81891.049	36437.665

Area	Sensor Name	Location (x)	Location (y)	
25-27 Farringdon Road	C430-RP11001	81878.456	36479.23	
	C430-RP11002	81877.141	36485.658	
	C430-RP11003	81876.502	36488.842	
	C430-RP11004	81874.52	36498.668	
	C430-RP11005	81873.221	36505.247	
	C430-RP11006	81870.163	36506.974	
	C430-RP11007	81863.871	36503.826	
	C430-RP11008	81856.786	36500.433	
	C430-RP11009	81848.252	36496.082	
	C430-RP11011	81878.553	36478.868	
	C430-RP11012	81877.182	36485.628	
	C430-RP11013	81875.856	36492.173	
	C430-RP11014	81874.548	36498.74	
	C430-RP11015	81873.203	36505.435	
	C430-RP11016	81870.025	36506.894	
	C430-RP11017	81863.906	36503.825	
	C430-RP11018	81856.767	36500.376	
	C430-RP11019	81848.013	36496.082	
	C430-RP11021	81878.615	36478.73	
	C430-RP11022	81876.532	36489.033	
	C430-RP11023	81875.883	36492.142	
	C430-RP11024	81874.565	36498.784	
	C430-RP11025	81873.216	36505.599	
	C430-RP11026	81870.093	36506.905	
	C430-RP11027	81864.316	36503.997	
	C430-RP11028	81857.006	36500.469	
	17-23 Farringdon Road	C430-RP12001	81883.001	36458.239
		C430-RP12002	81881.419	36465.538
C430-RP12003		81880.429	36470.07	
C430-RP12004		81878.844	36477.399	
C430-RP12021		81883.02	36458.152	
C430-RP12022		81881.411	36465.552	
C430-RP12023		81880.429	36470.079	
C430-RP12024		81878.829	36477.438	
19 Charterhouse Street	C430-RP13001	81895.023	36390.425	
	C430-RP13002	81893.803	36402.418	
	C430-RP13003	81891.807	36414.682	
	C430-RP13004	81890.735	36420.638	
	C430-RP13005	81888.345	36432.377	
	C430-RP13006	81885.946	36444.159	
	C430-RP13007	81883.558	36455.886	
	C430-RP13021	81895.028	36390.432	
	C430-RP13022	81893.806	36402.407	
	C430-RP13023	81891.813	36414.637	
	C430-RP13024	81890.759	36420.553	
	C430-RP13025	81888.361	36432.309	
	C430-RP13026	81885.948	36444.111	
	C430-RP13027	81883.536	36455.954	

Table 1: Details 3D Targets read by ATS 51 and ATS 51.



At the moment, this area monitored by these prisms is in a Long Term basis with readings every three months, being the last one recorded on 10/05/2015.

Prisms named as C430-RP524XX installed on the Farringdon Road Rider Main were read last time on 18/09/2013 when they all were uninstalled at the same time than the rider main.

These prisms read by ATS 51 and the ATS 51 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-39602
- C122-OVE-C2-DDJ-CR001\_Z-39606
- C122-OVE-C2-DDJ-CR001\_Z-39607

Installation Reports:

- C435-BFK-C2-RGN-M123-51009
- C435-BFK-C2-RGN-M123-50023

Handover Report:

- C435-BFK-C-RGN-M123-50136

\*All prisms included in this Close-out Report named as C430-RP524XX are included in the Handover Report named as C430-RP100XX.

## **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 Farringdon Road area. A drawing showing the location of these devices can be found in the Appendix A.



Figure 1 – Map showing the Location of ATS 51 and 3D Targets read by ATS 51.

## 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
WB TBM passage	09/09/2013	17/09/2013
EB TBM passage	14/12/2013	23/12/2013
STW3 enlargement	05/01/2014	12/01/2014
STW1 enlargement	26/03/2014	24/04/2014
SHW2 excavation works (to level -8 & sump)	11/04/2014	09/05/2014

#### C.1.2 Resulting Movements

- 17-23 Farringdon Road: monitoring data for 3D Targets installed on the east facade of this building located directly above the crown of the WB TBM is shown in Appendix B. This WB TBM passage caused a maximum settlement around 5mm. During the EB TBM passage, the enlargement of STW1 and STW3 and the SH-W2 shaft excavation works no significant movement was observed on these 3D Targets.
- 19 Charterhouse Street: monitoring data for 3D Targets installed on the east facade of this building is shown in Appendix B. The WB TBM passage caused a maximum settlement around 3mm. During the EB TBM passages, the enlargement of STW1 and STW3 and the SH-W2 shaft excavation works no significant movement was observed on these 3D Targets.

- 25-27 Farringdon Road: monitoring data for 3D Targets installed on the north and east facades of this building located between the crowns of the EB and WB TBMs is shown in Appendix B. The WB TBM passage caused a maximum settlement around 2mm and the EB one a maximum settlement of 3mm. During the enlargement of STW1 and STW3 and the SH-W2 shaft excavation works no significant movement was observed on these 3D Targets.
- Farringdon Road – Rider Main: monitoring data for 3D Targets installed to control this utility located along Farringdon Road as is shown in Appendix B. These 3D Targets were uninstalled at the same time than the rider main on 18/09/2013 after the C300 WB TBM passage, recording a maximum of 4mm settlement for this activity, showing stability before being removed.

## 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 Outside of the compensation grouting area:

- DEFAULT ALERT (in any direction): 10mm
- GREEN: 24mm settlement
- AMBER: 30mm settlement
- RED: 38 mm settlement

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

C435-BFK-C2-RGN-M123-51050

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL		
						WORST HISTORICAL STATUS	CURRENT STATUS	
Farrington Road - Rider Main	C430-RP52402	AUTOMATIC RP	X	06/06/2013 12:00	1.58	Clear	Clear	
	C430-RP52408	AUTOMATIC RP	X	17/09/2013 23:00	-3.80	Clear	Clear	
	C430-RP52409	AUTOMATIC RP	X	17/09/2013 23:00	-2.90	Clear	Clear	
	C430-RP52410	AUTOMATIC RP	X	18/09/2013 13:00	-0.60	Clear	Clear	
	C430-RP52411	AUTOMATIC RP	X	18/09/2013 13:00	-3.40	Clear	Clear	
	C430-RP52412	AUTOMATIC RP	X	18/09/2013 12:00	2.20	Clear	Clear	
	C430-RP52413	AUTOMATIC RP	X	13/08/2013 19:00	-0.80	Clear	Clear	
	C430-RP52414	AUTOMATIC RP	X	18/09/2013 18:00	1.20	Clear	Clear	
	C430-RP52415	AUTOMATIC RP	X	18/09/2013 18:00	3.20	Clear	Clear	
	C430-RP52416	AUTOMATIC RP	X	18/09/2013 18:00	0.90	Clear	Clear	
	C430-RP52417	AUTOMATIC RP	X	18/09/2013 18:00	1.30	Clear	Clear	
	C430-RP52418	AUTOMATIC RP	X	18/09/2013 18:00	-1.20	Clear	Clear	
	C430-RP52419	AUTOMATIC RP	X	18/09/2013 18:00	-0.70	Clear	Clear	
	C430-RP52420	AUTOMATIC RP	X	13/09/2013 22:00	-1.50	Clear	Clear	
	C430-RP52421	AUTOMATIC RP	X	18/09/2013 18:00	2.90	Clear	Clear	
	C430-RP52422	AUTOMATIC RP	X	18/09/2013 18:00	2.50	Clear	Clear	
	C430-RP52423	AUTOMATIC RP	X	18/09/2013 12:00	-0.70	Clear	Clear	
	25-27 FARRINGTON ROAD	C430-RP11001	AUTOMATIC RP	X	10/05/2015 12:00	-3.3	Clear	Clear
		C430-RP11002	AUTOMATIC RP	X	10/05/2015 12:00	-3	Clear	Clear
		C430-RP11003	AUTOMATIC RP	X	10/05/2015 12:00	-2.1	Clear	Clear
C430-RP11004		AUTOMATIC RP	X	10/05/2015 12:00	-1.3	Clear	Clear	
C430-RP11005		AUTOMATIC RP	X	10/05/2015 12:00	4.4	Clear	Clear	
C430-RP11007		AUTOMATIC RP	X	10/05/2015 12:00	4.3	Clear	Clear	
C430-RP11008		AUTOMATIC RP	X	10/05/2015 12:00	2.7	Clear	Clear	
C430-RP11009		AUTOMATIC RP	X	10/05/2015 12:00	1.9	Clear	Clear	
C430-RP11011		AUTOMATIC RP	X	10/05/2015 12:00	-4.3	Clear	Clear	
C430-RP11012		AUTOMATIC RP	X	10/05/2015 12:00	-1.7	Clear	Clear	
C430-RP11013		AUTOMATIC RP	X	10/05/2015 12:00	0	Clear	Clear	
C430-RP11014		AUTOMATIC RP	X	10/05/2015 12:00	-0.5	Clear	Clear	
C430-RP11015		AUTOMATIC RP	X	10/05/2015 12:00	3	Clear	Clear	
C430-RP11016		AUTOMATIC RP	X	10/05/2015 12:00	4.6	Clear	Clear	
C430-RP11017		AUTOMATIC RP	X	10/05/2015 12:00	4.2	Clear	Clear	
C430-RP11018		AUTOMATIC RP	X	10/05/2015 12:00	3.3	Clear	Clear	
C430-RP11019		AUTOMATIC RP	X	10/05/2015 12:00	0	Clear	Clear	
C430-RP11021		AUTOMATIC RP	X	10/05/2015 12:00	1	Clear	Clear	
C430-RP11022		AUTOMATIC RP	X	10/05/2015 12:00	-3.1	Clear	Clear	
C430-RP11023		AUTOMATIC RP	X	10/05/2015 12:00	-0.7	Clear	Clear	
C430-RP11024		AUTOMATIC RP	X	10/05/2015 12:00	0.3	Clear	Clear	
C430-RP11025		AUTOMATIC RP	X	10/05/2015 12:00	4.7	Clear	Clear	
C430-RP11026		AUTOMATIC RP	X	10/05/2015 12:00	4.3	Clear	Clear	
C430-RP11027		AUTOMATIC RP	X	10/05/2015 12:00	3.7	Clear	Clear	
C430-RP11028		AUTOMATIC RP	X	10/05/2015 12:00	5.4	Clear	Clear	
C430-RP11029		AUTOMATIC RP	X	10/05/2015 12:00	2.5	Clear	Clear	
17-23 FARRINGTON ROAD		C430-RP12001	AUTOMATIC RP	X	10/05/2015 12:00	1.3	Clear	Clear
		C430-RP12002	AUTOMATIC RP	X	10/05/2015 12:00	2.4	Clear	Clear
		C430-RP12003	AUTOMATIC RP	X	10/05/2015 12:00	2.9	Clear	Clear
		C430-RP12004	AUTOMATIC RP	X	10/05/2015 12:00	4.2	Clear	Clear
	C430-RP12021	AUTOMATIC RP	X	10/05/2015 12:00	-3	Clear	Clear	
	C430-RP12022	AUTOMATIC RP	X	10/05/2015 12:00	-2.5	Clear	Clear	
	C430-RP12023	AUTOMATIC RP	X	10/05/2015 12:00	-1.8	Clear	Clear	
	C430-RP12024	AUTOMATIC RP	X	10/05/2015 12:00	-1.6	Clear	Clear	
19 CHARTERHOUSE STREET	C430-RP13001	AUTOMATIC RP	X	10/05/2015 12:00	-1	Clear	Clear	
	C430-RP13002	AUTOMATIC RP	X	10/05/2015 12:00	0.1	Clear	Clear	
	C430-RP13003	AUTOMATIC RP	X	10/05/2015 12:00	4.2	Clear	Clear	
	C430-RP13004	AUTOMATIC RP	X	10/05/2015 12:00	4	Clear	Clear	
	C430-RP13005	AUTOMATIC RP	X	10/05/2015 12:00	3	Clear	Clear	
	C430-RP13006	AUTOMATIC RP	X	10/05/2015 12:00	2.1	Clear	Clear	
	C430-RP13007	AUTOMATIC RP	X	10/05/2015 12:00	2.6	Clear	Clear	
	C430-RP13021	AUTOMATIC RP	X	10/05/2015 12:00	4.1	Clear	Clear	
	C430-RP13022	AUTOMATIC RP	X	10/05/2015 12:00	3	Clear	Clear	
	C430-RP13023	AUTOMATIC RP	X	10/05/2015 12:00	3.1	Clear	Clear	
	C430-RP13024	AUTOMATIC RP	X	10/05/2015 12:00	3.3	Clear	Clear	
	C430-RP13025	AUTOMATIC RP	X	10/05/2015 12:00	4.1	Clear	Clear	
	C430-RP13026	AUTOMATIC RP	X	10/05/2015 12:00	1.7	Clear	Clear	
	C430-RP13027	AUTOMATIC RP	X	10/05/2015 12:00	2.1	Clear	Clear	



C435-BFK-C2-RGN-M123-51050

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
Farringdon Road - Rider Main	C430-RP52402	AUTOMATIC RP	Y	06/06/2013 12:00	-1.87	Clear	Clear
	C430-RP52408	AUTOMATIC RP	Y	17/09/2013 23:00	5.90	Clear	Clear
	C430-RP52409	AUTOMATIC RP	Y	17/09/2013 23:00	4.00	Clear	Clear
	C430-RP52410	AUTOMATIC RP	Y	18/09/2013 13:00	-8.10	Clear	Clear
	C430-RP52411	AUTOMATIC RP	Y	18/09/2013 13:00	2.10	Clear	Clear
	C430-RP52412	AUTOMATIC RP	Y	18/09/2013 12:00	3.30	Clear	Clear
	C430-RP52413	AUTOMATIC RP	Y	13/08/2013 19:00	0.30	Clear	Clear
	C430-RP52414	AUTOMATIC RP	Y	18/09/2013 18:00	-1.10	Clear	Clear
	C430-RP52415	AUTOMATIC RP	Y	18/09/2013 18:00	-1.90	Clear	Clear
	C430-RP52416	AUTOMATIC RP	Y	18/09/2013 18:00	5.00	Clear	Clear
	C430-RP52417	AUTOMATIC RP	Y	18/09/2013 18:00	8.30	Clear	Clear
	C430-RP52418	AUTOMATIC RP	Y	18/09/2013 18:00	6.90	Clear	Clear
	C430-RP52419	AUTOMATIC RP	Y	18/09/2013 18:00	-4.80	Clear	Clear
	C430-RP52420	AUTOMATIC RP	Y	13/09/2013 22:00	-6.20	Default alert	Clear
	C430-RP52421	AUTOMATIC RP	Y	18/09/2013 18:00	-14.00	Default alert	Default alert
	C430-RP52422	AUTOMATIC RP	Y	18/09/2013 18:00	-1.00	Clear	Clear
	C430-RP52423	AUTOMATIC RP	Y	18/09/2013 12:00	-31.60	Default alert	Default alert
25-27 FARRINGDON ROAD	C430-RP11001	AUTOMATIC RP	Y	10/05/2015 12:00	7	Clear	Clear
	C430-RP11002	AUTOMATIC RP	Y	10/05/2015 12:00	9.1	Default alert	Clear
	C430-RP11003	AUTOMATIC RP	Y	10/05/2015 12:00	7.7	Clear	Clear
	C430-RP11004	AUTOMATIC RP	Y	10/05/2015 12:00	4.9	Clear	Clear
	C430-RP11005	AUTOMATIC RP	Y	10/05/2015 12:00	3.6	Clear	Clear
	C430-RP11007	AUTOMATIC RP	Y	10/05/2015 12:00	5.1	Clear	Clear
	C430-RP11008	AUTOMATIC RP	Y	10/05/2015 12:00	3.8	Clear	Clear
	C430-RP11009	AUTOMATIC RP	Y	10/05/2015 12:00	5.7	Clear	Clear
	C430-RP11011	AUTOMATIC RP	Y	10/05/2015 12:00	6.5	Clear	Clear
	C430-RP11012	AUTOMATIC RP	Y	10/05/2015 12:00	7.7	Clear	Clear
	C430-RP11013	AUTOMATIC RP	Y	10/05/2015 12:00	8.7	Clear	Clear
	C430-RP11014	AUTOMATIC RP	Y	10/05/2015 12:00	7.8	Clear	Clear
	C430-RP11015	AUTOMATIC RP	Y	10/05/2015 12:00	3.3	Clear	Clear
	C430-RP11016	AUTOMATIC RP	Y	10/05/2015 12:00	4.8	Clear	Clear
	C430-RP11017	AUTOMATIC RP	Y	10/05/2015 12:00	5.2	Clear	Clear
	C430-RP11018	AUTOMATIC RP	Y	10/05/2015 12:00	5.8	Clear	Clear
	C430-RP11019	AUTOMATIC RP	Y	10/05/2015 12:00	2.9	Clear	Clear
	C430-RP11021	AUTOMATIC RP	Y	10/05/2015 12:00	5.2	Clear	Clear
	C430-RP11022	AUTOMATIC RP	Y	10/05/2015 12:00	7.8	Default alert	Clear
	C430-RP11023	AUTOMATIC RP	Y	10/05/2015 12:00	8.5	Clear	Clear
	C430-RP11024	AUTOMATIC RP	Y	10/05/2015 12:00	8.3	Clear	Clear
	C430-RP11025	AUTOMATIC RP	Y	10/05/2015 12:00	5.2	Clear	Clear
	C430-RP11026	AUTOMATIC RP	Y	10/05/2015 12:00	5	Clear	Clear
	C430-RP11027	AUTOMATIC RP	Y	10/05/2015 12:00	5.7	Clear	Clear
	C430-RP11028	AUTOMATIC RP	Y	10/05/2015 12:00	4.5	Clear	Clear
	C430-RP11029	AUTOMATIC RP	Y	10/05/2015 12:00	6.6	Default alert	Clear
	17-23 FARRINGDON ROAD	C430-RP12001	AUTOMATIC RP	Y	10/05/2015 12:00	5.1	Clear
C430-RP12002		AUTOMATIC RP	Y	10/05/2015 12:00	8.9	Clear	Clear
C430-RP12003		AUTOMATIC RP	Y	10/05/2015 12:00	7.8	Clear	Clear
C430-RP12004		AUTOMATIC RP	Y	10/05/2015 12:00	8.8	Clear	Clear
C430-RP12021		AUTOMATIC RP	Y	10/05/2015 12:00	8.6	Clear	Clear
C430-RP12022		AUTOMATIC RP	Y	10/05/2015 12:00	5.9	Clear	Clear
C430-RP12023		AUTOMATIC RP	Y	10/05/2015 12:00	6.8	Clear	Clear
C430-RP12024		AUTOMATIC RP	Y	10/05/2015 12:00	8	Clear	Clear
19 CHARTERHOUSE STREET	C430-RP13001	AUTOMATIC RP	Y	10/05/2015 12:00	17.7	Default alert	Default alert
	C430-RP13002	AUTOMATIC RP	Y	10/05/2015 12:00	19.7	Default alert	Default alert
	C430-RP13003	AUTOMATIC RP	Y	10/05/2015 12:00	19.2	Default alert	Default alert
	C430-RP13004	AUTOMATIC RP	Y	10/05/2015 12:00	15.9	Default alert	Default alert
	C430-RP13005	AUTOMATIC RP	Y	10/05/2015 12:00	6.8	Default alert	Clear
	C430-RP13006	AUTOMATIC RP	Y	10/05/2015 12:00	9.2	Default alert	Clear
	C430-RP13007	AUTOMATIC RP	Y	10/05/2015 12:00	2.7	Clear	Clear
	C430-RP13021	AUTOMATIC RP	Y	10/05/2015 12:00	18.6	Default alert	Default alert
	C430-RP13022	AUTOMATIC RP	Y	10/05/2015 12:00	17.5	Default alert	Default alert
	C430-RP13023	AUTOMATIC RP	Y	10/05/2015 12:00	14.4	Default alert	Default alert
	C430-RP13024	AUTOMATIC RP	Y	10/05/2015 12:00	14.6	Default alert	Default alert
	C430-RP13025	AUTOMATIC RP	Y	10/05/2015 12:00	17.8	Default alert	Default alert
	C430-RP13026	AUTOMATIC RP	Y	10/05/2015 12:00	14.1	Default alert	Default alert
	C430-RP13027	AUTOMATIC RP	Y	10/05/2015 12:00	9.6	Default alert	Clear

C435-BFK-C2-RGN-M123-51050

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL		
						WORST HISTORICAL STATUS	CURRENT STATUS	
Farrington Road - Rider Main	C430-RP52402	AUTOMATIC RP	Z	06/06/2013 12:00	2.4	Clear	Clear	
	C430-RP52408	AUTOMATIC RP	Z	18/09/2013 13:00	1.9	Clear	Clear	
	C430-RP52409	AUTOMATIC RP	Z	18/09/2013 13:00	2.4	Clear	Clear	
	C430-RP52410	AUTOMATIC RP	Z	18/09/2013 12:00	-5.2	Clear	Clear	
	C430-RP52411	AUTOMATIC RP	Z	13/08/2013 19:00	-4	Clear	Clear	
	C430-RP52412	AUTOMATIC RP	Z	18/09/2013 18:00	-3.2	Clear	Clear	
	C430-RP52413	AUTOMATIC RP	Z	18/09/2013 18:00	2.1	Clear	Clear	
	C430-RP52414	AUTOMATIC RP	Z	18/09/2013 18:00	-5.5	Clear	Clear	
	C430-RP52415	AUTOMATIC RP	Z	18/09/2013 18:00	-5.9	Clear	Clear	
	C430-RP52416	AUTOMATIC RP	Z	18/09/2013 18:00	-5.3	Clear	Clear	
	C430-RP52417	AUTOMATIC RP	Z	18/09/2013 18:00	-5.7	Clear	Clear	
	C430-RP52418	AUTOMATIC RP	Z	13/09/2013 22:00	-8	Clear	Clear	
	C430-RP52419	AUTOMATIC RP	Z	18/09/2013 18:00	-8.9	Default alert	Clear	
	C430-RP52420	AUTOMATIC RP	Z	18/09/2013 18:00	-25.4	GREEN	YELLOW	
	C430-RP52421	AUTOMATIC RP	Z	18/09/2013 12:00	-8.5	Clear	Clear	
	C430-RP52422	AUTOMATIC RP	Z	07/05/2015 12:00	-3	Clear	Clear	
	C430-RP52423	AUTOMATIC RP	Z	07/05/2015 12:00	-27.6	GREEN	YELLOW	
	25-27 FARRINGTON ROAD	C430-RP11001	AUTOMATIC RP	Z	10/05/2015 12:00	-2.1	Clear	Clear
		C430-RP11002	AUTOMATIC RP	Z	10/05/2015 12:00	-2.2	Clear	Clear
		C430-RP11003	AUTOMATIC RP	Z	10/05/2015 12:00	-1.8	Clear	Clear
C430-RP11004		AUTOMATIC RP	Z	10/05/2015 12:00	-2.8	Clear	Clear	
C430-RP11005		AUTOMATIC RP	Z	10/05/2015 12:00	-4.5	Clear	Clear	
C430-RP11007		AUTOMATIC RP	Z	10/05/2015 12:00	-4.4	Clear	Clear	
C430-RP11008		AUTOMATIC RP	Z	10/05/2015 12:00	-3.5	Clear	Clear	
C430-RP11009		AUTOMATIC RP	Z	10/05/2015 12:00	-2	Clear	Clear	
C430-RP11011		AUTOMATIC RP	Z	10/05/2015 12:00	-2.8	Clear	Clear	
C430-RP11012		AUTOMATIC RP	Z	10/05/2015 12:00	-1.1	Clear	Clear	
C430-RP11013		AUTOMATIC RP	Z	10/05/2015 12:00	-1.4	Clear	Clear	
C430-RP11014		AUTOMATIC RP	Z	10/05/2015 12:00	-3.5	Clear	Clear	
C430-RP11015		AUTOMATIC RP	Z	10/05/2015 12:00	-4	Clear	Clear	
C430-RP11016		AUTOMATIC RP	Z	10/05/2015 12:00	-4.4	Clear	Clear	
C430-RP11017		AUTOMATIC RP	Z	10/05/2015 12:00	-5.1	Clear	Clear	
C430-RP11018		AUTOMATIC RP	Z	10/05/2015 12:00	-3.2	Clear	Clear	
C430-RP11019		AUTOMATIC RP	Z	10/05/2015 12:00	-1.1	Clear	Clear	
C430-RP11021		AUTOMATIC RP	Z	10/05/2015 12:00	-1.9	Clear	Clear	
C430-RP11022		AUTOMATIC RP	Z	10/05/2015 12:00	0	Clear	Clear	
C430-RP11023		AUTOMATIC RP	Z	10/05/2015 12:00	0.1	Clear	Clear	
C430-RP11024	AUTOMATIC RP	Z	10/05/2015 12:00	-1	Clear	Clear		
C430-RP11025	AUTOMATIC RP	Z	10/05/2015 12:00	-3.4	Clear	Clear		
C430-RP11026	AUTOMATIC RP	Z	10/05/2015 12:00	-5.2	Clear	Clear		
C430-RP11027	AUTOMATIC RP	Z	10/05/2015 12:00	-4.6	Clear	Clear		
C430-RP11028	AUTOMATIC RP	Z	10/05/2015 12:00	-2.6	Clear	Clear		
C430-RP11029	AUTOMATIC RP	Z	10/05/2015 12:00	-0.9	Clear	Clear		
17-23 FARRINGTON ROAD	C430-RP12001	AUTOMATIC RP	Z	10/05/2015 12:00	-6.5	Clear	Clear	
	C430-RP12002	AUTOMATIC RP	Z	10/05/2015 12:00	-7.2	Clear	Clear	
	C430-RP12003	AUTOMATIC RP	Z	10/05/2015 12:00	-5.8	Clear	Clear	
	C430-RP12004	AUTOMATIC RP	Z	10/05/2015 12:00	-4.7	Clear	Clear	
	C430-RP12021	AUTOMATIC RP	Z	10/05/2015 12:00	-4.7	Clear	Clear	
	C430-RP12022	AUTOMATIC RP	Z	10/05/2015 12:00	-4.6	Clear	Clear	
C430-RP12023	AUTOMATIC RP	Z	10/05/2015 12:00	-3.1	Clear	Clear		
C430-RP12024	AUTOMATIC RP	Z	10/05/2015 12:00	-1.4	Clear	Clear		
19 CHARTERHOUSE STREET	C430-RP13001	AUTOMATIC RP	Z	10/05/2015 12:00	5.3	Clear	Clear	
	C430-RP13002	AUTOMATIC RP	Z	10/05/2015 12:00	5.6	Clear	Clear	
	C430-RP13003	AUTOMATIC RP	Z	10/05/2015 12:00	1.2	Clear	Clear	
	C430-RP13004	AUTOMATIC RP	Z	10/05/2015 12:00	1.1	Clear	Clear	
	C430-RP13005	AUTOMATIC RP	Z	10/05/2015 12:00	-2	Clear	Clear	
	C430-RP13006	AUTOMATIC RP	Z	10/05/2015 12:00	0	Clear	Clear	
	C430-RP13007	AUTOMATIC RP	Z	10/05/2015 12:00	-1.6	Clear	Clear	
	C430-RP13021	AUTOMATIC RP	Z	10/05/2015 12:00	3.1	Clear	Clear	
	C430-RP13022	AUTOMATIC RP	Z	10/05/2015 12:00	3.2	Clear	Clear	
	C430-RP13023	AUTOMATIC RP	Z	10/05/2015 12:00	2.7	Clear	Clear	
	C430-RP13024	AUTOMATIC RP	Z	10/05/2015 12:00	2.7	Clear	Clear	
	C430-RP13025	AUTOMATIC RP	Z	10/05/2015 12:00	2	Clear	Clear	
	C430-RP13026	AUTOMATIC RP	Z	10/05/2015 12:00	-0.4	Clear	Clear	
	C430-RP13027	AUTOMATIC RP	Z	10/05/2015 12:00	-0.9	Clear	Clear	

\*Isolated peak reading

\*Isolated peak reading

Learning

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

- 3D Target C430-RP11006 was covered after installation, being blocked the visual from any ATS.
- 3D Targets C430-RP52406 and C430-RP52407 were never read due to the lack of visual from any ATS.

### **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 STW1 and STW3 and the excavation of SH-W2 shaft, the maximum measured settlement and horizontal movement in X and Y directions for these 3D Targets remain less than the expected.

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

Learning Legacy Document



Close-Out Report – Automated Total Station at 20 Farringdon  
Road (ATS 51) and 3D Targets read by ATS 51

**GEOCISA UK**

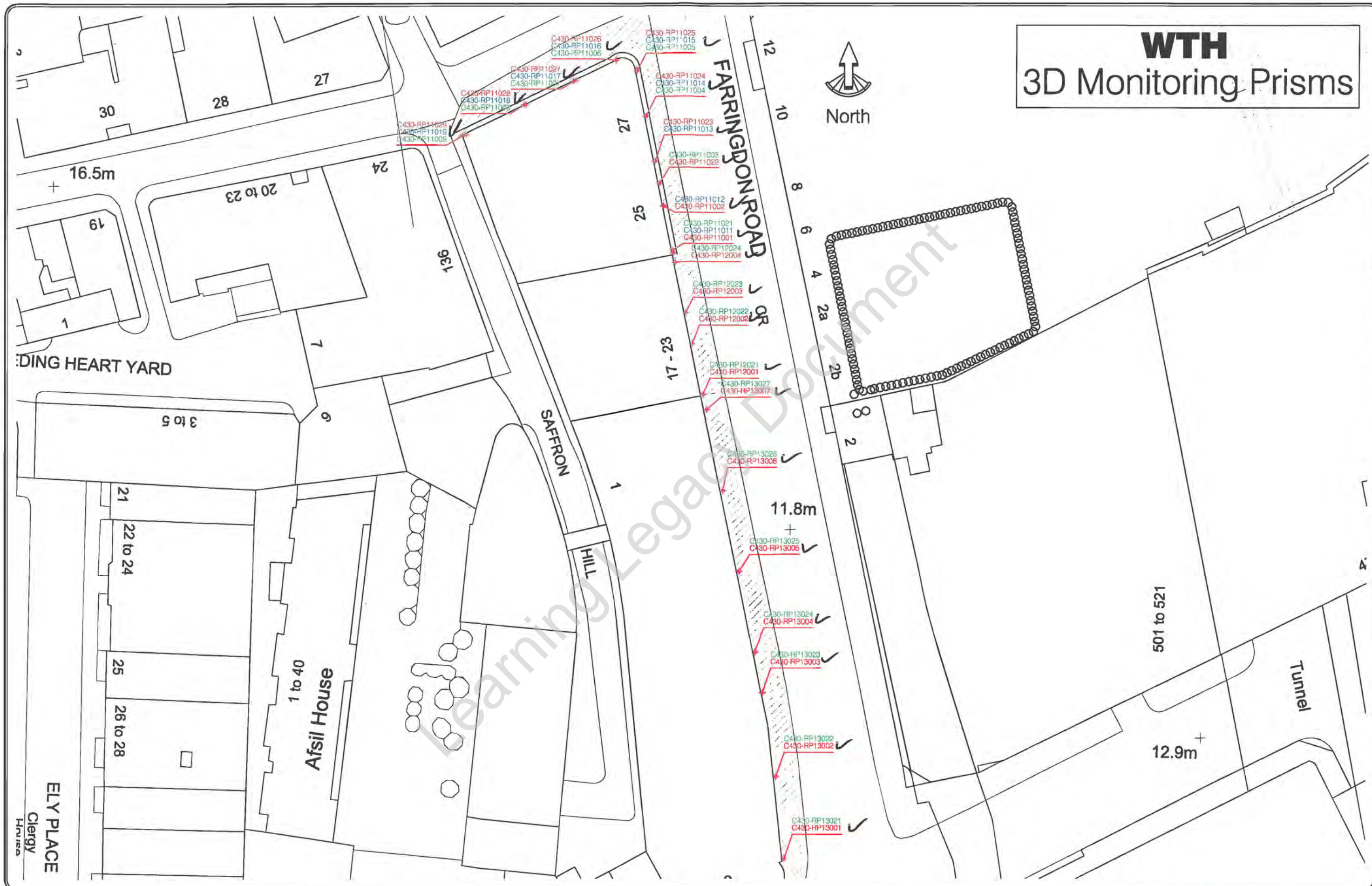
C435-BFK-C2-RGN-M123-51050

Learning Legacy Document

## **Appendix A: Drawings / Photomontages**



# WTH 3D Monitoring Prisms



**UK Head Office**  
 8 Bournemouth Square,  
 London, EC4M 6YF  
 Phone: 020 2178 6644  
 Fax: 020 2178 6648  
 london@murphysurveys.co.uk  
 www.murphysurveys.co.uk

**Luton Office**  
 Unit 721,  
 Capability Green Business Park,  
 Luton,  
 Bedfordshire,  
 LU1 2LJ  
 Phone: 01525 466000  
 Fax: 01525 736409  
 luton@murphysurveys.co.uk

**Head Office**  
 Global House  
 Phone: (+353) 043 883402  
 Fax: (+353) 043 883400  
 Email: info@murphysurveys.ie  
 Cork  
 Phone: (+353) 091 4883700  
 Fax: (+353) 091 4366000  
 Email: cork@murphysurveys.ie

**LEGEND**

- Monitoring Prisms at Higher Level
- Monitoring Prisms at Mid Level
- Monitoring Prisms at Lower Level

**London HSE/CDM**  
 LONDON HSE/CDM fee supplied by client  
 LONDON SURVEY/GRD fee supplied by client

**Geodata**

**Supply-Line**

**Project Information**

Scale: 1:500	Date: 23/08/2012
Drawn by: [Name]	Checked by: [Name]
Project No: [Number]	Sheet No: [Number]

**murphy**  
 GLOBAL CONSULTING SURVEYORS  
 London Belfast Kildare Cork

**GEODATA**

**Client:**  
 LAING O'Rourke Strabag Joint Venture

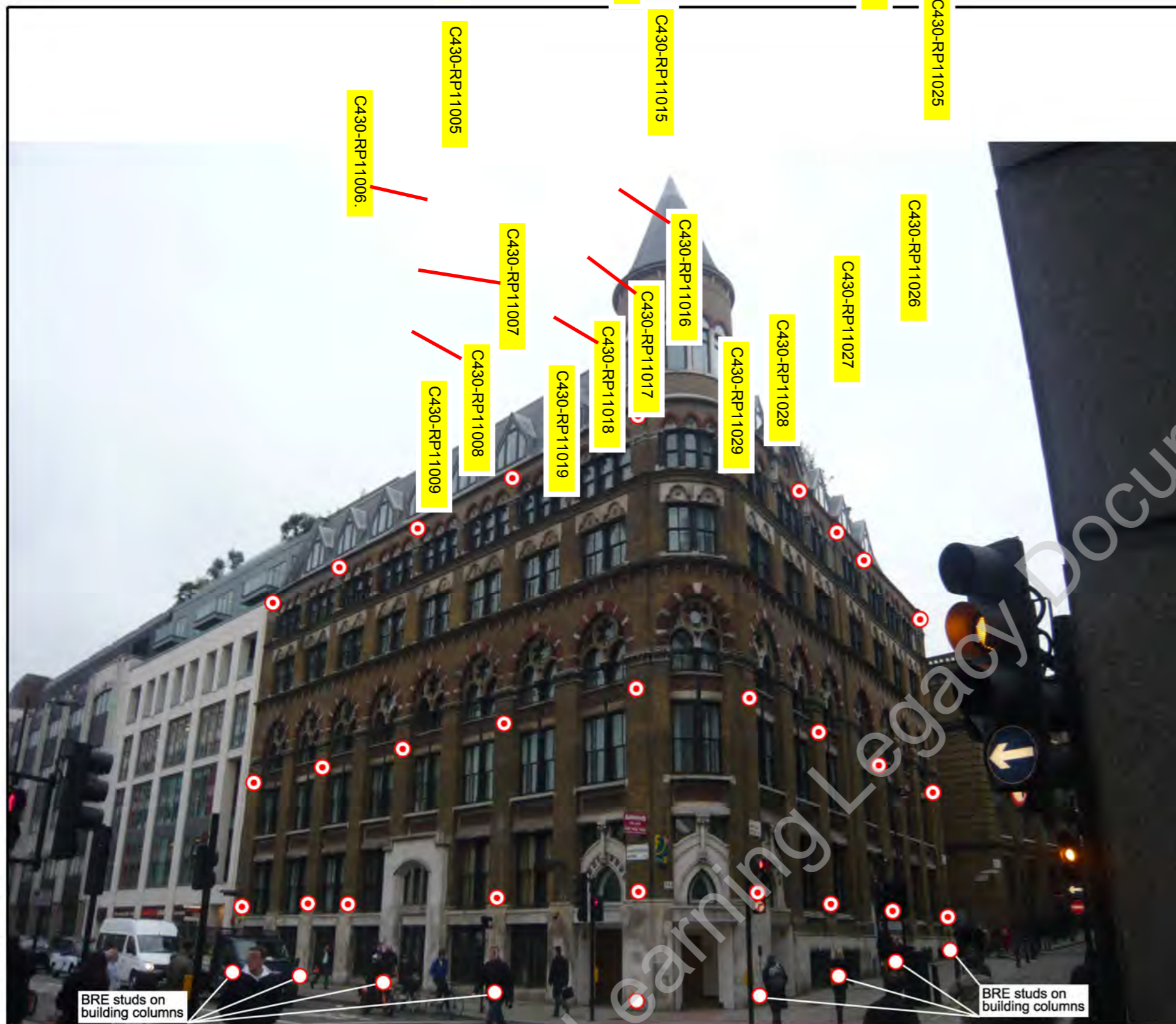
**Project:**  
 C430 - Instrumentation & Monitoring

**Date:** 23/08/2012 **Scale:** 1:500 @ A3

**Description:**  
 3D - WTH - 19-27 FARRINGDON ROAD

**Drawing Number:** MSL4100-S-WTH-3D-2






**External Monitoring Instrumentation**

Monitoring type	Number of Instruments	Fixings per instrument	Fixing details by C430	Making good strategy by C435
BRE Levelling Studs	9	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	28	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.
Vibrating Wire Crackmeters	3	2, with transmitter box with up to 4	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10 mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box, with screw fixings.	Crackmeters and receiver box will be removed, and recessed fixing areas 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.



**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-30830

**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.

- 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.
  - Vibrating Wire Crackmeters to be installed at selected cracks encountered on site, with the agreement of the Supervisor, at the time of installation.

Rev.	Date	Description	By	Chkd	App	Auth
P01	20/04/2011	First Issue	MK	CC		
P02	13/05/2011	---	MK	CC	RM	
P03	27/05/2011	Issued as per note 1	MK	PC	PC	
P04	22/07/2011	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

Scale : NTS @ A3

Contract : Bored Tunnels (Alignment and Track)

Originator : Ove Arup & Partners Limited

Location : Crossrail General

Title : Proposed Building Instrumentation  
Farringdon Station  
25-27 Farringdon Road MDC2\_00329 1 of 2

Drg No : C122-OVE-C2-DDJ-CR001\_Z-39602

Rev : C01 Suit : A

By : [REDACTED]  
 Chk : [REDACTED]  
 App : [REDACTED]  
 Auth : [REDACTED]





**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	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	3	2, with transmitter box with up to 4	Attached by screws with movable ball joints into slightly recessed shell anchor fixings approximately 10 mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box, with screw fixings.	Crackmeters and receiver box will be removed, and recessed fixing areas made good with materials to match the existing façade finish.

C430-RP-12024

**Internal Monitoring Instrumentation**

Internal monitoring not required

**Legend**

- Geodetic Prism
- BRE Levelling Stud
- Vibrating Wire Crackmeter



**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.



**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.
- 5) Vibrating Wire Crackmeters to be installed at selected cracks encountered on site, with the agreement of the Supervisor, at the time of installation.

**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	20/04/2011	First Issue	MK	CC		
P02	13/05/2011	---	MK	CC	-	
P03	19/05/2011	---	MK	CC	RM	
P04	27/05/2011	Issued as per note 1	MK	PC	PC	
P05	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

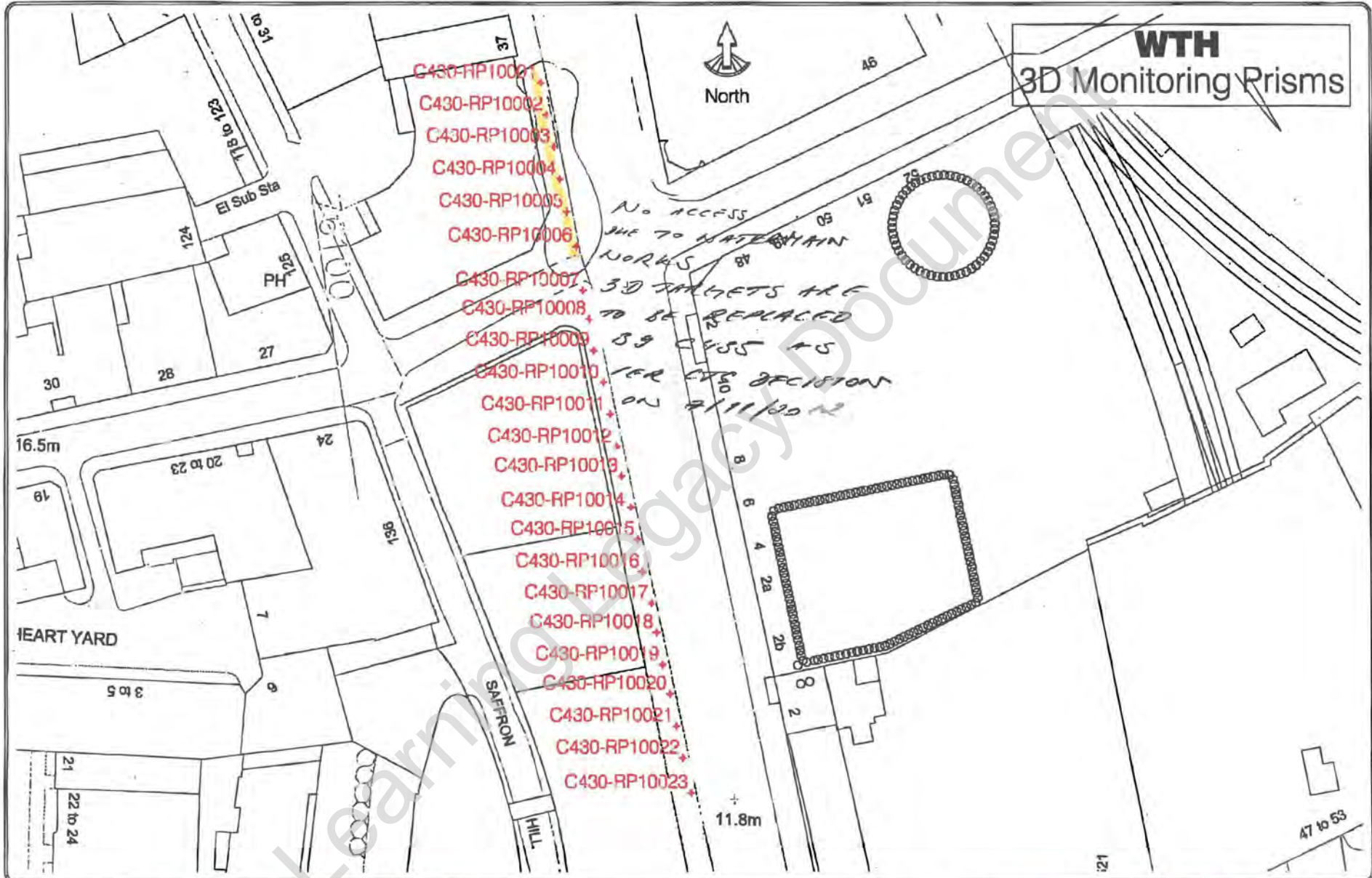
Contract : Bored Tunnels (Alignment and Track)	
Originator : Ove Arup & Partners Limited	
Location : Crossrail General	
Title : Proposed Building Instrumentation Farringdon Station 17-23 Farringdon Road MDC2_01896	By : [Redacted] Chk : [Redacted] App : [Redacted] Auth : [Redacted]
Scale : NTS @ A3	Drg No : C122-OVE-C2-DDJ-CR001_Z-39606 Rev : C01 Suit : A Auth : [Redacted]







12/23



**WTH**  
3D Monitoring Prisms

No ACCESS  
due to WATER MAIN  
WORKS  
3D TARGETS ARE  
TO BE REPLACED  
BY CIVS AS  
PER CTS DECISION  
ON 9/11/2012

- C430-RP10001
- C430-RP10002
- C430-RP10003
- C430-RP10004
- C430-RP10005
- C430-RP10006
- C430-RP10007
- C430-RP10008
- C430-RP10009
- C430-RP10010
- C430-RP10011
- C430-RP10012
- C430-RP10013
- C430-RP10014
- C430-RP10015
- C430-RP10016
- C430-RP10017
- C430-RP10018
- C430-RP10019
- C430-RP10020
- C430-RP10021
- C430-RP10022
- C430-RP10023

<b>Site Visit Officer</b> Name: [blank] Phone: [blank] Email: [blank]	<b>Site Visit Officer</b> Name: [blank] Phone: [blank] Email: [blank]	<b>Scale</b> 1:1000
--	--	------------------------

Monitoring Prisms on Farmington Road Footpath  
Devices named in this report as C430-RP524XX

<b>Client</b> WTH	<b>Project</b> 3D - WTH - Farmington Road Footpath
<b>Date</b> [blank]	<b>Scale</b> 1:1000



<b>Client</b> LAND O'ROUSE STRAWG JOINT VENTURE
<b>Project</b> C430 - Instruments/Prisms & Monitoring
<b>Date</b> 20/02/12
<b>Scale</b> 1:1000 @ A3
<b>Drawn</b> 3D - WTH - FARMINGTON ROAD FOOTPATH
<b>Checked</b> [blank]



Close-Out Report – Automated Total Station at 20 Farringdon  
Road (ATS 51) and 3D Targets read by ATS 51

**GEOCISA UK**

C435-BFK-C2-RGN-M123-51050

Learning Legacy Document

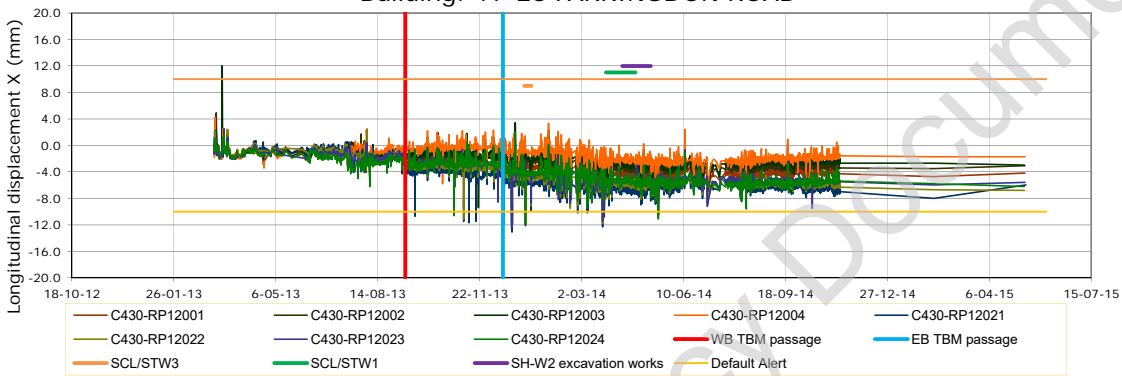
## **Appendix B: Graphs**



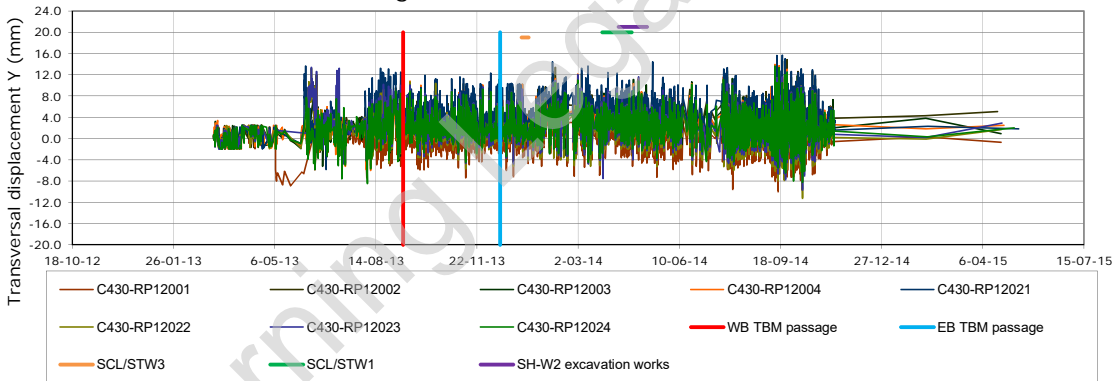
REPORT Automatic Prisms  
 AREA Farringdon Station  
 DEVICE 3D Target



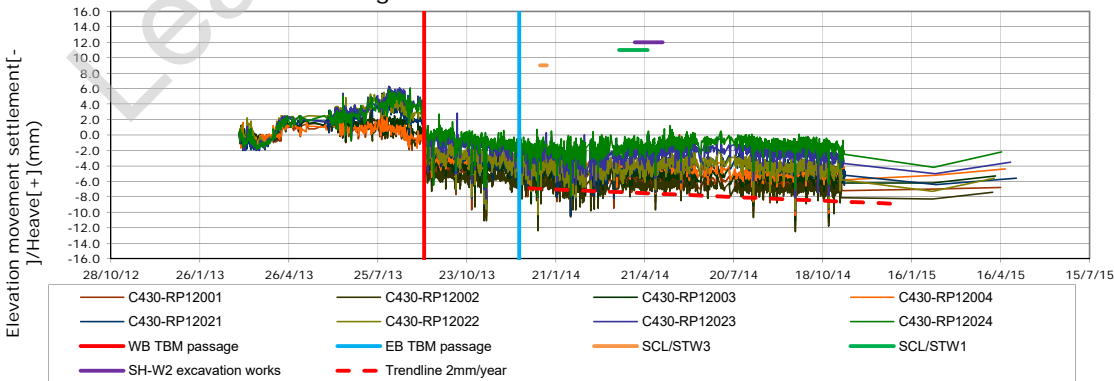
Building: 17-23 FARRINGDON ROAD



Building: 17-23 FARRINGDON ROAD



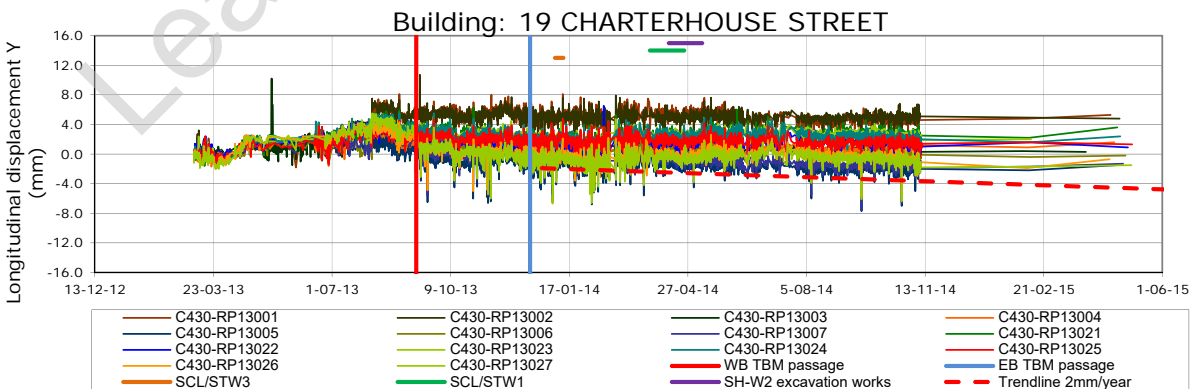
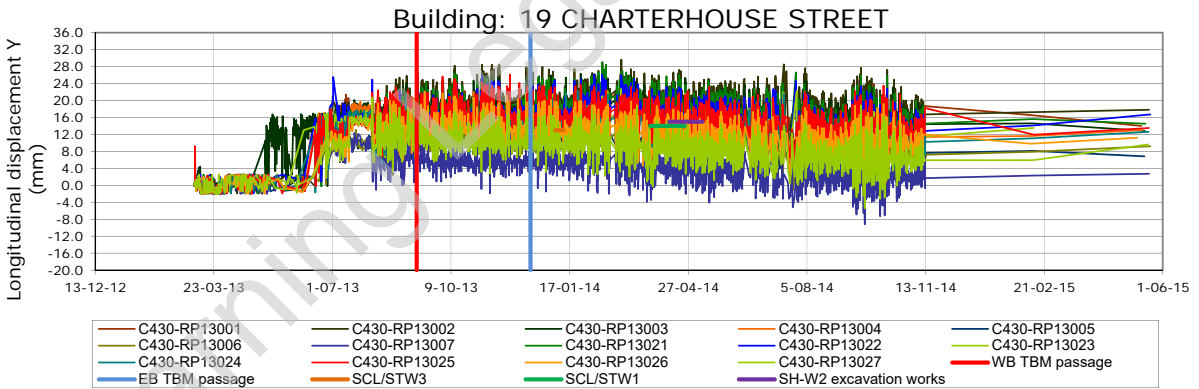
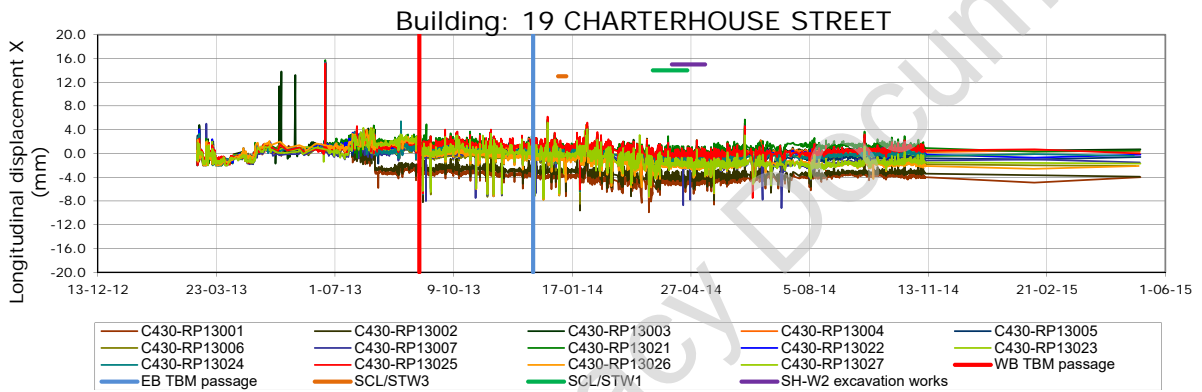
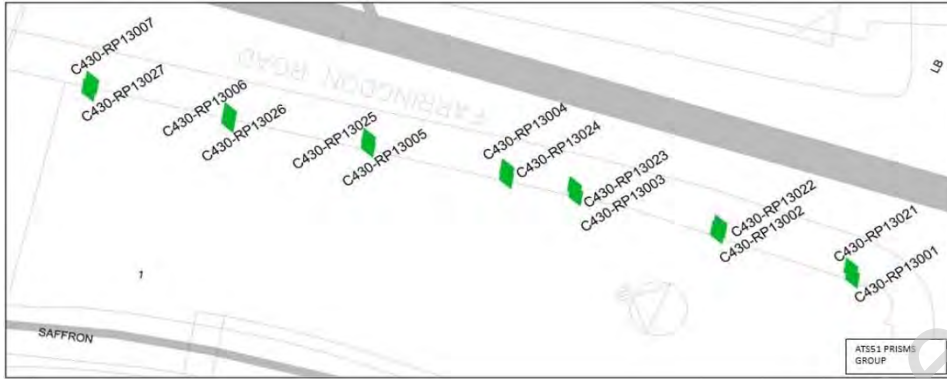
Building: 17-23 FARRINGDON ROAD



REMARKS:

20-02-2014: Gap in the readings due to software issues  
 Baseline done by C430. First reading from C435 was done at 07-02-2013 (handover date) keeping C430's historical data.  
 The jump in the data is because we start to work with the global Network.

REPORT Automatic Prisms  
 AREA Farringdon Station  
 DEVICE 3D Target



**REMARKS:**

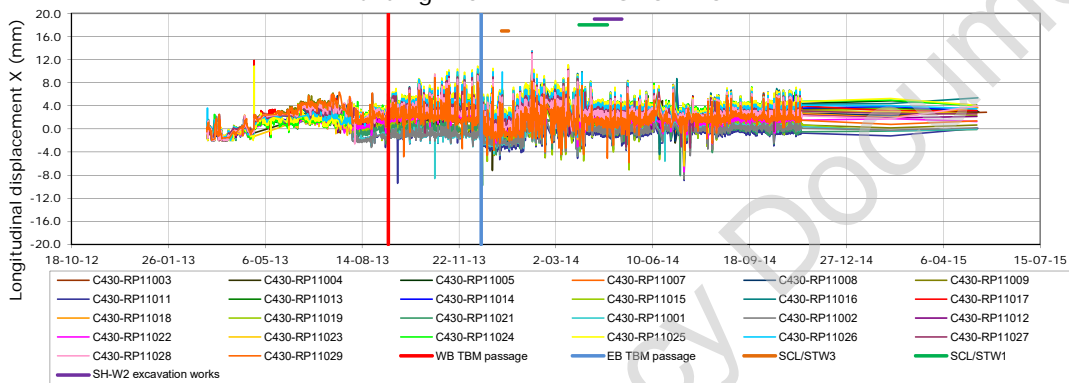
The jump in the data is because we start to work with the global Network.



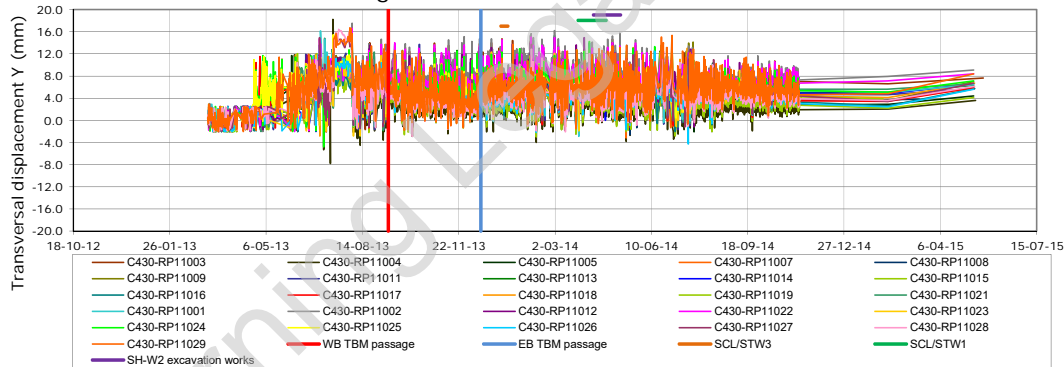
REPORT Automatic Prisms  
 AREA Farringdon Station  
 DEVICE 3D Target



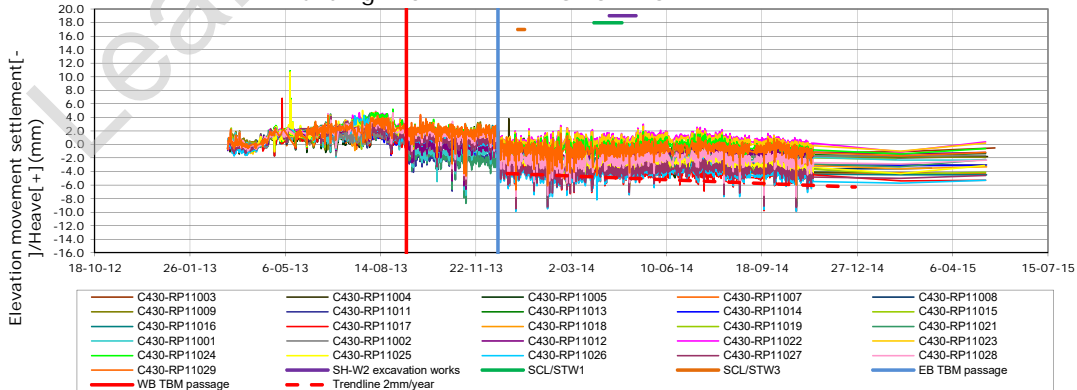
Building: 25-27 FARRINGDON ROAD



Building: 25-27 FARRINGDON ROAD



Building: 25-27 FARRINGDON ROAD



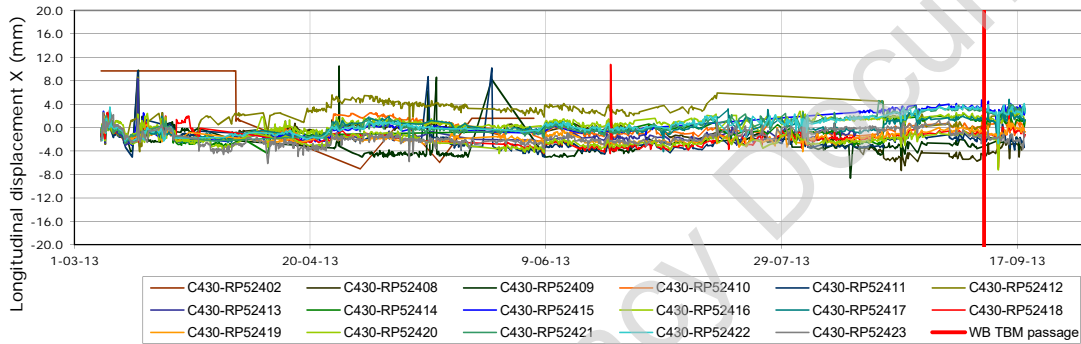
**REMARKS:**

01-09-2013: Prisms C430-RP19001, C430-RP19004 and C430-RP19005 are covered.  
 18-02-2014: ATS 52 is being calibrating. Readings will be recovered  
 20-02-2014: Gap in the readings due to software issues  
 Baseline done by C430. First reading from C435 was done at 07-02-2013 (handover date) keeping C430's historical data.  
 The jump in the data is because we start to work with the global Network.

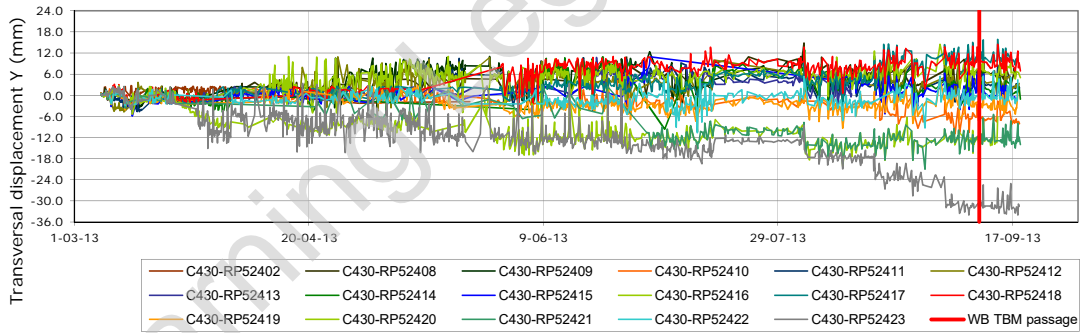
REPORT Automatic Prisms  
 AREA Farringdon Station  
 DEVICE 3D Target



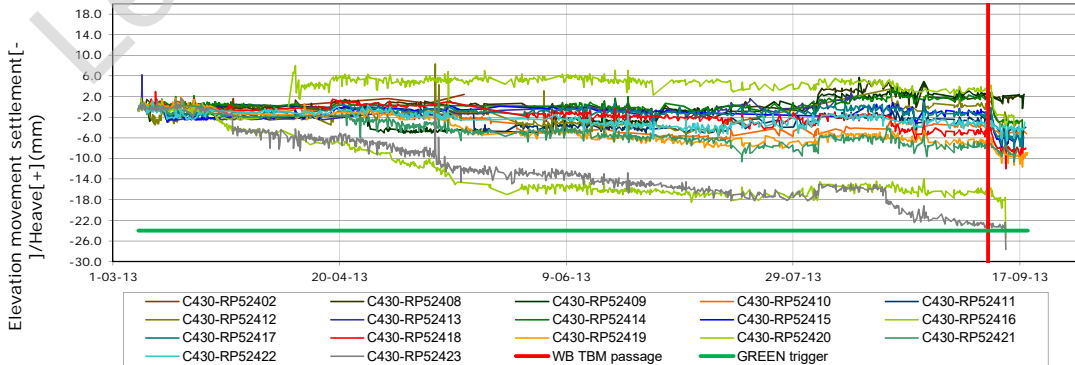
Building: FARRINGDON RD. RIDER MAIN



Building: FARRINGDON RD. RIDER MAIN



Building: FARRINGDON RD. RIDER MAIN



**REMARKS:**

01-09-2013: Prisms C430-RP19001, C430-RP19004 and C430-RP19005 are covered.  
 Baseline done by C430. First reading from C435 was done at 07-02-2013 (handover date) keeping C430's historical data.  
 The last reading for these prisms was on 17-03-2013 because the structure where the prisms were installed was remove.