



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 23 and 3D Targets read by ATS 23.

**CRL Document Number: C435-BFK-C2-RGN-M123-51615**

Supplier Document Number: N/A

Contract MDL reference C13.012

### 1. Contractor Document Submittal History:

Revision:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
1.0	17-09-2015	[REDACTED]	[REDACTED]	[REDACTED]	For acceptance
2.0	13-11-2015	[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
			compliance with their contractual obligations and does not constitute ds or materials developed or selected by the designer/supplier.		<input type="checkbox"/>
		[REDACTED]			<input type="checkbox"/>
				07/12/2015	<input type="checkbox"/>

### 3. Acceptance by Crossrail:

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## 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 Grand Avenue area, consisting 3D Targets read by ATS 23 and 1No. Automated Total Station (ATS 23) located in the Grand Avenue. See table 1 below with details.

ATS 23 CODE	LOCATION	COORDINATES	
		X (m)	Y (m)
C435-AT00023	Smithfield Market Grand Avenue	82191.0112	36470.3555

PRISM CODE	LOCATION	COORDINATES	
		X (m)	Y (m)
C435-RP02301	Grand Avenue	82179.0319	36488.3389
C435-RP02302	Grand Avenue	82173.344	36485.4179
C435-RP02303	Grand Avenue	82168.6437	36483.0099
C435-RP02304	Grand Avenue	82166.5486	36482.0321
C435-RP02305	Grand Avenue	82177.0206	36492.4434
C435-RP02306	Grand Avenue	82171.3676	36489.5323
C435-RP02307	Grand Avenue	82166.6072	36487.1243
C435-RP02308	Grand Avenue	82164.4901	36486.0947
C435-RP02320	Grand Avenue	82174.887	36496.4062
C435-RP02321	Grand Avenue	82167.6906	36497.9078
C435-RP02322	Grand Avenue	82164.5105	36491.1181
C435-RP02323	Grand Avenue	82162.42	36490.138
C435-RP02324	Grand Avenue	82172.7996	36500.4895
C435-RP02325	Grand Avenue	82167.6905	36497.9078
C435-RP02326	Grand Avenue	82162.4207	36495.25
C435-RP02327	Grand Avenue	82160.3251	36494.2682
C435-RP02328	Grand Avenue	82180.7082	36489.2033
C435-RP02329	Grand Avenue	82178.1725	36493.0434
C435-RP02330	Grand Avenue	82176.0366	36497.0653
C435-RP02331	Grand Avenue	82173.9468	36501.1479

Table 1: Details 3D Targets read by ATS 23 and ATS 23.

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 09/09/2015.

These prisms read by ATS 23 and the ATS 23 itself are shown in the following documents:

Drawings:

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

Installation Reports:

- C435-BFK-C2-RGN-M123-50022
- C435-BFK-C2-RGN-M123-50068

## 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 23 and 3D Targets read by ATS 23.

## 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
Moorgate Spur Shaft No. 1 TAM Installation	08/07/2013	20/08/2013
Moorgate Spur Shaft No. 1 Pre-Treatment works	19/08/2013	15/09/2013
WB TBM passage	30/09/2013	04/10/2013
SCL-PTW enlargement	24/07/2014	06/10/2014

#### C.1.2 Resulting Movements

- Grand Avenue:  
WB TBM passage caused around 4mm settlement and SCL-PTW enlargement works around 3mm. Almost 5mm heave recorded during the TAM installation and 2.5mm because of the Pre-Treatment works carried out from Moorgate Spur Shaft No.1.  
From March 2014 to November 2014, compensation grouting works were carried out from Moorgate Spur No.1 in line with PTW enlargement works undertaken at the same time.

### 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-M123-51615

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
GRAND AVENUE	C435-RP02301	AUTOMATIC RP	Settlement	09/09/2015 11 00	-2.00	Clear	Clear
	C435-RP02302	AUTOMATIC RP	Settlement	09/09/2015 11 00	-2.10	Clear	Clear
	C435-RP02303	AUTOMATIC RP	Settlement	09/09/2015 11 00	-2.50	Clear	Clear
	C435-RP02304	AUTOMATIC RP	Settlement	09/09/2015 11 00	-1.60	Clear	Clear
	C435-RP02305	AUTOMATIC RP	Settlement	09/09/2015 11 00	-2.30	Clear	Clear
	C435-RP02306	AUTOMATIC RP	Settlement	09/09/2015 11 00	-2.80	Clear	Clear
	C435-RP02307	AUTOMATIC RP	Settlement	09/09/2015 11 00	-3.40	Clear	Clear
	C435-RP02308	AUTOMATIC RP	Settlement	09/09/2015 11 00	-1.70	Clear	Clear
	C435-RP02320	AUTOMATIC RP	Settlement	09/09/2015 11 00	-3.70	Clear	Clear
	C435-RP02321	AUTOMATIC RP	Settlement	09/09/2015 11 00	-5.60	Clear	Clear
	C435-RP02322	AUTOMATIC RP	Settlement	09/09/2015 11 00	-1.90	Clear	Clear
	C435-RP02323	AUTOMATIC RP	Settlement	09/09/2015 11 00	-3.70	Clear	Clear
	C435-RP02324	AUTOMATIC RP	Settlement	09/09/2015 11 00	-6.40	Clear	Clear
	C435-RP02325	AUTOMATIC RP	Settlement	09/09/2015 11 00	-5.80	Clear	Clear
	C435-RP02326	AUTOMATIC RP	Settlement	09/09/2015 11 00	-6.00	Clear	Clear
	C435-RP02327	AUTOMATIC RP	Settlement	09/09/2015 11 00	-5.70	Clear	Clear
	C435-RP02328	AUTOMATIC RP	Settlement	09/09/2015 11 00	-6.00	Clear	Clear
	C435-RP02329	AUTOMATIC RP	Settlement	09/09/2015 11 00	-3.50	Clear	Clear
	C435-RP02330	AUTOMATIC RP	Settlement	09/09/2015 11 00	-5.30	Clear	Clear
	C435-RP02331	AUTOMATIC RP	Settlement	09/09/2015 11 00	-7.90	Clear	Clear
GRAND AVENUE	C435-RP02301	AUTOMATIC RP	Transversal	09/09/2015 11 00	-2.41	Clear	Clear
	C435-RP02302	AUTOMATIC RP	Transversal	09/09/2015 11 00	2.03	Clear	Clear
	C435-RP02303	AUTOMATIC RP	Transversal	09/09/2015 11 00	1.42	Clear	Clear
	C435-RP02304	AUTOMATIC RP	Transversal	09/09/2015 11 00	-0.82	Clear	Clear
	C435-RP02305	AUTOMATIC RP	Transversal	09/09/2015 11 00	-2.05	Clear	Clear
	C435-RP02306	AUTOMATIC RP	Transversal	09/09/2015 11 00	2.28	Clear	Clear
	C435-RP02307	AUTOMATIC RP	Transversal	09/09/2015 11 00	1.65	Clear	Clear
	C435-RP02308	AUTOMATIC RP	Transversal	09/09/2015 11 00	-0.06	Clear	Clear
	C435-RP02320	AUTOMATIC RP	Transversal	09/09/2015 11 00	-3.66	Clear	Clear
	C435-RP02321	AUTOMATIC RP	Transversal	09/09/2015 11 00	1.95	Clear	Clear
	C435-RP02322	AUTOMATIC RP	Transversal	09/09/2015 11 00	-0.14	Clear	Clear
	C435-RP02323	AUTOMATIC RP	Transversal	09/09/2015 11 00	0.57	Clear	Clear
	C435-RP02324	AUTOMATIC RP	Transversal	09/09/2015 11 00	-3.34	Clear	Clear
	C435-RP02325	AUTOMATIC RP	Transversal	09/09/2015 11 00	2.26	Clear	Clear
	C435-RP02326	AUTOMATIC RP	Transversal	09/09/2015 11 00	2.49	Clear	Clear
	C435-RP02327	AUTOMATIC RP	Transversal	09/09/2015 11 00	0.96	Clear	Clear
	C435-RP02328	AUTOMATIC RP	Transversal	09/09/2015 11 00	-3.50	Clear	Clear
	C435-RP02329	AUTOMATIC RP	Transversal	09/09/2015 11 00	-2.50	Clear	Clear
	C435-RP02330	AUTOMATIC RP	Transversal	09/09/2015 11 00	-4.40	Clear	Clear
	C435-RP02331	AUTOMATIC RP	Transversal	09/09/2015 11 00	-4.20	Clear	Clear
GRAND AVENUE	C435-RP02301	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	1.66	Clear	Clear
	C435-RP02302	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-1.58	Clear	Clear
	C435-RP02303	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-1.84	Clear	Clear
	C435-RP02304	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-2.28	Clear	Clear
	C435-RP02305	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	1.93	Clear	Clear
	C435-RP02306	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-1.03	Clear	Clear
	C435-RP02307	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-1.40	Clear	Clear
	C435-RP02308	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-2.10	Clear	Clear
	C435-RP02320	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	1.85	Clear	Clear
	C435-RP02321	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-0.77	Clear	Clear
	C435-RP02322	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-1.16	Clear	Clear
	C435-RP02323	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-2.42	Clear	Clear
	C435-RP02324	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	2.92	Clear	Clear
	C435-RP02325	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-3.00	Clear	Clear
	C435-RP02326	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-2.39	Clear	Clear
	C435-RP02327	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	-3.18	Clear	Clear
	C435-RP02328	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	1.70	Clear	Clear
	C435-RP02329	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	1.80	Clear	Clear
	C435-RP02330	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	1.60	Clear	Clear
	C435-RP02331	AUTOMATIC RP	Longitudinal	09/09/2015 11 00	2.10	Clear	Clear

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

- No issues recorded in any of the devices included in this document

### **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 TBMs passage and the SCL enlargement of PTW, the maximum measured settlement for these 3D Targets has been around 8mm, being the maximum horizontal movement recorded in longitudinal and transversal directions of -3.18mm and -3.66mm.

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



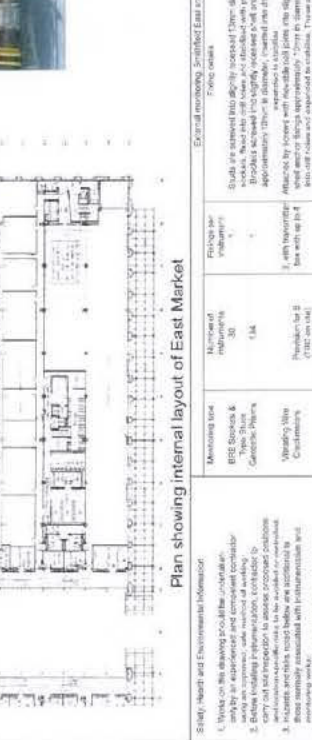
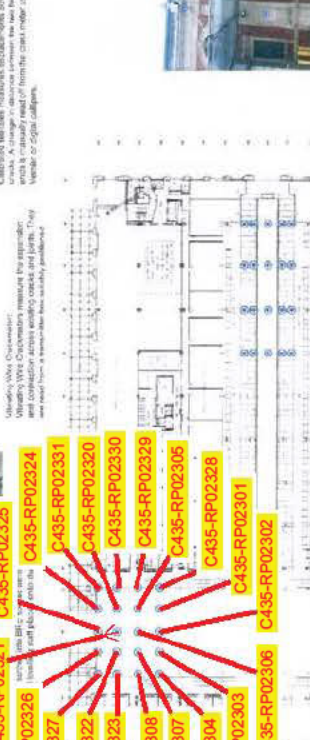
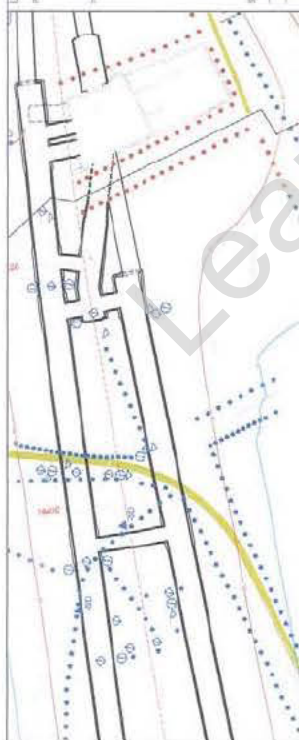
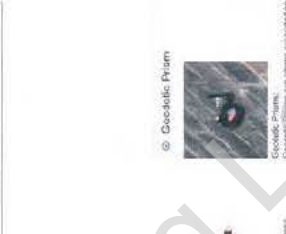
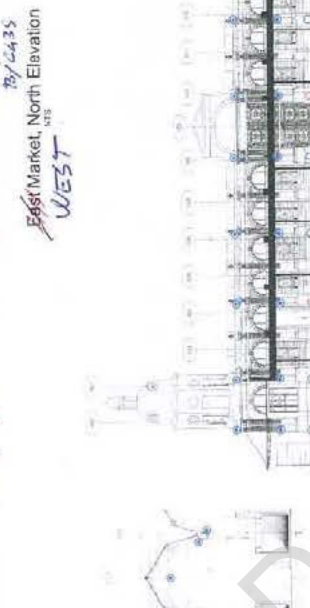
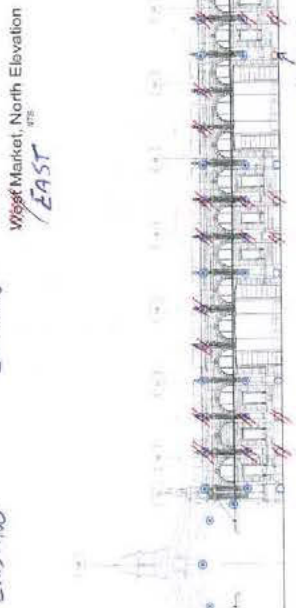
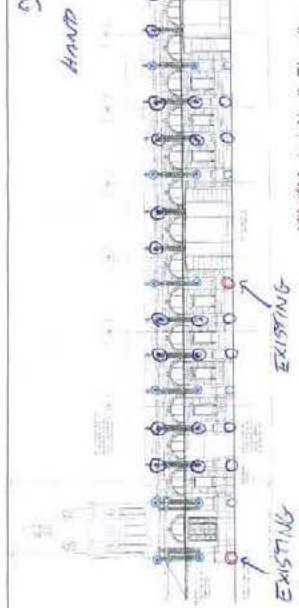
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**Appendix A: Drawings / Photomontages**





10 July 2012  
HAND MARK-UP BY CIZZ



**Legend**

Particulars Responsible for the installation of the (A & B)

- 1. C435
- 2. Offices
- 3. Automatic Total Station
- 4. Electronic Level
- 5. Inclinometer
- 6. Recorder - Storage of Data
- 7. 3D Coordinate System
- 8. Scales - BSE Type - Structure
- 9. Tripod
- 10. Bubble Level
- 11. Spirit Level
- 12. Total Station
- 13. Tripod
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**Plan at Street Level (Showing studs only)**

1. BRE Levelling Staff

2. Verifying Wire Cracometer

3. Calibrated Tell Tale

4. Concrete Prism

5. Concrete Prism

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**Typical Arrangement**

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**Plan showing internal layout of East Market**

1. Safety, Health and Environmental Management

2. Work on the existing structure

3. Existing structure

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**Plan showing internal layout of East Market (continued)**

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**Appendix B: Graphs**

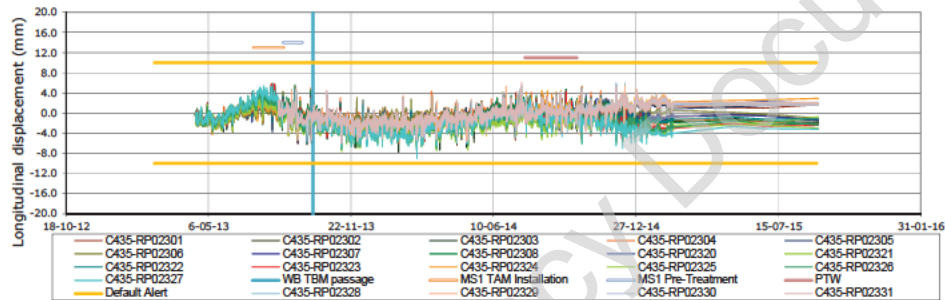


**GEOCISA UK**

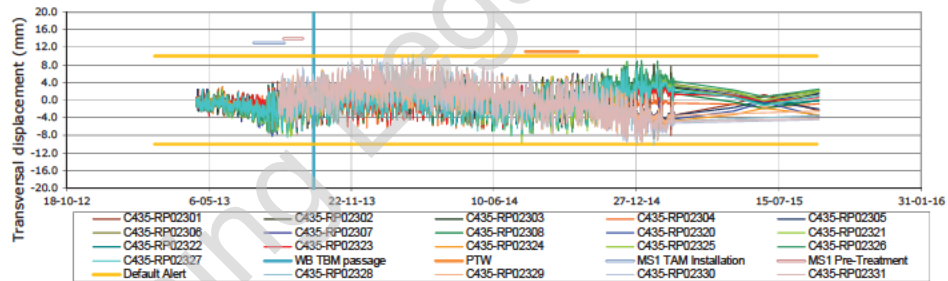
REPORT Automatic Prisms  
 AREA Farringdon Station  
 DEVICE 3D Target



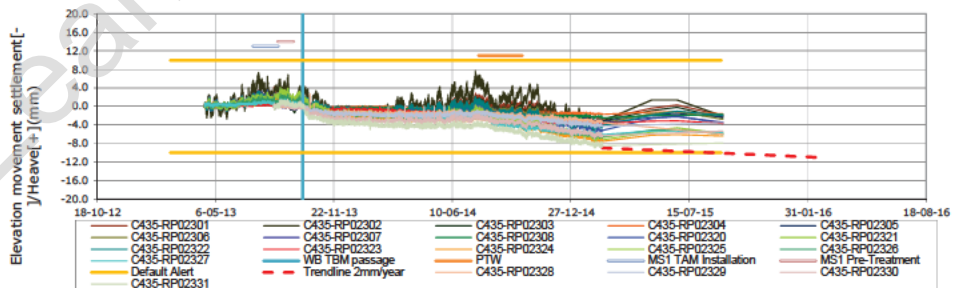
Building: GRAND AVENUE



Building: GRAND AVENUE



Building: GRAND AVENUE



**REMARKS:**  
 WB TBM passage caused around 4mm settlement. SCL-PTW enlargement works caused a maximum settlement around 3mm.  
 Almost 5mm heave recorded during the TAM installation and 2.5mm because of the Pre-Treatment works carried out from Moorgate Spur Shaft No. 1.  
 From March 2014 to November 2014, compensation grouting works carried out from Moorgate Spur No. 1 movements dispated as result of the PTW enlargement works undertaken at the same time.