



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

# C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer:

## Monitoring Close-Out Report: Automated Total Station ATS 08 and 3D Targets read by ATS 08.

**CRL Document Number: C435-BFK-C2-RGN-M123-51642**

**Supplier Document Number: N/A**

**Contract MDL reference C13.012**

### 1. Contractor Document Submittal History:

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### 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"/>
			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"/>

15/10/2016

### 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 to the prisms read by ATS08 installed on 23-28 Charterhouse Sq, refer to Table 1 below for the details of the prisms read by ATS08.

PRISM CODE	LOCATION	COORDINATES		
		Easting (m)	Northing (m)	Elevation (mATD)
C435-RP00802	East Market - East Elevation	82254.2656	36538.4685	126.0249
C435-RP00803	East Market - East Elevation	82257.3609	36532.3873	126.0451
C435-RP00804	East Market - East Elevation	82261.2776	36524.643	126.0478
C435-RP00805	East Market - East Elevation	82265.0782	36517.1321	126.0352
C435-RP00806	East Market - East Elevation	82270.5943	36506.3093	126.0492
C435-RP00807	East Market - East Elevation	82272.9834	36501.5956	126.0514
C435-RP00808	East Market - East Elevation	82276.8872	36493.9813	126.0442
C435-RP00809	East Market - East Elevation	82280.7368	36486.403	126.038
C435-RP00810	91-93 CHARTERHOUSE STREET	82200.1837	36547.5371	138.0513
C435-RP00811	91-93 CHARTERHOUSE STREET	82202.0478	36546.2827	138.0405
C435-RP00812	33-37 Charterhouse Square	82323.6958	36577.2794	133.1687
C435-RP00813	33-37 Charterhouse Square	82316.9018	36574.2234	133.1771
C435-RP00817	33-37 Charterhouse Square	82328.2504	36569.5602	133.169
C435-RP00824	99 CHARTERHOUSE STREET	82203.3214	36567.1681	137.10458
C435-RP00825	99 CHARTERHOUSE STREET	82199.996	36562.0532	136.49336
C435-RP00826	99 CHARTERHOUSE STREET	82194.6335	36555.5135	138.38888
C435-RP00838	33-37 Charterhouse Square	82309.395	36571.1293	123.374
C435-RP00839	33-37 Charterhouse Square	82315.3114	36573.7356	123.3681
C435-RP00840	33-37 Charterhouse Square	82320.3726	36575.9888	123.3984

Table 1: Details of the prisms read by ATS 08.



Installation and as-built-details are available in the following documents:

Drawings:

- C435-BFK-C2-DWG-M123-50045. 3D Targets Installed for Farringdon Station

Installation Reports:

- C435-BFK-C2-RGN-M123-50003. Installation Report of ATS08
- C435-BFK-C2-RGN-M123-50030 Installation Report of 3D Targets read by ATS 08.

## B.2 Location of the Instruments

Prisms associated with ATS08 are located on the plan below highlighted in yellow.

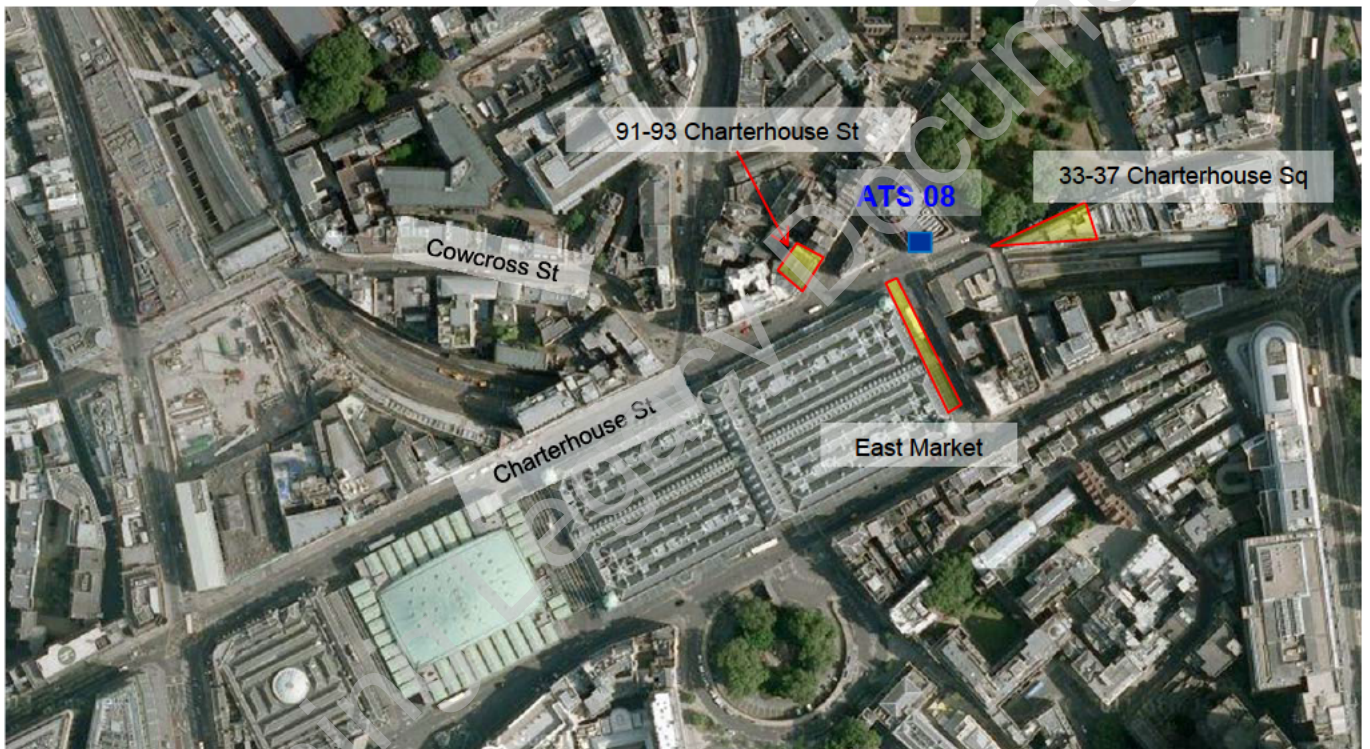


Figure 1 – Plan showing the Location prisms read by ATS08.

## C. MOVEMENTS

### C.1 Movements Resulting from Construction Activities

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

The construction activities affecting these instruments are outlined in the table below:

ACTIVITY	START DATE	END DATE
Moorgate Spur Shaft No. 2 TAM Installation	01/05/2013	16/07/2013
Moorgate Spur Shaft No. 2 Pre-Treatment works	29/07/2013	02/09/2013
Charterhouse Street Shaft TAM Installation	27/06/2013	30/10/2013
Charterhouse Street Shaft Pre-Treatment works	27/09/2013	08/11/2013
In-tunnel Grouting	19/11/2014	24/11/2014
C300-WB TBM passage	30/09/2013	07/10/2013
SCL-PTW enlargement	24/07/2014	06/10/2014
C300-EB TBM passage	16/01/2014	23/01/2014
SCL-PTE enlargement	17/08/2014	18/01/2015
SCL-STE1	13/02/2015	02/03/2015
C305-WB TBM passage	21/05/2015	23/05/2015
C305-EB TBM passage	08/05/2015	12/05/2015
SCL-STE2	02/02/2015	12/02/2015
SCL-VA2	16/04/2015	02/05/2015
SCL-CP8	16/06/2015	22/06/2015
SCL-CP9	10/06/2015	15/06/2015
SCL-RTE2	18/10/2014	11/11/2014
SCL-CP6	12/11/2014	22/11/2014
SCL-CP7	23/02/2015	26/02/2015
SCL-CH2Enlargement (CH2E)	15/01/2015	05/03/2015
SCL-CH2 Phase2	15/05/2015	28/05/2015
SCL-ES2	04/06/2015	21/09/2015
ETH-Excavation works	26/04/2013	29/08/2014
Hayne Street Shaft	19/11/2015	04/02/2016

Table 2 – Construction Activities associated with prisms read by ATS08.

### C.1.2 Resulting Movements

To analyse the results for the prisms buildings will be assessed individually:

- East Market East façade.
- 91-93 Charterhouse St
- 99 Charterhouse St
- 33-37 Charterhouse Sq

- East Market:

The monitoring data for the prisms located at this building are shown in Appendix B.

- TAM's drilling from Moorgate Shaft 2 caused 8-10mm of heave in May 2013.
- WB TBM caused 4mm of settlement on 30-09-2013
- EB TBM caused 9mm maximum of settlement on 16-01-2014
- PTW construction caused 3mm of settlement from 24-07-2014 to 06-10-2014.
- PTE enlargement caused 2-3mm maximum of settlement between 17-08-2014 to 18-01-2015.
- Compensation grouting caused 6mm maximum of heave from 02-09-2014 to 13-10-2014.
- RTE2 and CP6 combination caused 13-14mm of settlement from 18-10-2014 to 17-01-2015.
- Compensation grouting caused maximum 4-5mm of heave from 12-01-2015 to 30-01-2015.
- CH2 construction caused 5-6mm of settlement from 05-03-2015 to 28-05-2015.
- ES2 caused maximum 5-6mm of settlement from 04-06-2015 to 21-09-2015

- 91-93 Charterhouse Street:

The monitoring data for the prisms located at this building are shown in Appendix B.

- WB TBM caused maximum 4mm of settlement on 30-09-2013
- EB TBM caused 6mm of settlement on 16-01-2014
- Residual settlement caused 2mm.
- Compensation grouting from Moorgate Shaft 2 caused maximum 5mm of heave between 08-07-2014 and 03-09-2014
- PTW construction caused 2mm of settlement from 17-08-2014 to 06-10-2014.
- Ground treatment caused 4-5mm of heave in October 2014.
- PTE enlargement caused 16mm of settlement from 09-09-2014 to 18-01-2015
- CP6 and RTE2 combination caused 4mm of settlement from 18-10-2014 to 22-11-2014.
- CH2 construction caused 7mm of settlement from 15-01-2015 to 05-03-2015.

- 99 Charterhouse Street:

The monitoring data for the prisms located at this building are shown in Appendix B.

- EB TBM caused maximum 8mm of settlement on 16-01-2014.
- Residual settlement caused 4mm.
- Compensation grouting from Moorgate Shaft 2 caused maximum 6-7mm of heave from 08-07-2014 to 06-10-2014.
- Ground treatment caused maximum 6-8mm of heave in October 2014
- PTE construction caused 14-15mm of settlement from 07-09-2014 to 18-01-2015.
- CP6 and RTE2 combination caused 3-4mm of settlement from 18-10-2014 to 22-11-2014.
- CH2 and ES2 combination caused 6mm maximum of settlement from 15-05-2015 to 21-09-2015.



- 33-37 Charterhouse Square:

The monitoring data for the prisms located at this building are shown in Appendix B.

- TAM's drilling from Charterhouse Shaft caused 3-4mm of heave from 14-10-2013 to 22-11-2013.
- EB TBM caused maximum 10mm of settlement on 16-01-2014.
- Compensation grouting caused maximum 3-4mm of heave from 21-05-2014 to 21-06-2014
- Compensation grouting caused 10mm of heave from 02-10-2014 to 21-01-2015.
- PTE enlargement caused maximum 10mm of settlement from 10-01-2015 to 27-01-2015
- STE2 tunnel caused 4-5mm of settlement from 02-02-2015 to 12-02-2015.
- VA2 excavation caused maximum 5mm of settlement from 16-04-2015 to 02-05-2015

## C.2 Triggers/Default Alerts Breached

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.

No triggers breached. The Table 3 below shows the 10mm default alerts breached:

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
EAST MARKET - EAST ELEVATION	C435-RP00802	AUTOMATIC RP	Settlement	13/04/2016 07:00	-25.9	Default Alert	Default Alert
	C435-RP00803	AUTOMATIC RP	Settlement	13/04/2016 07:00	-17.1	Default Alert	Default Alert
	C435-RP00804	AUTOMATIC RP	Settlement	13/04/2016 07:00	-13.4	Default Alert	Default Alert
	C435-RP00805	AUTOMATIC RP	Settlement	13/04/2016 07:00	-2.8	Clear	Clear
	C435-RP00806	AUTOMATIC RP	Settlement	13/04/2016 07:00	-0.6	Default Alert	Clear
	C435-RP00807	AUTOMATIC RP	Settlement	13/04/2016 07:00	0.4	Default Alert	Clear
	C435-RP00808	AUTOMATIC RP	Settlement	13/04/2016 07:00	0.2	Clear	Clear
91-93 CHARTERHOUSE STREET	C435-RP00809	AUTOMATIC RP	Settlement	13/04/2016 07:00	2.8	Clear	Clear
	C435-RP00810	AUTOMATIC RP	Settlement	13/01/2016 10:00	-28.2	Default Alert	Default Alert
33-37 CHARTERHOUSE SQUARE	C435-RP00811	AUTOMATIC RP	Settlement	13/01/2016 10:00	-27.9	Default Alert	Default Alert
	C435-RP00812	AUTOMATIC RP	Settlement	29/04/2014 12:00	-3.4	Clear	Clear
99 CHARTERHOUSE STREET	C435-RP00813	AUTOMATIC RP	Settlement	13/01/2016 10:00	-22.9	Default Alert	Default Alert
	C435-RP00817	AUTOMATIC RP	Settlement	13/01/2016 10:00	-18.4	Default Alert	Default Alert
33-37 CHARTERHOUSE SQUARE	C435-RP00824	AUTOMATIC RP	Settlement	13/01/2016 10:52	-20.4	Default Alert	Default Alert
	C435-RP00825	AUTOMATIC RP	Settlement	13/01/2016 10:51	-24	Default Alert	Default Alert
33-37 CHARTERHOUSE SQUARE	C435-RP00826	AUTOMATIC RP	Settlement	13/01/2016 10:50	-26.5	Default Alert	Default Alert
	C435-RP00838	AUTOMATIC RP	Settlement	13/04/2016 14:00	-23.6	Default Alert	Default Alert
	C435-RP00839	AUTOMATIC RP	Settlement	13/04/2016 14:00	-26.4	Default Alert	Default Alert
	C435-RP00840	AUTOMATIC RP	Settlement	13/04/2016 14:00	-25.1	Default Alert	Default Alert

Table 3 – Default alerts breached by the prisms read by ATS08.

## C.3 Significant issues with the Instrumentation

Prisms from C435-R00802 to 00809 installed to control the East Market East elevation and from C435-RP00838 to 00840 to monitor the 33-37 Charterhouse Square building were read automatically by ATS 08 until 13/01/2016, when they started to be controlled automatically by ATS 07, showing graphs a gap during this overlap process until 04/02/2016.

Line of sight from ATS 08 to prism C435-RP00812 was blocked by a tree on 12/10/2013, being the prism reinstalled on 05/01/2014 and visual blocked again from 29/04/2014.

## C.4 Residual Risks

No risks remain.

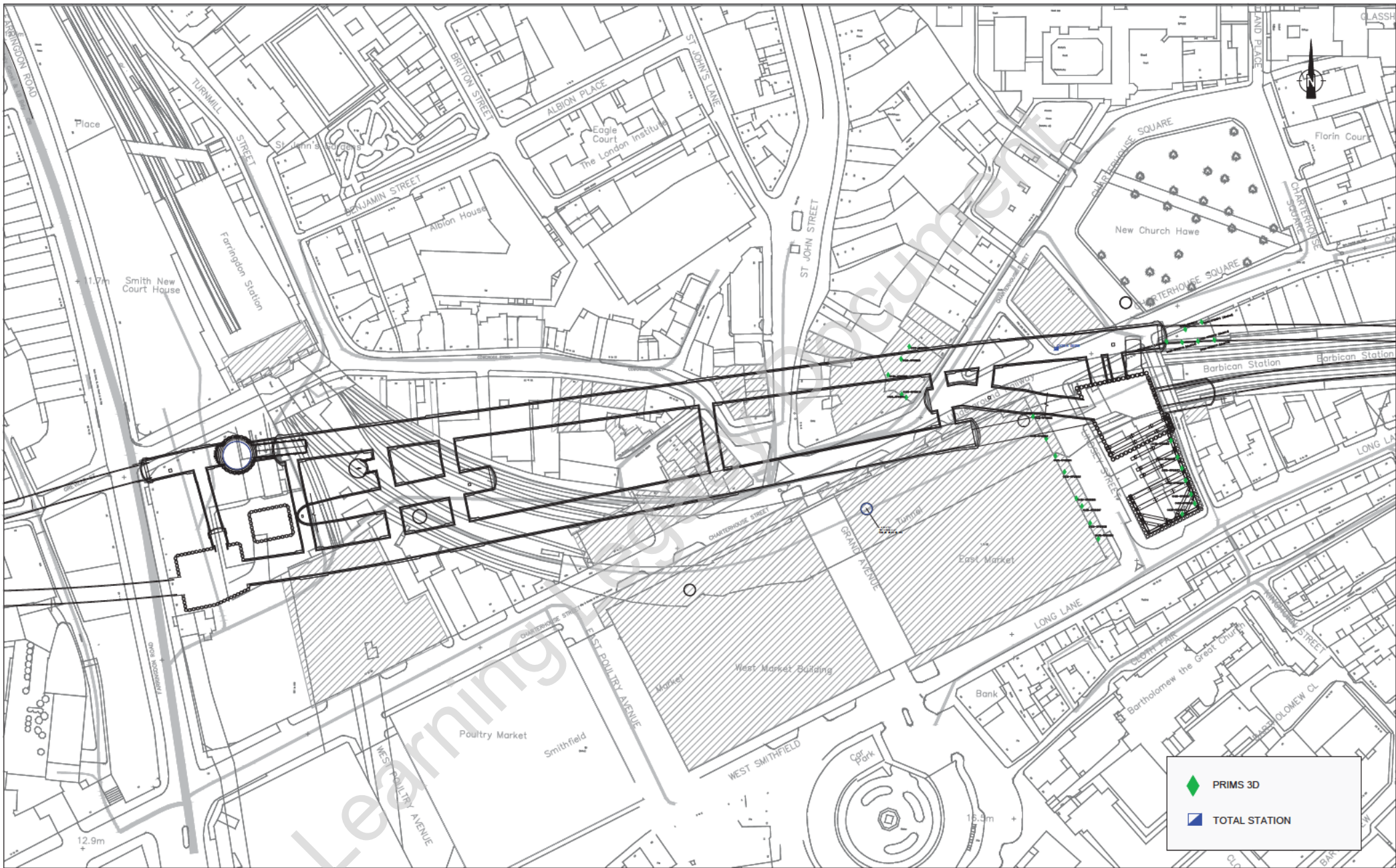
## D. CONCLUSIONS



No triggers breached, monitoring stable. No residual risks remain. Long term monitoring to be completed by Crossrail.

APPENDIX A: DRAWINGS

Learning Legacy Document





	PRIMS 3D
	TOTAL STATION

Notes:

Rev.	Date	Description	By	Chkd	App	Auth
1	20-02-2014					



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Scale :

@ A3

Contract : C435 I&M FARRINGDON

Originator : GEOCISA

Location : CROSSRAIL GENERAL

Title :

3D TARGETS INSTALLED FOR FARRINGDON STATION

Drg No : C435-BFK-C2-DWG-M123-50045

By :

Chk :

App :

Auth :



SBbyS

APPENDIX B: GRAPHS

Learning Legacy Document

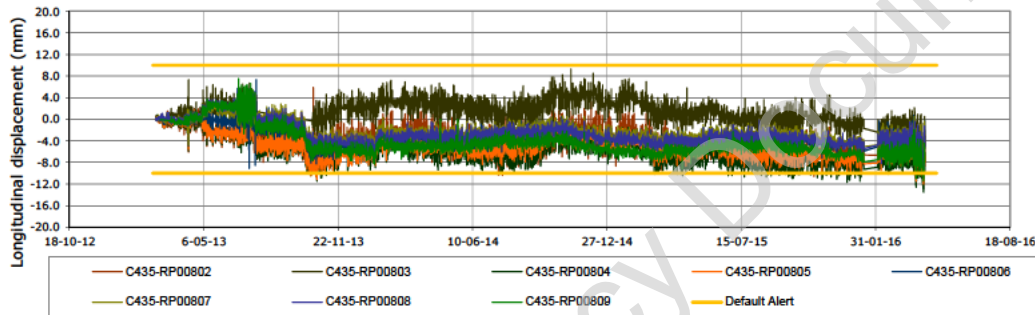


**GEOCISA UK**

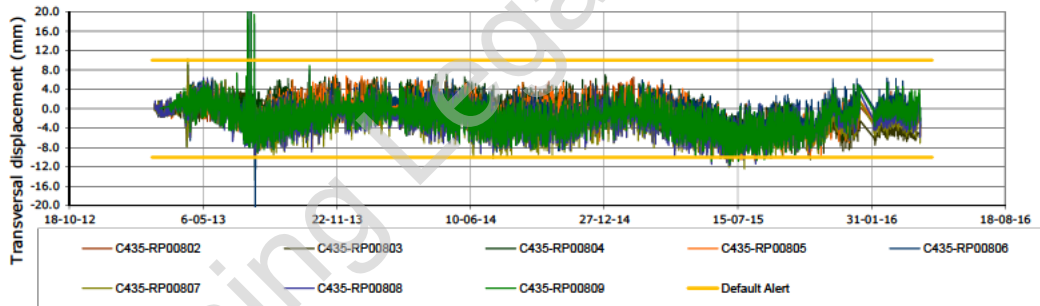
REPORT Automatic Prisms  
 AREA Farringdon Station  
 DEVICE 3D Target



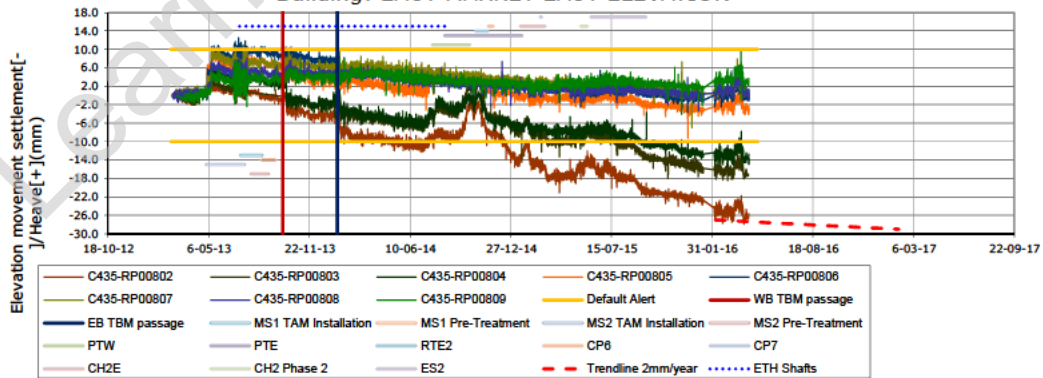
Building: EAST MARKET EAST ELEVATION



Building: EAST MARKET EAST ELEVATION



Building: EAST MARKET EAST ELEVATION

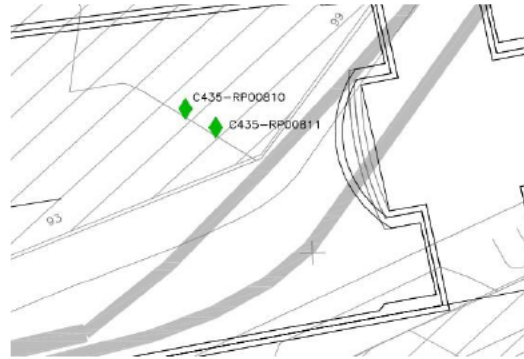


REMARKS

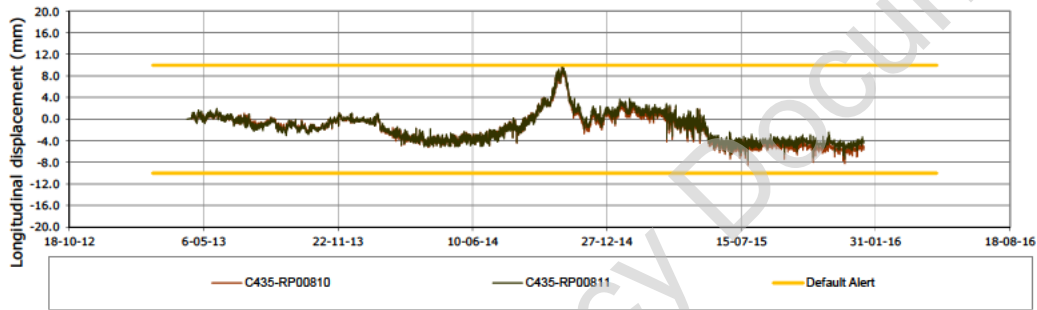


**GEOCISA UK**

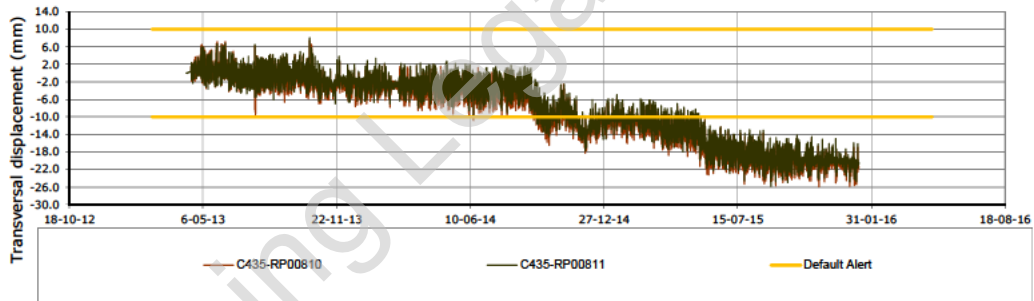
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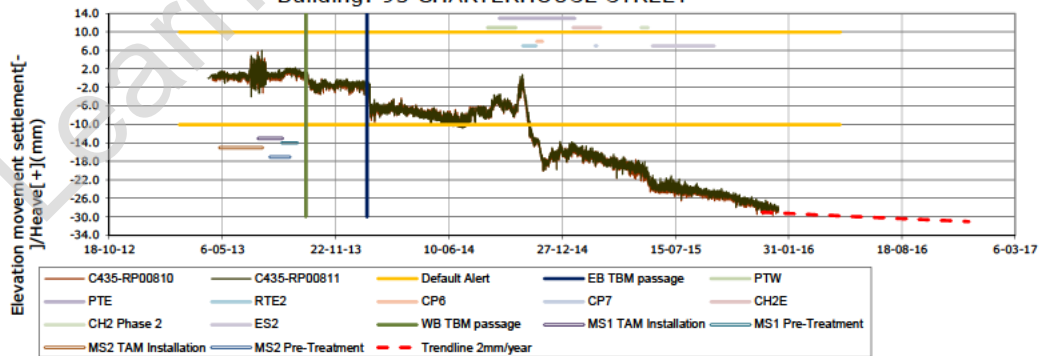
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Building: 93 CHARTERHOUSE STREET



Building: 93 CHARTERHOUSE STREET



REMARKS



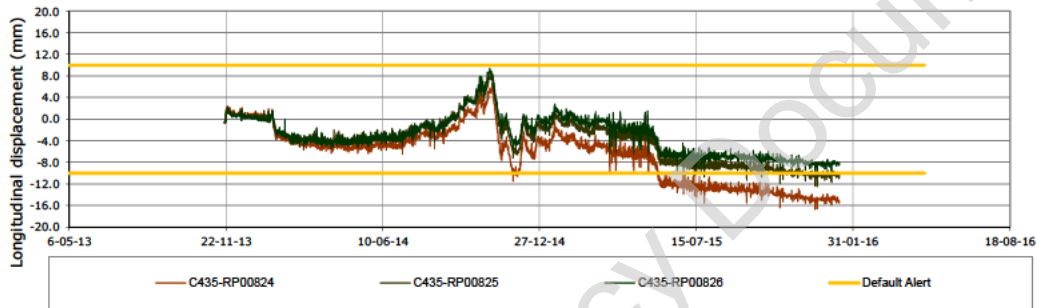


**GEOCISA UK**

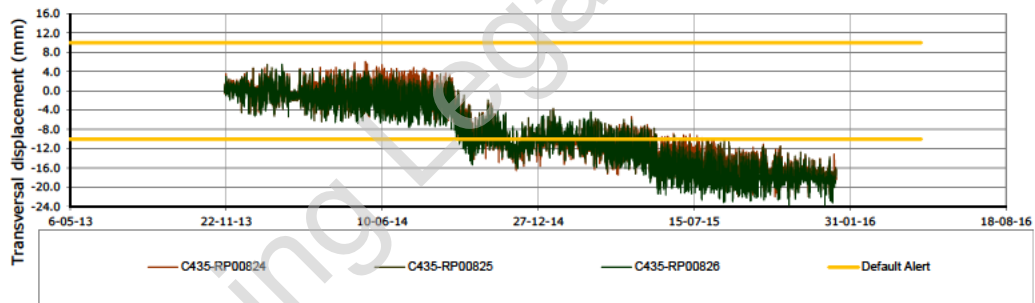
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AREA Farringdon Station  
DEVICE 3D Target



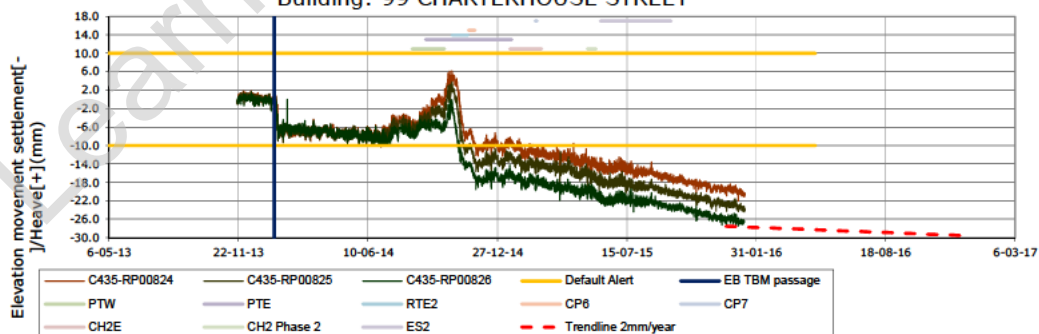
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Building: 99 CHARTERHOUSE STREET

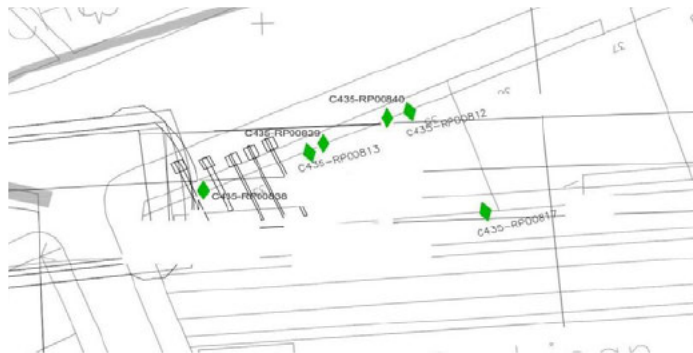


Building: 99 CHARTERHOUSE STREET

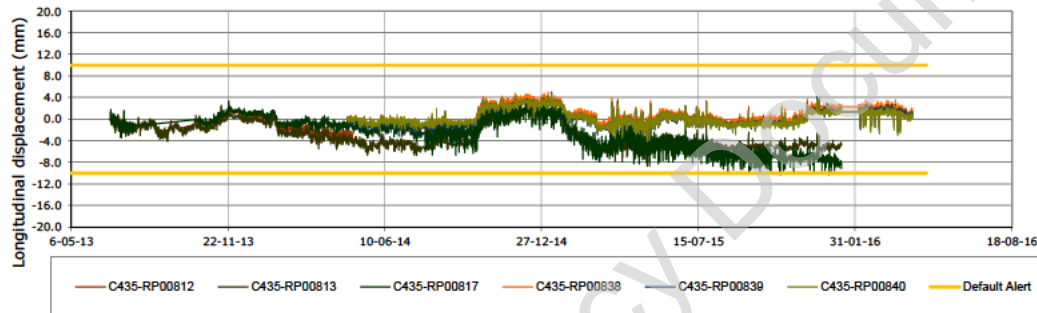


REMARKS

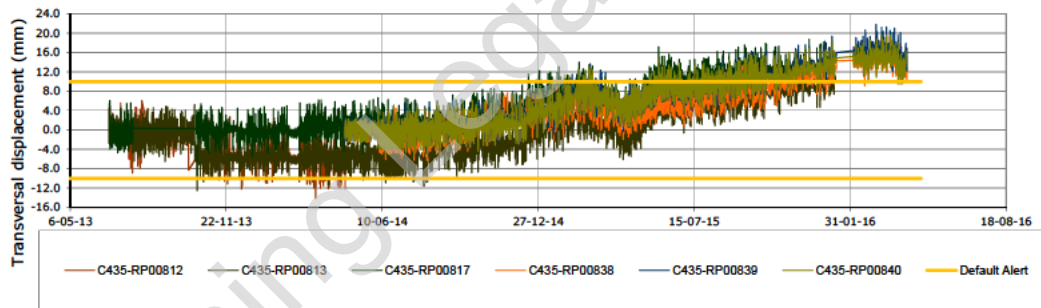
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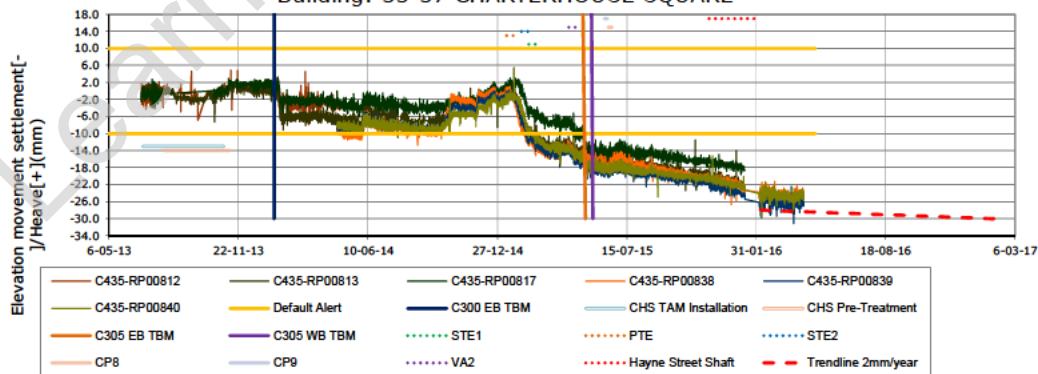
Building: 33-37 CHARTERHOUSE SQUARE



Building: 33-37 CHARTERHOUSE SQUARE



Building: 33-37 CHARTERHOUSE SQUARE



REMARKS

## APPENDIX C: GLOSSARY

- ATS Automatic Total Station.
- ETH Eastern Ticket Hall.
- WB Westbound.
- TBM Tunnel Boring Machine.
- EB Eastbound.
- PTW Platform Tunnel West.
- PTE Platform Tunnel East.
- CP Cross passages.
- CH Concourse Hall.
- VA Ventilation Adit.
- STE Stub Tunnel East.
- RTE Running Tunnel East.
- ES Escalator Shaft Shaft.
- TaM Tube a Manchette.

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