



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

C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer:

Monitoring Close-Out Report: Automated Total Station ATS04 and 3D Targets read by ATS04.

CRL Document Number: C435-BFK-C2-RGN-M123-51639

Supplier Document Number: N/A

Contract MDL reference C14.022

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2.0	17-05-2016	[Redacted]	[Redacted]	[Redacted]	For acceptance
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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]		22/06/2016	<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 2.

- 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 ATS04 installed on 90-99 Charterhouse St, refer to Table 1 below for the details of the prisms read by ATS04.

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-RP00401	East Market North Façade	82174.2447	36506.7465	126.0187
C435-RP00402	East Market North Façade	82178.1145	36508.7223	126.0289
C435-RP00403	East Market North Façade	82182.0286	36510.7059	126.031
C435-RP00404	East Market North Façade	82185.9864	36512.7096	126.0394
C435-RP00405	East Market North Façade	82189.9447	36514.7152	126.0478
C435-RP00406	East Market North Façade	82193.857	36516.7084	126.0458
C435-RP00407	East Market North Façade	82197.9033	36518.7739	126.0508
C435-RP00408	East Market North Façade	82201.7189	36520.7171	126.0405
C435-RP00409	East Market North Façade	82205.5994	36522.6951	126.0467
C435-RP00410	East Market North Façade	82209.5293	36524.6911	126.0351
C435-RP00411	East Market North Façade	82213.4846	36526.7152	126.036
C435-RP00412	East Market North Façade	82216.6429	36528.3346	126.0339
C435-RP00413	East Market North Façade	82220.1543	36530.1261	126.0399
C435-RP00414	East Market North Façade	82224.4825	36532.3056	126.0475
C435-RP00415	East Market North Façade	82228.4545	36534.3288	126.0446
C435-RP00416	East Market North Façade	82232.3207	36536.2953	126.0426
C435-RP00417	East Market North Façade	82236.1865	36538.2647	126.0391
C435-RP00418	East Market North Façade	82240.1817	36540.2805	126.038
C435-RP00419	East Market North Façade	82244.4135	36542.4055	126.0304
C435-RP00425	38 Charterhouse St	82241.407	36579.8883	120.0365
C435-RP00426	38 Charterhouse St	82239.2703	36576.4571	120.7724
C435-RP00427	38 Charterhouse St	82236.6099	36572.2083	119.8259
C435-RP00428	23-28 Charterhouse Sq.	82235.5968	36570.854	121.3832
C435-RP00429	23-28 Charterhouse Sq.	82231.8163	36564.9529	121.4138
C435-RP00430	23-28 Charterhouse Sq.	82226.9845	36557.1242	121.2052

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-RP00431	23-28 Charterhouse Sq.	82245.5244	36586.7696	122.0982
C435-RP00432	23-28 Charterhouse Sq.	82250.8471	36595.14	122.0332
C435-RP00434	33-37 Charterhouse Sq.	82257.9285	36606.2582	121.6558
C435-RP00435	33-37 Charterhouse Sq.	82250.824	36594.994	141.453
C435-RP00436	33-37 Charterhouse Sq.	82257.8444	36606.0169	141.4672
C435-RP00437	33-37 Charterhouse Sq.	82309.9769	36567.9845	123.5644
C435-RP00438	33-37 Charterhouse Sq.	82310.1321	36568.0441	131.8084
C435-RP00439	33-37 Charterhouse Sq.	82316.3088	36568.4661	122.7576
C435-RP00440	33-37 Charterhouse Sq.	82316.1749	36568.4993	131.7496
C435-RP00441	33-37 Charterhouse Sq.	82323.0464	36568.9691	123.4568
C435-RP00442	33-37 Charterhouse Sq.	82322.8805	36568.9814	131.7328
C435-RP00443	33-37 Charterhouse Sq.	82334.8262	36569.9236	123.6363
C435-RP00444	33-37 Charterhouse Sq.	82335.0967	36569.9468	131.7874
C435-RP00449	33-37 Charterhouse Sq.	82306.2772	36547.3353	116.4361
C435-RP00450	40-42 Charterhouse St	82309.3471	36571.1241	123.4194
C435-RP00451	40-42 Charterhouse St	82315.282	36573.7268	123.4042
C435-RP00452	40-42 Charterhouse St	82320.3471	36575.982	123.4352

Table 1: Details of the prisms read by ATS04

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-C-RGN-M123-50056. Installation Report of 3D Targets Read by ATS04.
- C435-BFK-C2-RGN-M123-50009. Installation Report of ATS04.

B.2 Location of the Instruments

Prisms associated with ATS04 are located on the plan below highlighted in yellow.

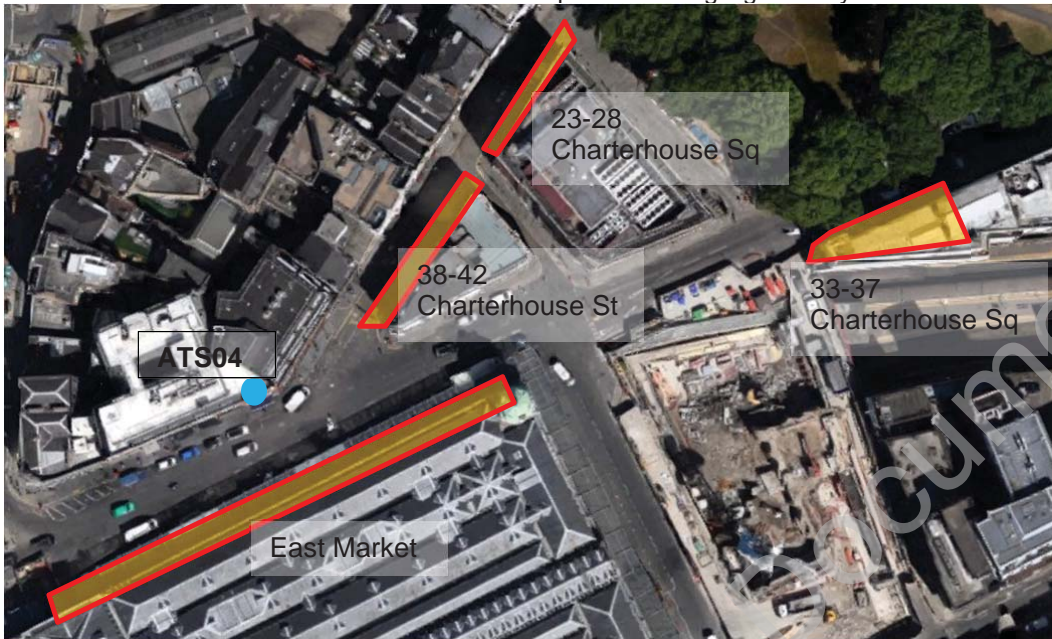


Figure 1 – Plan showing the Location prisms read by ATS04.

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
ETH excavation	26-04-2013	28-10-2014
WB TBM passage	02-10-2013	07-10-2013
PTW	10-08-2014	06-10-2014
EB TBM	20-01-2014	24-01-2014
PTE	27-10-2014	27-01-2015
CH2	05-03-2015	28-05-2015
CP6	12-11-2014	25-11-2014
CP7	23-02-2015	25-02-2015
CP8	16-06-2015	22-06-2015
CP9	10-06-2015	14-06-2015
VA2	16-04-2015	02-05-2015
ES2	04-06-2015	02-07-2015
STE1	13-02-2015	02-03-2015
STE2	02-02-2015	12-02-2015
RTE2	18-10-2014	01-11-2014

Table 2 – Construction Activities associated with prisms read by ATS04.

C.1.2 Resulting Movements

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

- East Market North façade.
- 38-42 Charterhouse St.
- 23-28 Charterhouse Sq.
- 33-37 Charterhouse Sq.

- East Market North façade.

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

- TAM's drilling from Moorgate Shaft 2 caused 8mm of heave in September 2013
- WB TBM passage from 02-10-2013 to 07-10-2013 caused a settlement of 3-4mm.
- Compensation grouting episodes from July 2014 to November 2014 caused maximum 6mm of heave.
- PTW enlargement works caused 18mm maximum of settlement between 19-09-2014 and 22-12-2014
- Compensation grouting on January 2015 caused 8mm of heave.
- From 23-02-2015 to 25-02-2015 CP7 construction caused maximum 4mm of settlement.
- 4-5mm maximum of settlement due to ES2 and CH2 from 05-03-2015 to 04-06-2015.
- Maximum Longitudinal movement -12mm
- Maximum Transversal movement -10mm

- 38-42 Charterhouse St.

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

- Compensation Grouting between August 2013 and September 2013 caused 4-5mm maximum of heave.
- EB TBM caused 6-8mm maximum of settlement between 20-01-2014 and 23-01-2014.
- Residual settlement after the EB TBM caused 4mm of settlement.
- Compensation grouting between July 2014 and November 2014 caused 14mm maximum of heave.
- PTE enlargement works caused 12-14mm maximum of settlement from 29-10-2014 to 07-01-2015
- Compensation grouting episodes on January 2015 caused 8mm maximum of heave.
- CP7 construction caused 4-5mm of settlement between 23-02-2015 and 27-02-2015.
- Between 05-03-2015 and 10-04-2015 CH2 pilot caused 2-3mm maximum of settlement.
- CH2 enlargement caused 4-5mm of settlement from 06-05-2015 to 28-05-2015.
- Maximum Longitudinal movement -12mm
- Maximum Transversal movement +24mm

- 23-28 Charterhouse Sq.

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

- Eastbound TBM caused 2-3mm maximum of settlement from 21-01-2014 to 23-01-2014.
- Residual settlement after the EB TBM caused 2mm of settlement.
- Compensation grouting episodes from October 2014 to November 2014 caused 4-6mm of heave.
- From 07-10-2014 to 27-01-2015 PTE construction caused 8-10mm maximum of settlement.
- VA2 (Ventilation Adit) caused 2mm of settlement from 16-04-2015 to 02-05-2015

- The combination between CP8 and CP9 construction caused 4-6mm maximum settlement.
- Maximum Longitudinal movement -30mm
- Maximum Transversal movement +26mm

- 33-37 Charterhouse Sq.

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

- Compensation grouting episodes in January 2014 caused 2-3mm of heave.
- Between 22-01-2014 and 24-01-2014 EB TBM caused maximum 7-8mm of settlement.
- Compensation grouting on June 2014 caused 4-5mm of heave.
- Compensation grouting on September 2014 caused 2-3mm of heave.
- In November 2014 a compensation grouting caused 2-3mm maximum of heave.
- Concurrent grouting in January 2015 caused 6-8mm of heave.
- From 18-01-2015 to 27-01-2015 PTE enlargement works caused 6-7mm of settlement.
- VA2 construction from 16-04-2015 to 02-05-2015, caused 3-4mm of settlement.
- Maximum Longitudinal movement -4mm
- Maximum Transversal movement +18mm

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 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 North façade	C435-RP00401	AUTOMATIC RP	Settlement	13/04/2016 08:59	-11.7	Default Alert	Default Alert
	C435-RP00402	AUTOMATIC RP	Settlement	13/04/2016 08:59	-11.8	Default Alert	Default Alert
	C435-RP00403	AUTOMATIC RP	Settlement	13/04/2016 08:58	-12.6	Default Alert	Default Alert
	C435-RP00404	AUTOMATIC RP	Settlement	13/04/2016 08:58	-14.6	Default Alert	Default Alert
	C435-RP00405	AUTOMATIC RP	Settlement	13/04/2016 08:56	-15	Default Alert	Default Alert
	C435-RP00406	AUTOMATIC RP	Settlement	13/04/2016 08:55	-17.5	Default Alert	Default Alert
	C435-RP00407	AUTOMATIC RP	Settlement	13/04/2016 08:54	-18.9	Default Alert	Default Alert
	C435-RP00408	AUTOMATIC RP	Settlement	13/04/2016 08:54	-20	Default Alert	Default Alert
	C435-RP00409	AUTOMATIC RP	Settlement	13/04/2016 08:53	-23.1	Default Alert	Default Alert
	C435-RP00410	AUTOMATIC RP	Settlement	13/04/2016 10:55	-23.8	Default Alert	Default Alert
	C435-RP00411	AUTOMATIC RP	Settlement	13/04/2016 10:54	-24.1	Default Alert	Default Alert
	C435-RP00412	AUTOMATIC RP	Settlement	13/04/2016 10:54	-25.4	Default Alert	Default Alert
	C435-RP00413	AUTOMATIC RP	Settlement	13/04/2016 10:53	-27.6	Default Alert	Default Alert
	C435-RP00414	AUTOMATIC RP	Settlement	13/04/2016 10:52	-27.8	Default Alert	Default Alert
	C435-RP00415	AUTOMATIC RP	Settlement	11/04/2016 18:00	-28.8	Default Alert	Default Alert
	C435-RP00416	AUTOMATIC RP	Settlement	12/04/2016 04:00	-29	Default Alert	Default Alert
	C435-RP00417	AUTOMATIC RP	Settlement	10/04/2016 14:00	-29.1	Default Alert	Default Alert
C435-RP00418	AUTOMATIC RP	Settlement	11/04/2016 20:00	-27.9	Default Alert	Default Alert	
C435-RP00419	AUTOMATIC RP	Settlement	12/04/2016 00:00	-26.8	Default Alert	Default Alert	
C435-RP00425	AUTOMATIC RP	Settlement	07/03/2016 10:00	-16	Default Alert	Default Alert	
C435-RP00426	AUTOMATIC RP	Settlement	07/03/2016 10:00	-17.4	Default Alert	Default Alert	
C435-RP00427	AUTOMATIC RP	Settlement	07/03/2016 10:00	-25.1	Default Alert	Default Alert	
C435-RP00450	AUTOMATIC RP	Settlement	07/03/2016 10:00	-14.2	Default Alert	Default Alert	
C435-RP00451	AUTOMATIC RP	Settlement	07/03/2016 10:00	-14.6	Default Alert	Default Alert	
C435-RP00452	AUTOMATIC RP	Settlement	07/03/2016 10:00	-12.5	Default Alert	Default Alert	
C435-RP00428	AUTOMATIC RP	Settlement	24/02/2016 09:00	-14	Default Alert	Default Alert	
C435-RP00429	AUTOMATIC RP	Settlement	15/02/2016 09:00	-10.7	Default Alert	Default Alert	
C435-RP00430	AUTOMATIC RP	Settlement	29/01/2016 08:00	-6.5	Clear	Clear	
C435-RP00431	AUTOMATIC RP	Settlement	16/02/2016 08:00	-9.7	Default Alert	Clear	
C435-RP00432	AUTOMATIC RP	Settlement	16/02/2016 08:00	-1.6	Clear	Clear	
C435-RP00434	AUTOMATIC RP	Settlement	11/04/2016 23:46	-24.7	Default Alert	Default Alert	
C435-RP00435	AUTOMATIC RP	Settlement	11/04/2016 23:46	-24.6	Default Alert	Default Alert	
C435-RP00436	AUTOMATIC RP	Settlement	12/04/2016 23:46	-23.9	Default Alert	Default Alert	
C435-RP00437	AUTOMATIC RP	Settlement	12/04/2016 :46:00	-24.9	Default Alert	Default Alert	
C435-RP00438	AUTOMATIC RP	Settlement	11/04/2016 23:46	-21.9	Default Alert	Default Alert	
C435-RP00439	AUTOMATIC RP	Settlement	11/04/2016 23:46	-20.6	Default Alert	Default Alert	
C435-RP00440	AUTOMATIC RP	Settlement	11/04/2016 23:46	-18.1	Default Alert	Default Alert	
C435-RP00441	AUTOMATIC RP	Settlement	11/04/2016 23:46	-17.8	Default Alert	Default Alert	
C435-RP00442	AUTOMATIC RP	Settlement	11/04/2016 23:46	-21.9	Default Alert	Default Alert	
C435-RP00443	AUTOMATIC RP	Settlement	11/04/2016 23:46	-18.9	Default Alert	Default Alert	
C435-RP00444	AUTOMATIC RP	Settlement	11/04/2016 23:46	-17.5	Default Alert	Default Alert	
C435-RP00449	AUTOMATIC RP	Settlement	11/04/2016 23:46	-24.5	Default Alert	Default Alert	

Table 3 – Default alerts breached by the prisms read by ATS04.

C.3 Significant Issues with the Instrumentation

The gap in the data for the prisms installed on the Market was caused by a scaffold being erected where ATS04 was installed. This occurred during the period of 23-09-2014 to 22-10-2014, covering the visual between the prisms and the ATS04. The prisms that show the gap are from C435-RP00401 to C435-RP00415.

The prisms installed in 23-28 Charterhouse Sq. are covered by a scaffold due the refurbishment works carried out on the building.

Some prisms installed on 38-42 Charterhouse St were installed by C430. At the beginning these prisms was reading manually. As per the works information the prisms were then orientated to be read automatically on December 2014. The offsets for the movements were calculated using the sockets and the rest of the prisms.

C.4 Residual Risks

The rate of settlement for all instrumentation within this report has been analysed and in all cases the rate is less than 2mm/year

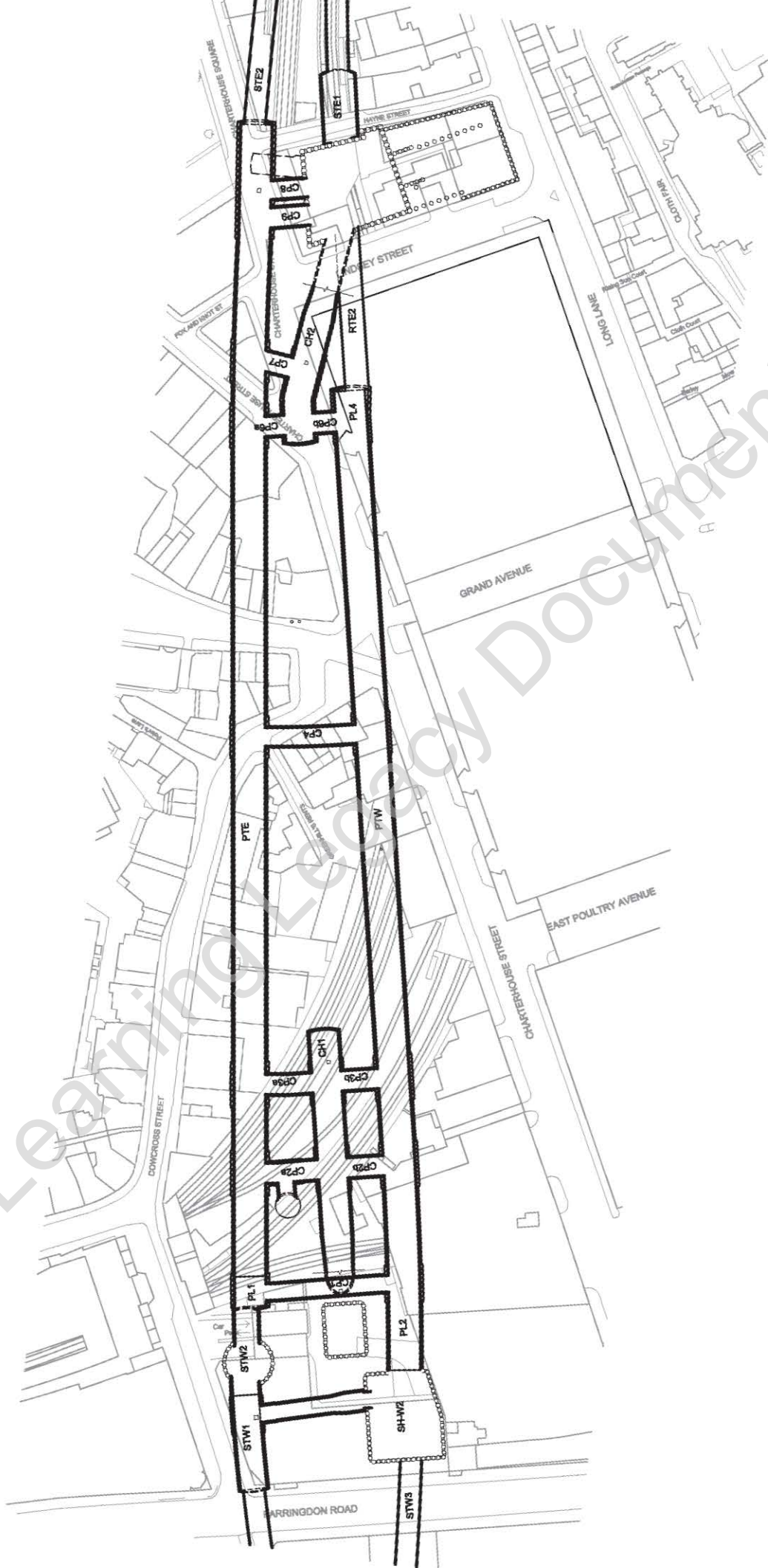
D. CONCLUSIONS

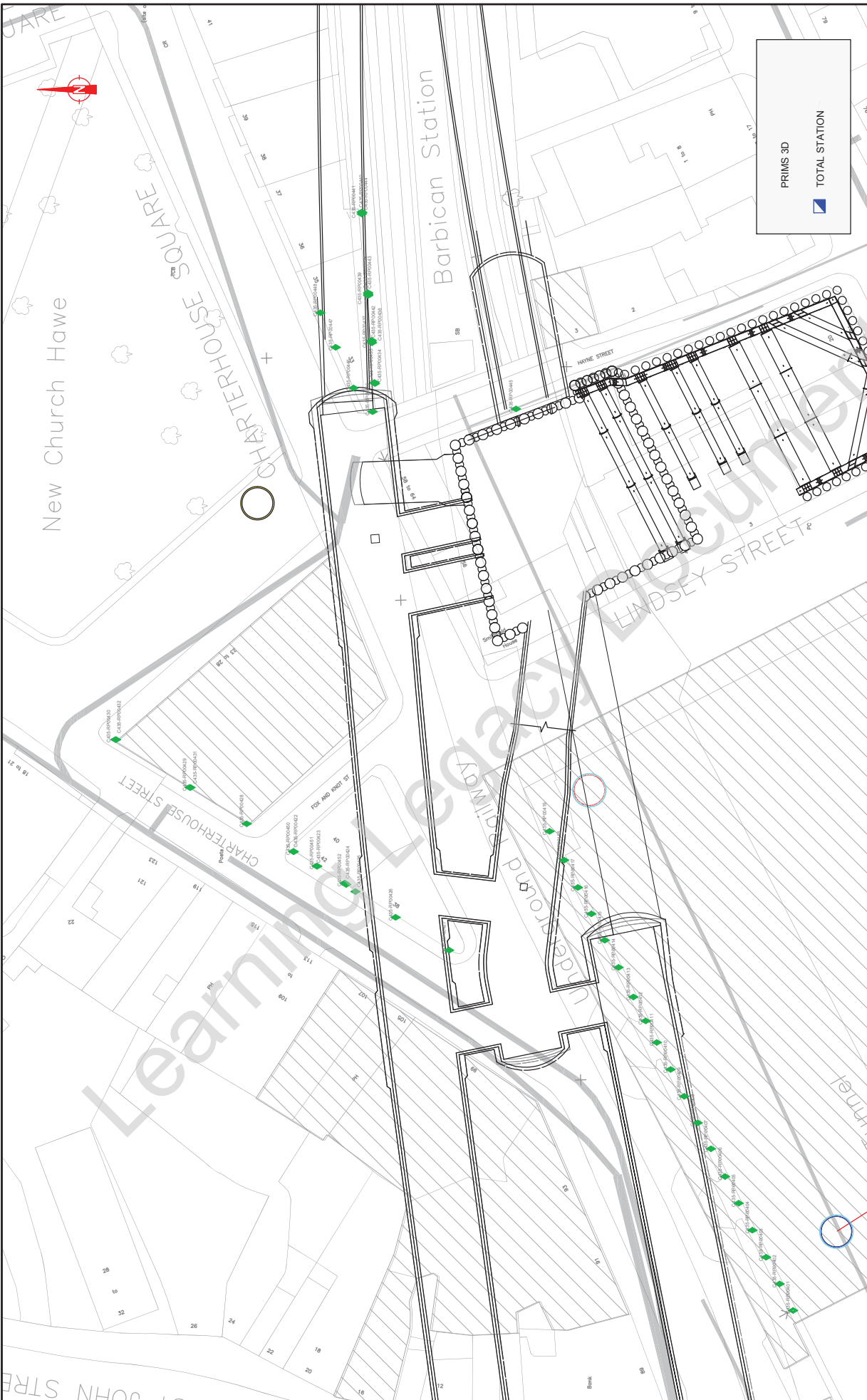
No triggers breached, monitoring stable. No residual risks remain. Long term monitoring to be completed by Crossrail.

APPENDIX A: DRAWINGS

Learning Legacy Document

Learning Technology Document





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

Notes:	

 C/ Los Llanos de Jerez 10-12 28823- MADRID www.geocisa.com		Contract : C435 IMI FARRINGTON Originator : GEOCISA Location : CROSSRAIL GENERAL Title : 3D PRIMS AT504
 	Scale : @ A3	Drg No : C435-BFK-C2-DWG-M123-50045
		By :  Chk :  App :  Auth :  Sult :  Rev : 

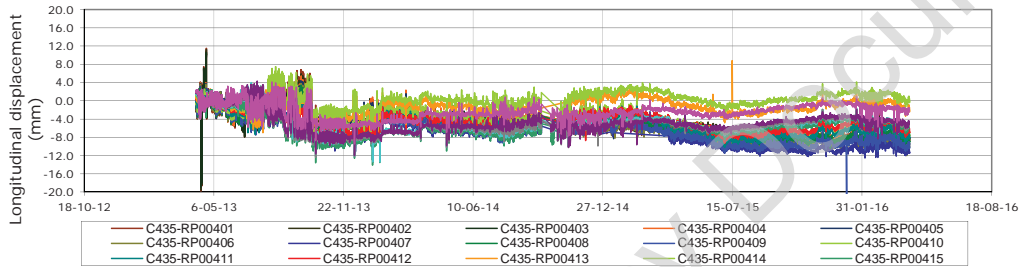
APPENDIX B: GRAPHS

Learning Legacy Document

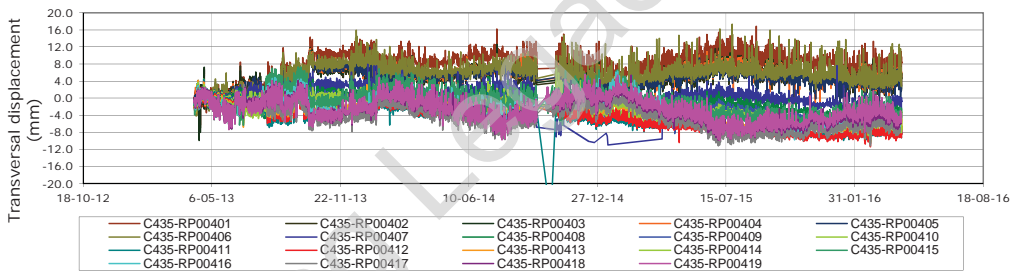
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 AREA Farringdon Station
 DEVICE 3D Target



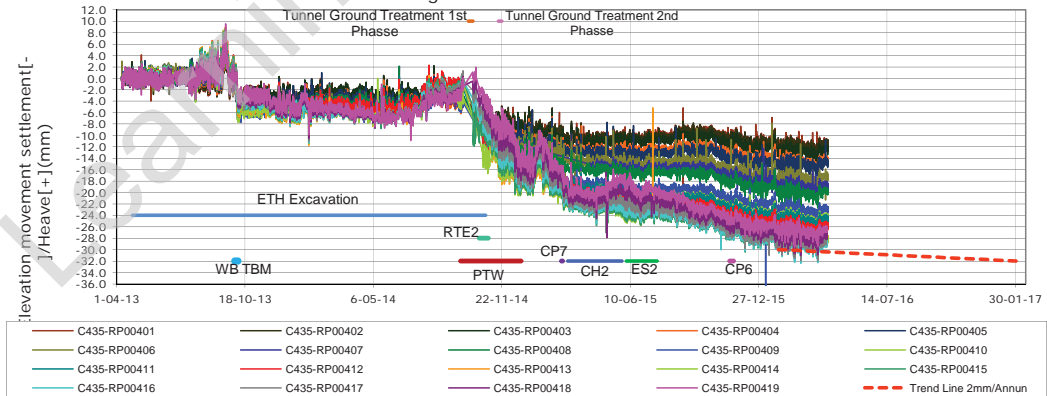
Building: EAST MARKET NORTH ELEVATION



Building: EAST MARKET NORTH ELEVATION

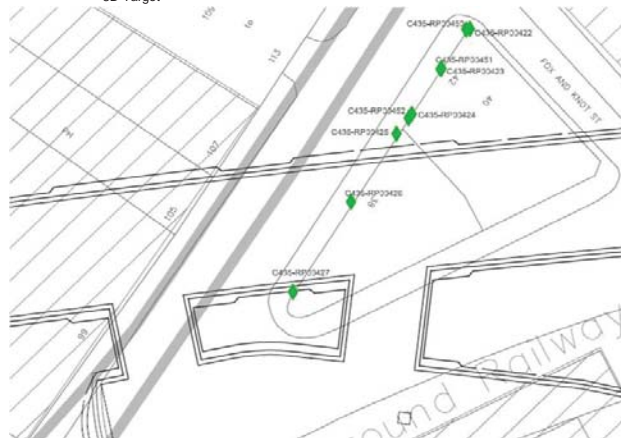


Building: EAST MARKET NORTH ELEVATION

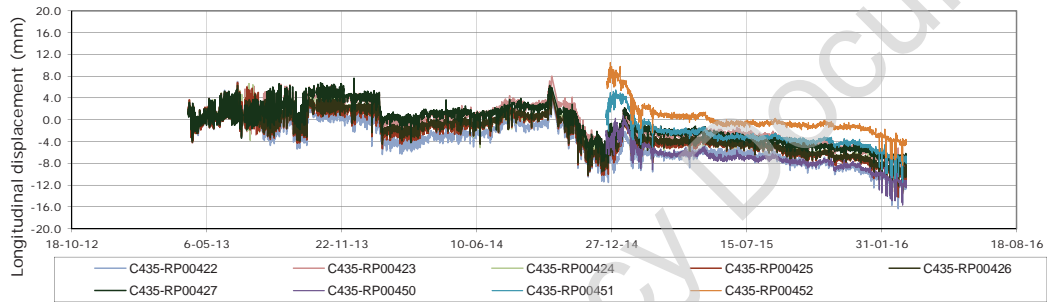


REMARKS:

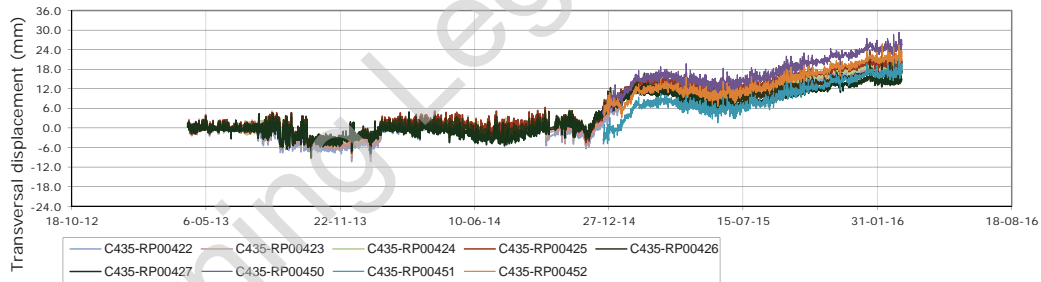
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 AREA: Farringdon Station
 DEVICE: 3D Target



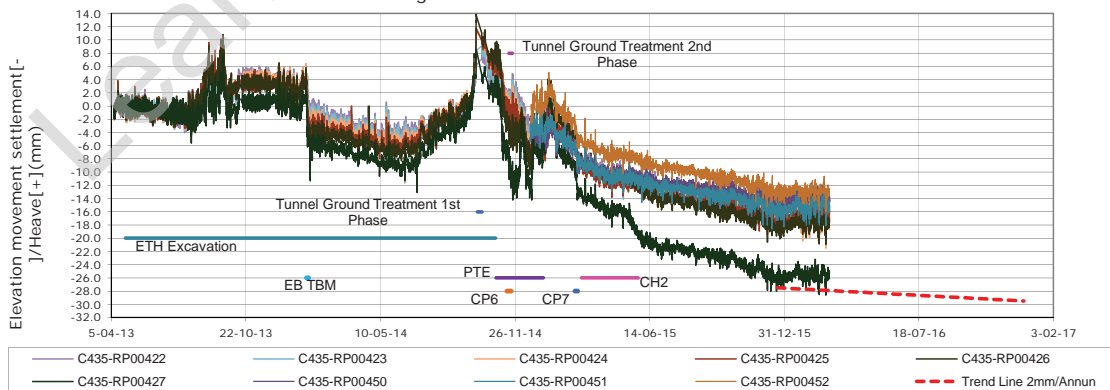
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Building: 38-42 CHARTERHOUSE STREET



Building: 38-42 CHARTERHOUSE STREET



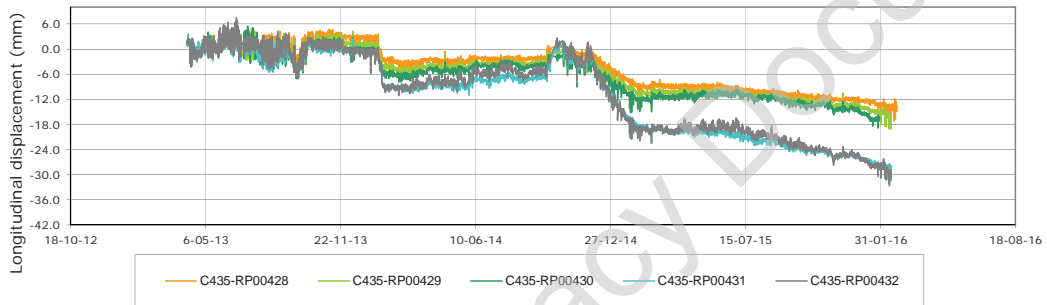
REMARKS:

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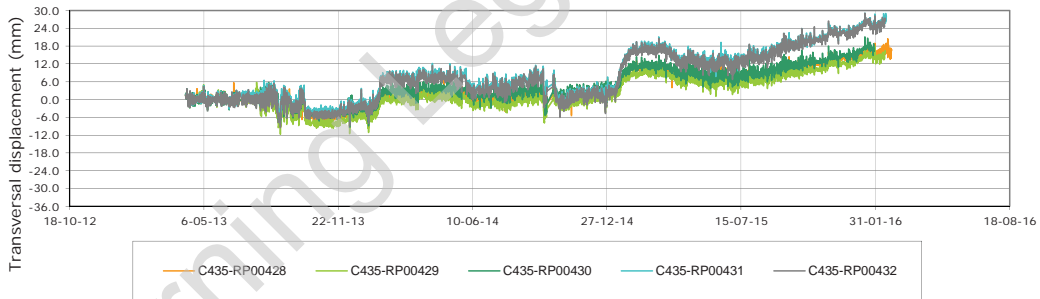
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



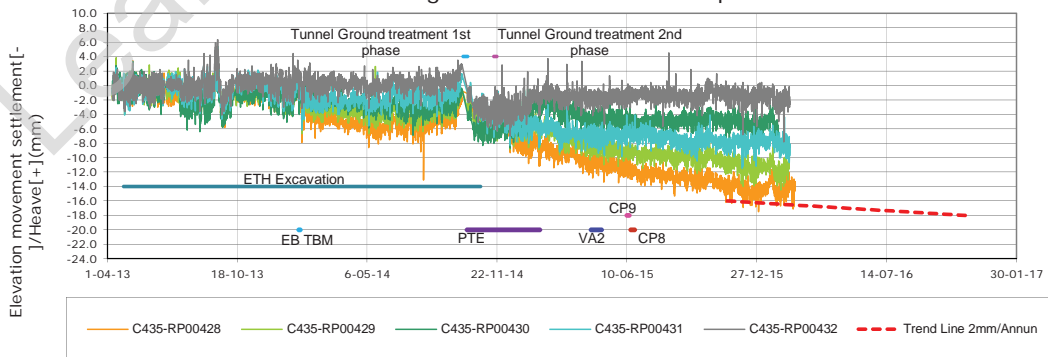
Building: 23-28 Charterhouse Sq.



Building: 23-28 Charterhouse Sq.



Building: 23-28 Charterhouse Sq.

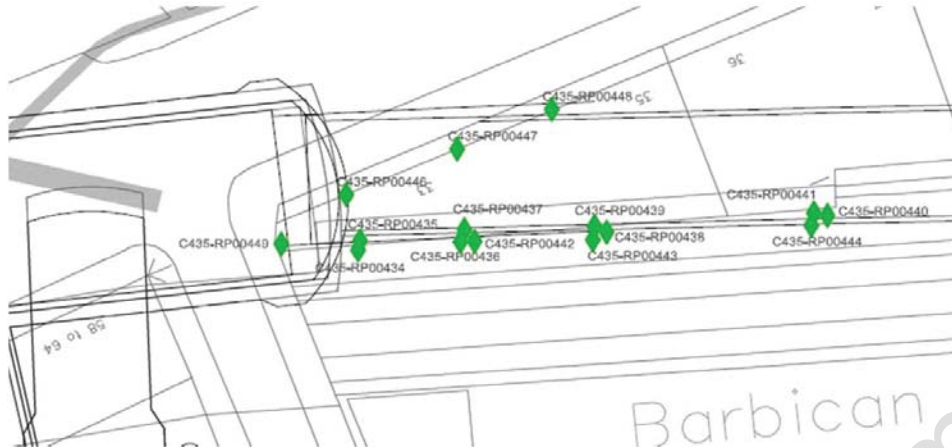


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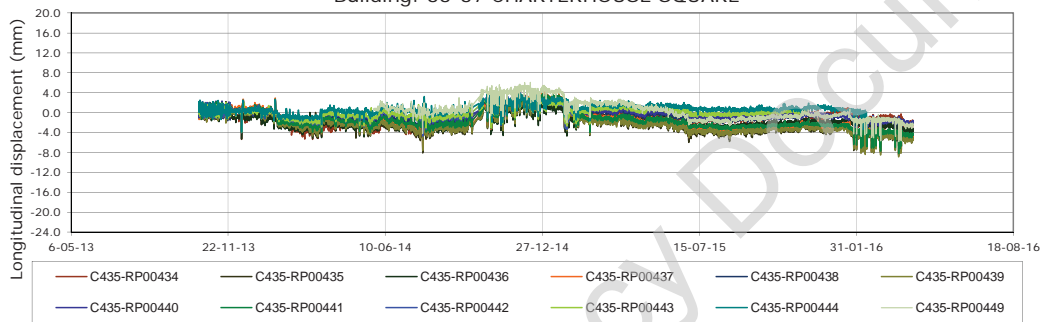
REPORT
AREA
DEVICE

Automatic Prisms
Farringdon Station
3D Target

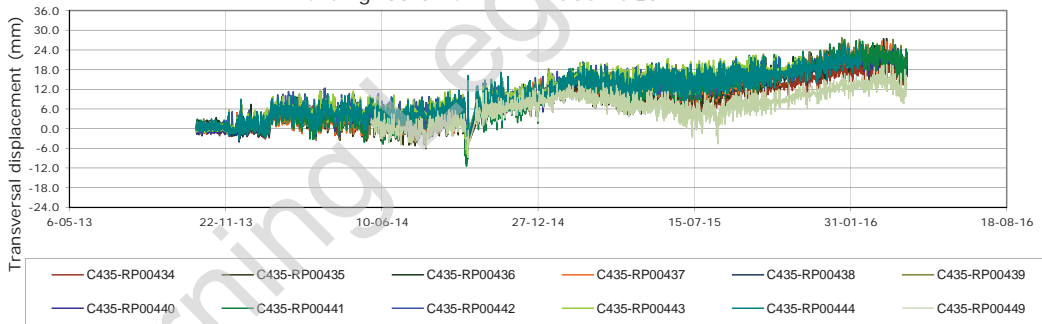


Barbican

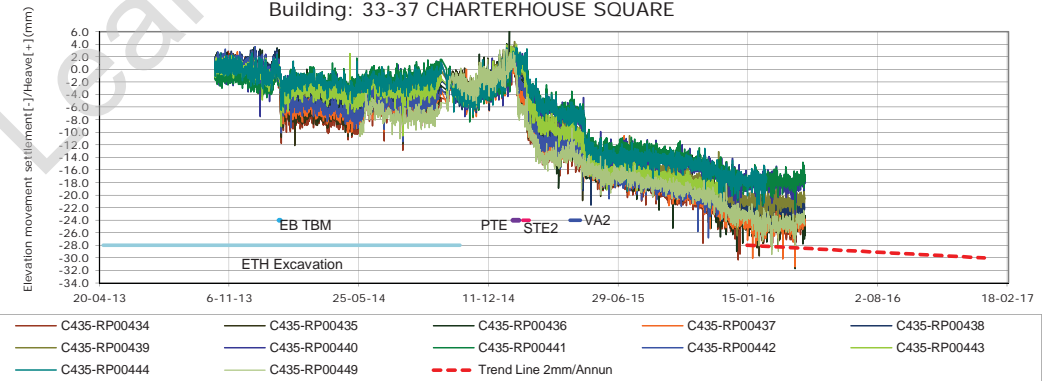
Building: 33-37 CHARTERHOUSE SQUARE



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

Learning Legacy Document