



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

C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer:

Monitoring Close-Out Report: Extensometers XR04000, XR05000, XR08000, XR09000 and XR25000.

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Stakeholder submission required: LU NR DLR RfL LO Other: _____

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

14/11/2016

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 report will provide justification for the decommissioning of the instruments.

B. INSTRUMENTS

B.1 Description of the Instruments

This Close-Out Report relates the In-ground Monitoring installed for Farringdon Station, consisting of 5 No Extensometers. See Table 1 below with details.

Instrument	Depths (Below the ground level)	Easting (m)	Northing (m)	Elevation (mATD)	Location
C435-XR04000	5, 8, 12, 18, 21 and 27 (m)	81944.72	36470.409	105.351	Caxton Slab
C435-XR05000	5, 8, 11, and 16 (m)	81942.803	36477.516	105.397	Caxton Slab
C435-XR08000	3, 6, 9 and 11 (m)	82019.877	36490.9931	107.1695	Butchers Ramp Shaft
C435-XR09000	3, 8, 13, 16 and 19 (m)	82026.2092	36533.0175	112.7758	67-69 Cowcross St
C435-XR25000	3, 8, 11 and 15 (m)	82201.7786	36517.966	105.1772	Moorgate Spur Tunnel.

Table 1: Details of the extensometers.

The extensometers installed for Farringdon Station are shown in the following documents:

Drawings:

- C122-OVE-C2-DDA-CR001_Z-31531. Asset Protection I&M Ground surface and In-ground Farringdon Station C435.
- C435-BFK-C2-DWG-M123-50042. In ground devices installed for Farringdon Station.

Installation Reports:

- C435-BFK-C2-RGN-M123-50045. Installation Report- In ground monitoring- Extensometer XR04000.
- C435-BFK-C2-RGN-M123-50046. Installation Report- In ground monitoring- Extensometer XR05000.
- C435-BFK-C2-RGN-M123-50988. Installation Report- In ground monitoring- Extensometer XR08000.
- C435-BFK-C2-RGN-M123-50932. Installation Report- In ground monitoring- Extensometer XR09000.
- C435-BFK-C2-RGN-M123-50933. Installation Report- In ground monitoring- Extensometer XR25000.

B.2 Location of the Instruments

In ground device is located on the plan below highlighted in yellow.

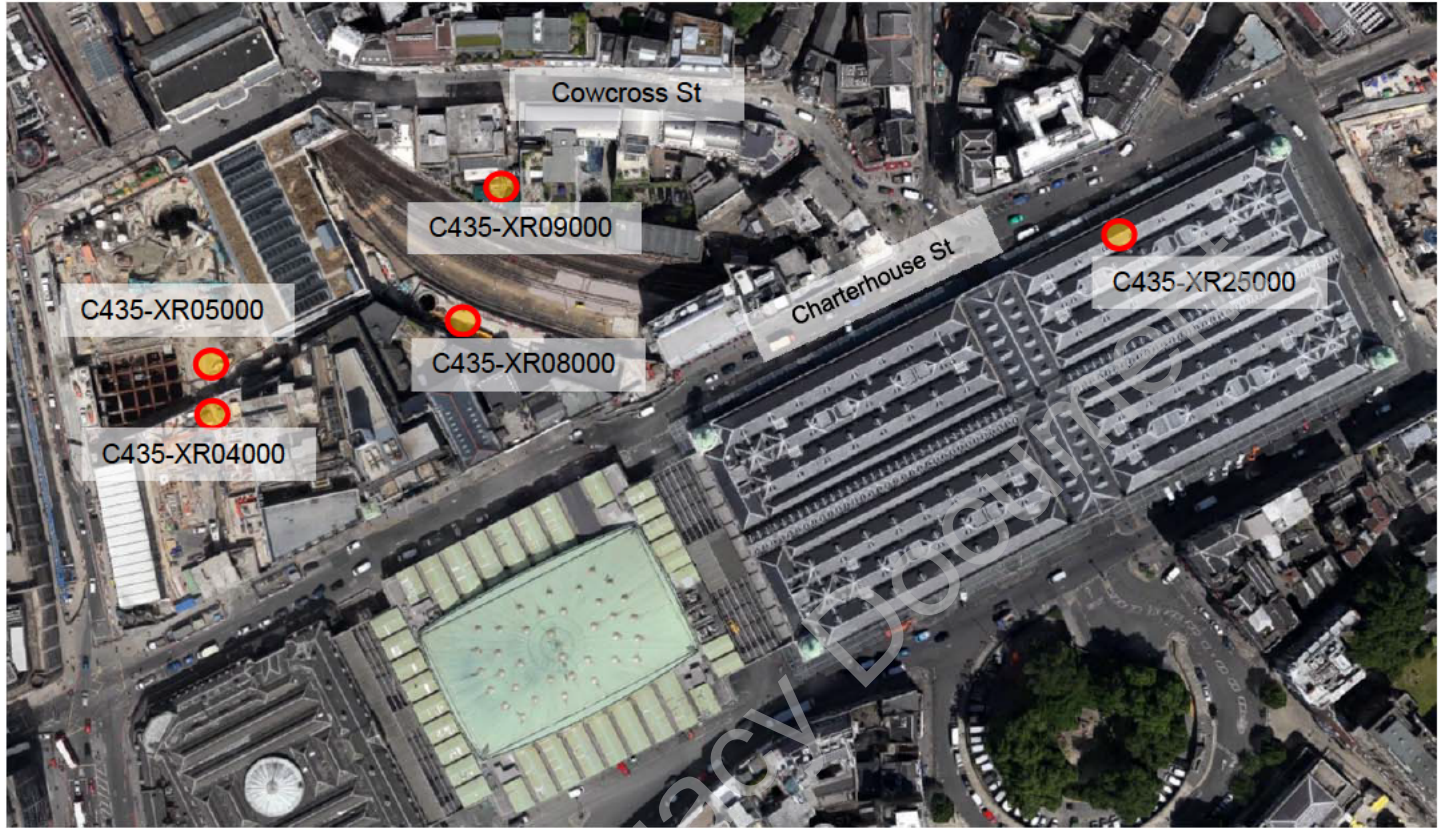


Figure 1 – Plan showing the Location for the Extensometers.

C. MOVEMENTS

C.1 Movements Resulting from Construction Activities

C.1.1 Relevant Crossrail (BKF) Works

The construction activities affecting this instrument are outlined in the Table 2 below.

Activity	Start Date	End Date
WB TBM	17/09/2013	05/10/2013
EB TBM	09/01/2014	13/01/2014
PTW Enlargement	30/03/2014	18/09/2014
CP3a	24/05/2014	27/08/2014
CP3b	28/05/2014	18/06/2014
PTE enlargement	30/05/2014	01/07/2014
CP1	07/07/2014	18/07/2014
CP6b	12/11/2014	14/11/2014
PL2	04/05/2015	24/05/2015

Table 2 – Construction Activities associated to the Extensometers

C.1.2 Resulting Movements

To analyse the result for the extensometers, this report looks at the following extensometers.

- Extensometer C435-XR04000.
- Extensometer C435-XR05000.
- Extensometer C435-XR08000.
- Extensometer C435-XR09000.
- Extensometer C435-XR25000.

- Extensometer C435-XR04000.

The monitoring data for the extensometer is shown in Appendix B.

- WB TBM caused maximum 12mm of settlement, captured on the deepest anchor from 17-09-2013 to 19-09-2013.
- Residual settlement caused 2mm maximum.
- Compensation grouting from Butcher's ramp Shaft caused maximum of 9mm of heave from 04-04-2014 to 12-05-2014.
- No movements caused by the CP1 works.
- PL2 caused maximum 16mm of settlement from 04-05-2015 to 24-05-2015.
- Maximum settlement captured by the extensometer at the end of the works -31mm.

- Extensometer C435-XR05000.

The monitoring data for the extensometer is shown in Appendix B.

- WB TBM caused maximum 8mm of settlement from 15-09-2013 to 19-09-2013.
- Residual settlement caused 2mm maximum.
- Compensation grouting from Butcher's Ramp Shaft caused maximum 3mm of heave from 14-03-2014 to 24-03-2014.
- Maximum settlement captured by the extensometer was 8mm.

Due the TBM passage, the deepest anchor of the extensometer (16m) was damaged after the WB TBM passage on 19-09-2013. The other anchors were not affected by the TBM.

The extensometer was installed on WTH site. During the excavation works and pile works for the Escalator Shaft, the extensometer was covered by concrete on 05-04-2014.

- Extensometer C435-XR08000.

The monitoring data for the extensometer is shown in Appendix B.

- During the TaM's drilling from Butcher's Ramp Shaft, 2mm maximum of heave was captured by the extensometer from 01-08-2013 to 25-09-2013.
- WB TBM caused maximum 7mm of settlement from 28-09-2013 to 30-09-2013.
- Residual settlement caused 3mm maximum.
- Compensation grouting from Butcher's Ramp Shaft caused maximum 5mm of heave from 18-02-2014 to 06-04-2014.
- PTW enlargement works caused maximum 7mm of settlement from 12-04-2014 to 25-04-2014.
- CP3b caused maximum 3mm of settlement from 28-05-2014 to 18-06-2014.
- Maximum settlement captured by the extensometer was 15mm.

The deepest anchor was damaged after the WB TBM due the passage. The rest of the anchors work properly.

- Extensometer C435-XR09000

The monitoring data for the extensometer is shown in Appendix B.

- TaM's drilling caused maximum 2mm of heave from 06-09-2013 to 25-09-2013.
- EB TBM caused maximum 5mm of settlement from 09-01-2014 to 13-01-2014.
- Residual settlement caused maximum 3mm.
- Compensation grouting from Butcher's Ramp caused maximum 12 mm of heave from 08-04-2014 to 28-05-2014.
- PTE enlargement works caused maximum 37mm captured in the deepest anchor. The rest of the anchors showed 20mm of settlement.
- CP3a caused maximum 6mm of settlement from 24-05-2014 to 27-08-2014.
- Compensation grouting caused maximum 5mm of heave from 16-07-2014 to 05-08-2014.
- Maximum settlement captured by the extensometer at the end of the works -44mm.

- Extensometer C435-XR25000.

The monitoring data for the extensometer is shown in Appendix B.

- TaM's drilling from Moorgate Spur 2 caused maximum 3mm of heave from 01-08-2013 to 19-09-2013.
- WB TBM caused maximum 10mm of settlement from 03-10-2013 to 05-10-2013.
- Residual settlement caused 2-3mm.
- Compensation grouting from Moorgate Shaft 2 caused maximum 5mm of heave from 25-02-2014 to 13-05-2014.
- PTW enlargement caused maximum 24mm of settlement captured in the deepest anchor.
- No movements caused by the CP6b works.
- Maximum settlement captured at the end of the works -33mm.

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 devices. No triggers have been defined for the instrument included in this report.

C.3 Significant Issues with the Instrumentation

- Extensometer XR05000:

Due the TBM passage, the deepest anchor of the extensometer (16m) was damaged after the WB TBM on 19-09-2013. The other anchors were not affected by the TBM.

The extensometer was installed on WTH site. During the excavation works and pile works for the Escalator Shaft, the extensometer was covered by concrete on 05-04-2014.

- Extensometer XR08000

The deepest anchor was damaged by the WB TBM due the passage. The rest of the anchors work properly.

C.4 Residual Risks

As per C435-PMI-00549 the Long Term Monitoring has been ceased by Contract C435 in this area. The last measurements carried out for these devices are:

- For Extensometer XR04000 was on 02-06-2015.
- For Extensometer XR08000 was on 18-06-2015.
- For Extensometer XR09000 was on 03-12-2015.
- For Extensometer XR25000 was on 30-11-2015.

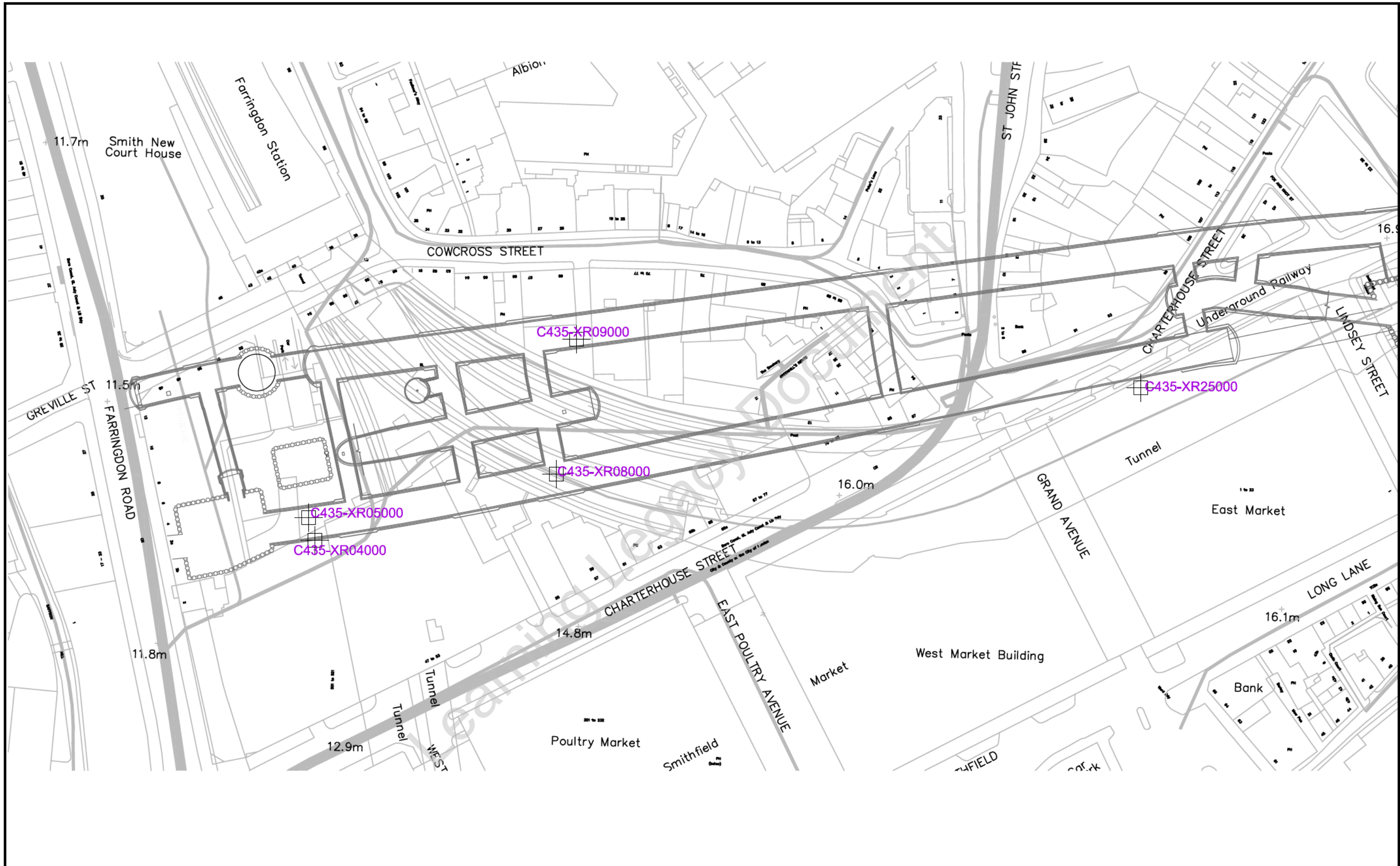
D. CONCLUSIONS

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

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APPENDIX A: DRAWINGS

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Rev.	Date	Description	By	Chkd	App	Auth

Notes:

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Contract : BORED TUNNELS (ALIGNMENT AND TRACK)
 Originator : OVE ARUP & PARTNERS LIMITED
 Location : CROSSRAIL GENERAL
 Title : IN-GROUND DEVICES INSTALLED FOR FARRINGDON STATION

Scale : @ A3 Drg No : C435-BFK-C2-DWG-M123-50042 Rev : Sult : Auth :

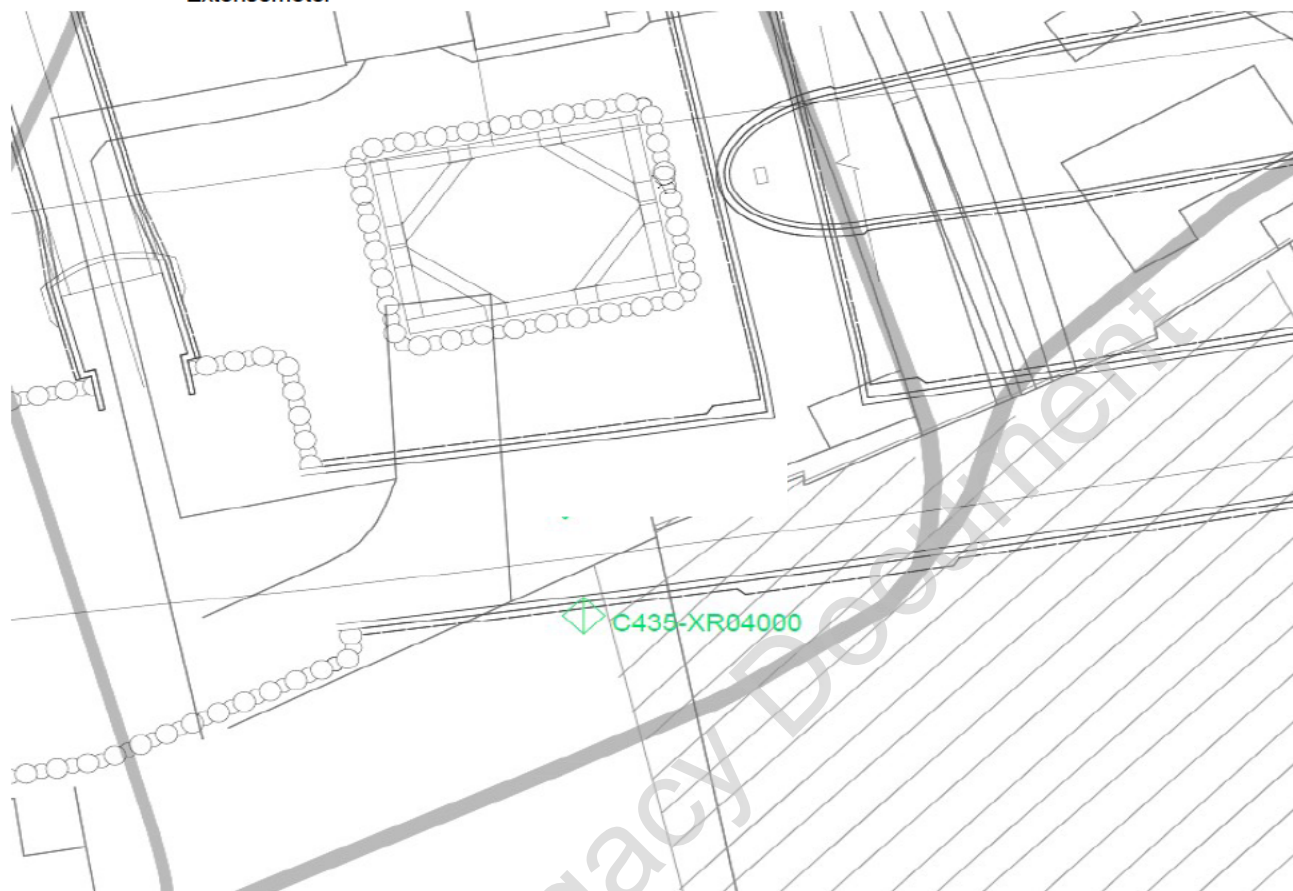
By :
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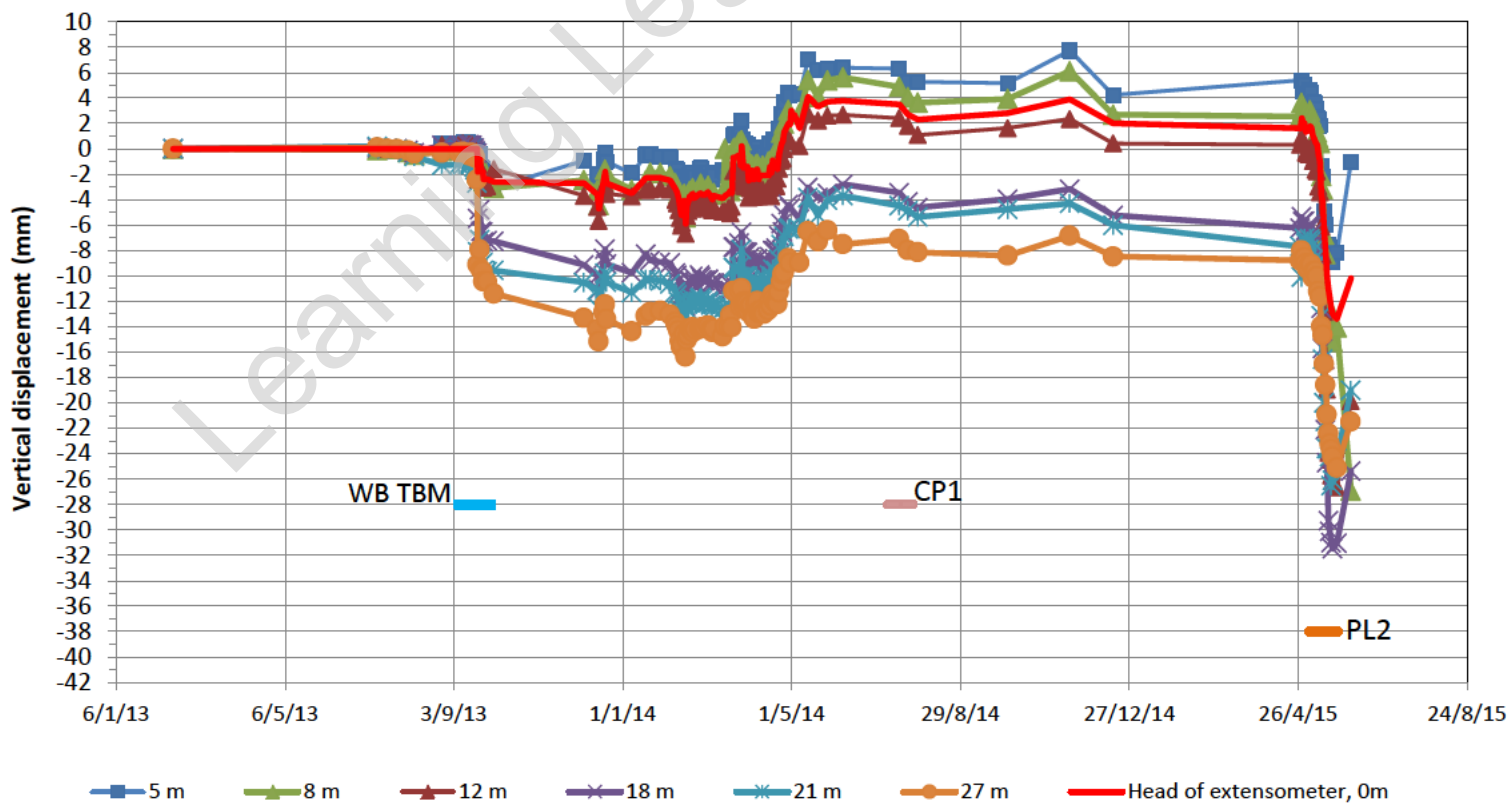
APPENDIX B: GRAPHS

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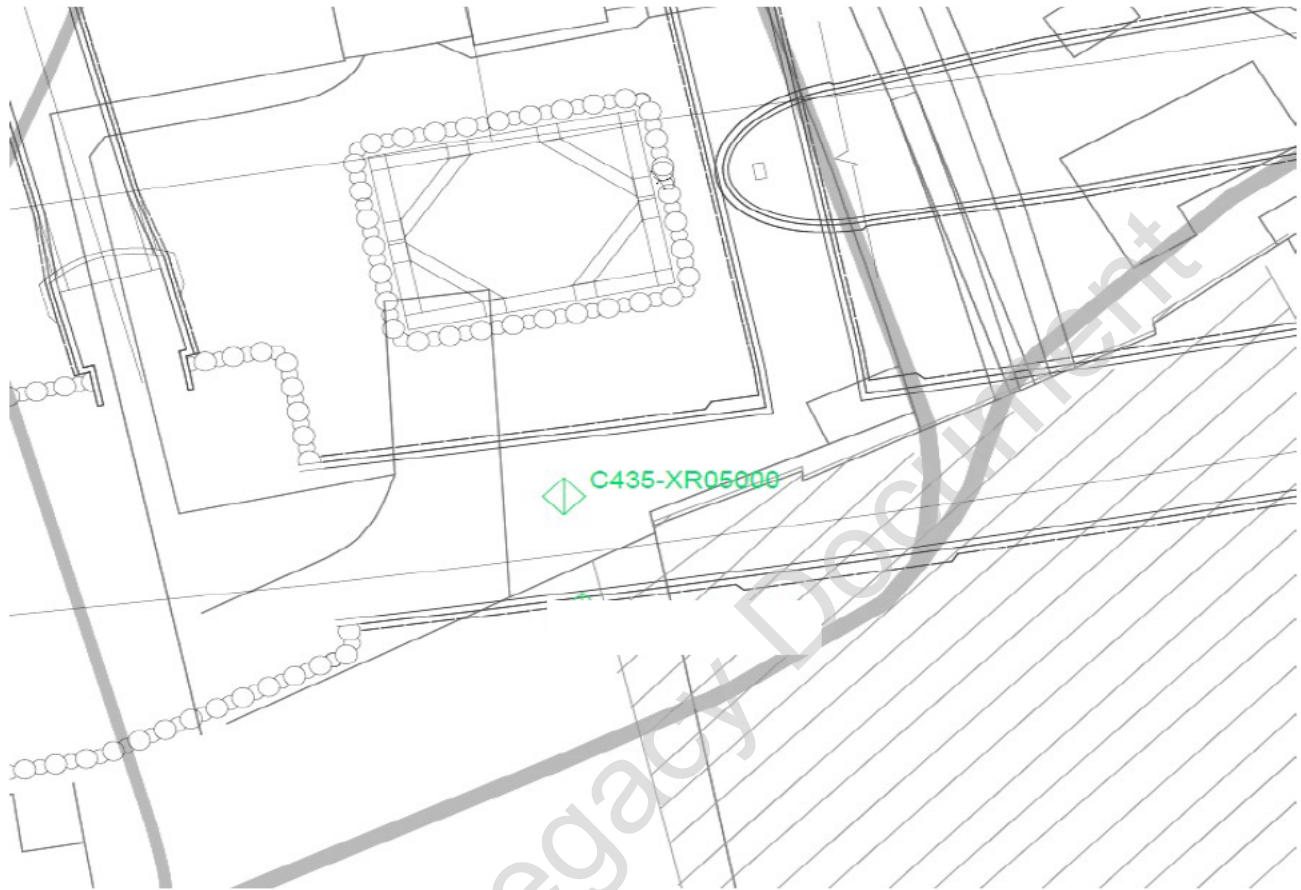
REPORT: In-ground monitoring
AREA: Caxton Slab
DEVICE: Extensometer



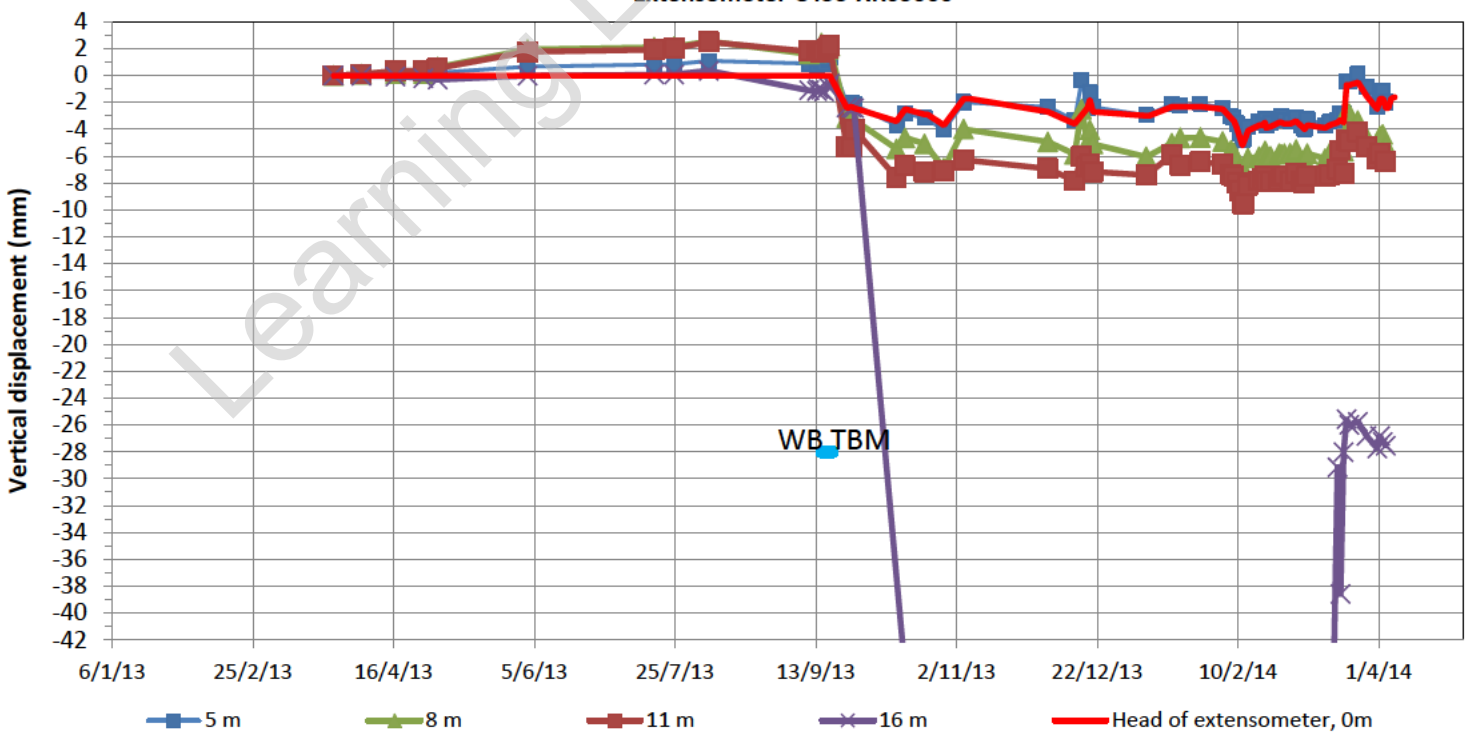
Extensometer C435-XR04000



REPORT: In-ground monitoring
AREA: Caxton Slab
DEVICE: Extensometer



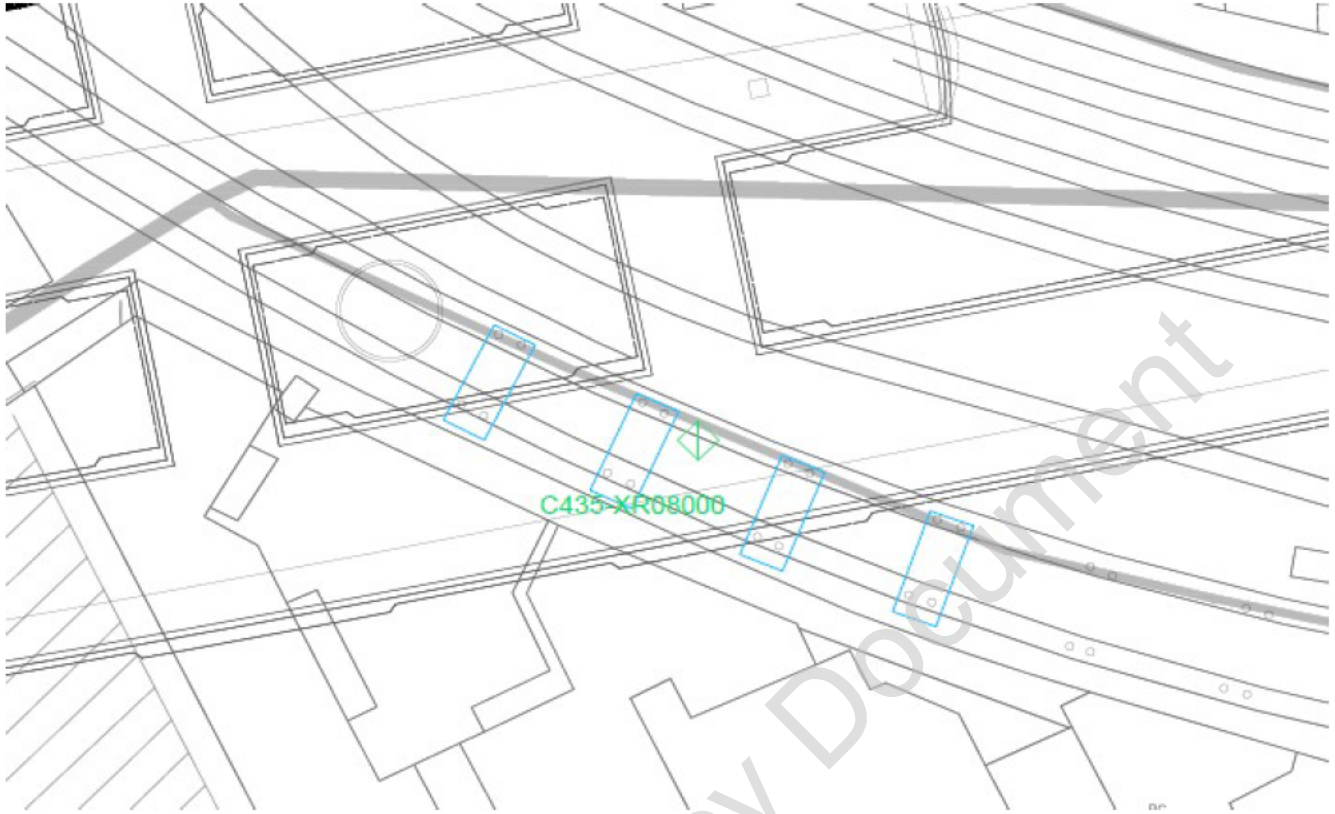
Extensometer C435-XR05000



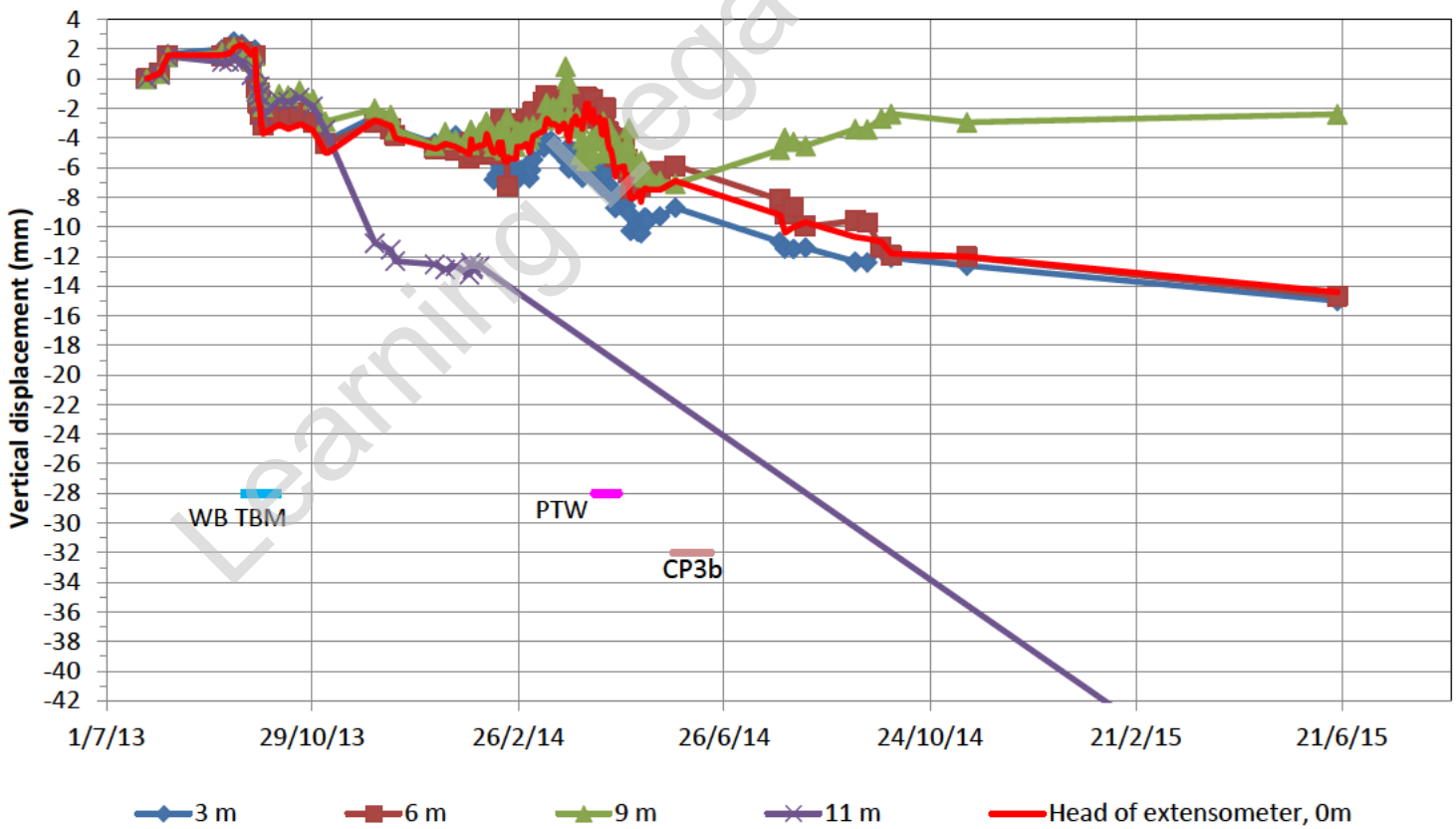
REMARKS:

The deepest anchor was broke due the TBM passage from 15-09-2013 to 19-09-2013.
 The extensometer was covered by concrete on 05-04-2014 due the works carried out on Caxton Slab. No more reading

REPORT: In-ground monitoring
AREA: Butcher's Ramp Shaft
DEVICE: Extensometer



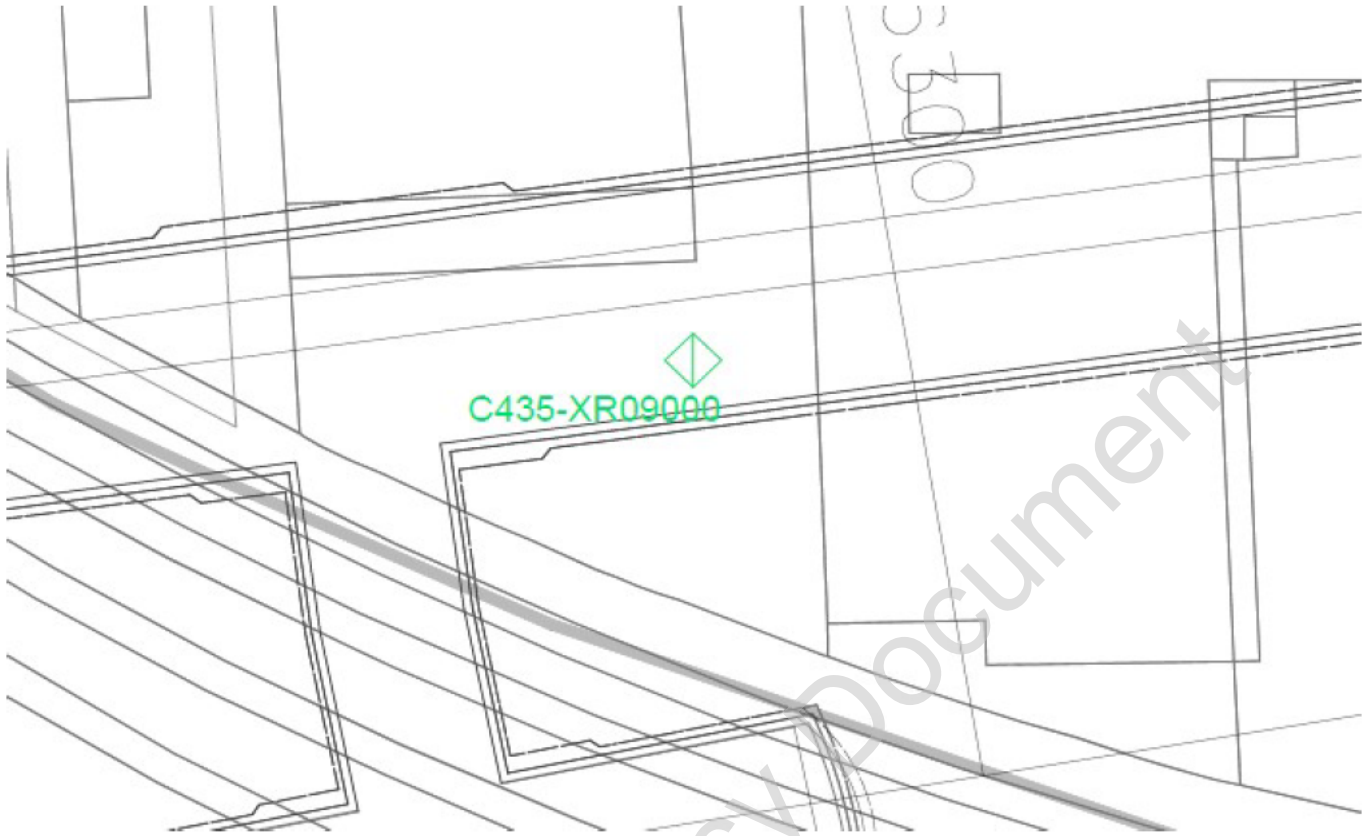
Extensometer C435-XR08000



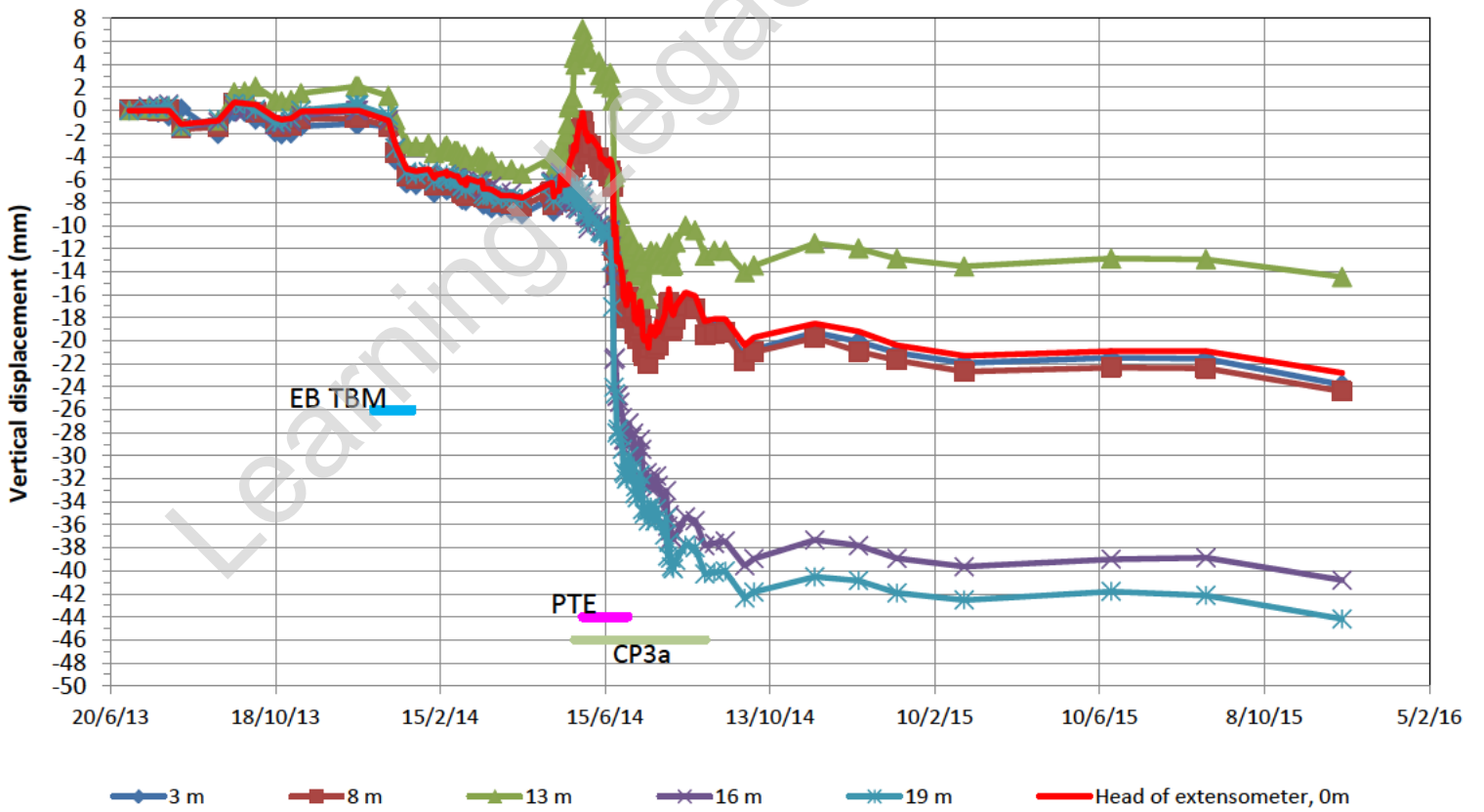
REMARKS:

The deepest anchor was broke due the TBM passage. The rest of the anchors cotinued working properly.

REPORT: In-ground monitoring
AREA: 67 Cowcross St Backyard
DEVICE: Extensometer



Extensometer C435-XR09000

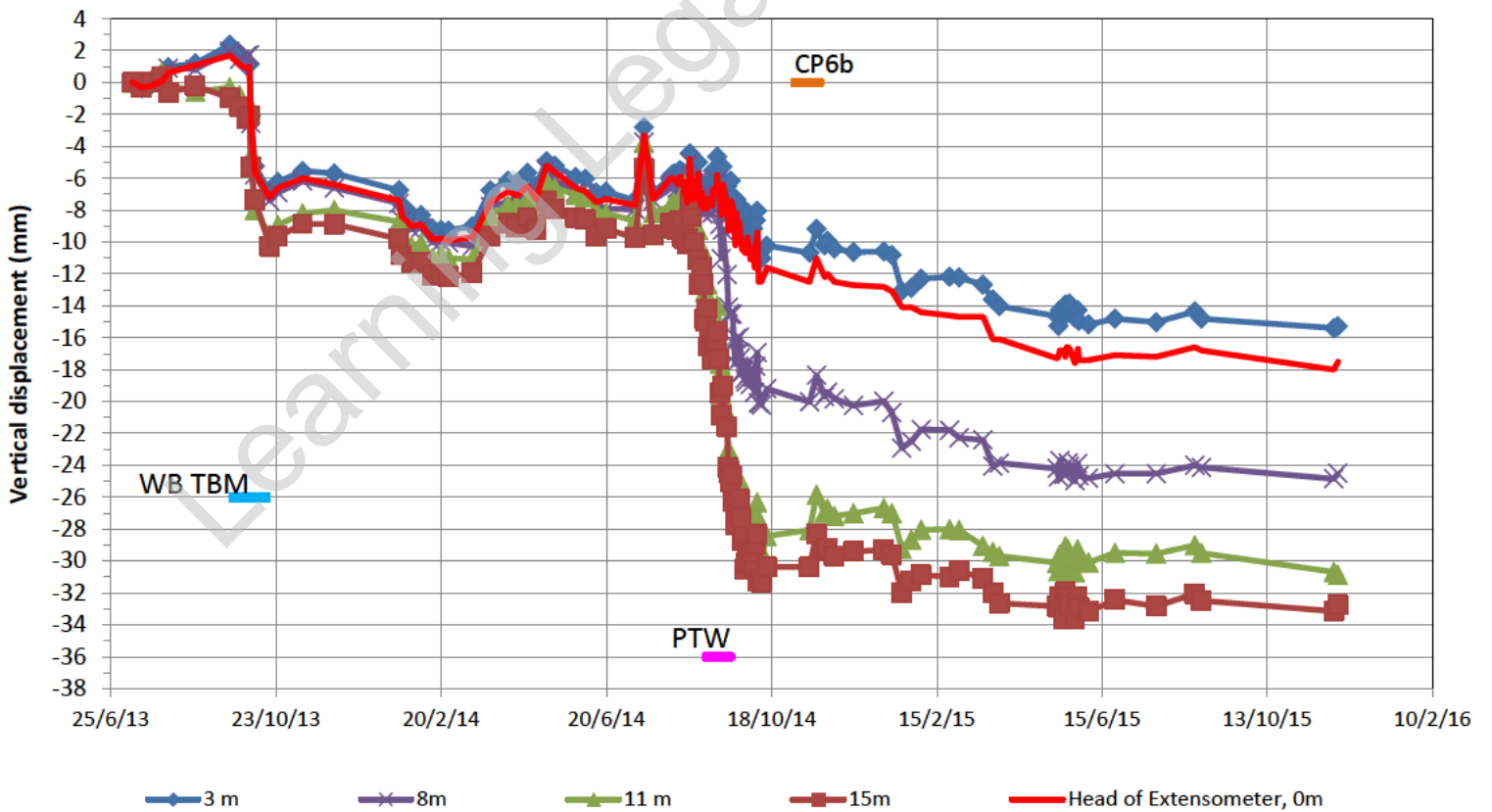


REMARKS:

REPORT: In-ground monitoring
AREA: Moorgate Spur Tunnel
DEVICE: Extensometer



Extensometer C435-XR25000



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 Passage.
- CH Concourse Hall.
- VA Ventilation Adit.
- STE Stub Tunnel East.
- STW Stub Tunnel West.
- RTE Running Tunnel East.
- ES Escalator Shaft.
- TaM Tube a Manchette.

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