



Work Area: SMM
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Originator Company: GEOCISA

C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer: [Redacted]

Monitoring Close-Out Report: Automated Total Station ATS11 and 3D Targets read by ATS11.

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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"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

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

3. Acceptance by Crossrail:

[Redacted] eer
09/03/2016

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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 the prisms read by ATS11, most of the installed on St John St. See table 1 below with the details for the prisms.

Sensor	Location	Northing	Estaing	Elevation
C435-RP01101	20 ST JOHN ST	82166.2988	36581.0202	121.9105
C435-RP01102	20 ST JOHN ST	82166.2199	36580.8999	129.6977
C435-RP01103	20 ST JOHN ST	82161.7889	36573.5453	122.216
C435-RP01104	20 ST JOHN ST	82162.0929	36574.164	129.6011
C435-RP01107	3-5 ST JOHN ST	82145.9531	36545.0703	121.0182
C435-RP01108	3-5 ST JOHN ST	82145.9911	36545.0032	129.0265
C435-RP01109	3-5 ST JOHN ST	82145.563	36549.6708	128.8784
C435-RP01110	3-5 ST JOHN ST	82145.5448	36549.9625	122.0414
C435-RP01111	7-9 ST JOHN ST	82145.563	36549.6707	128.8786
C435-RP01112	7-9 ST JOHN ST	82144.9005	36557.2698	120.5687
C435-RP01113	7-9 ST JOHN ST	82144.7714	36560.7655	128.8685
C435-RP01114	11-33 ST JOHN ST	82144.7461	36560.7023	120.1153
C435-RP01115	11-33 ST JOHN ST	82144.9037	36557.3389	128.4995
C435-RP01116	7-9 ST JOHN ST	82143.7175	36572.8773	120.1515
C435-RP01117	11-33 ST JOHN ST	82143.7476	36572.9151	128.3138
C435-RP01118	11-33 ST JOHN ST	82143.5371	36583.4003	120.8059
C435-RP01119	11-33 ST JOHN ST	82143.5509	36583.4823	128.2262
C435-RP01120	11-33 ST JOHN ST	82143.3643	36594.1971	120.5924
C435-RP01121	11-33 ST JOHN ST	82143.3832	36594.1992	128.7627
C435-RP01122	11-33 ST JOHN ST	82143.2792	36599.6058	120.7338
C435-RP01123	11-33 ST JOHN ST	82143.2907	36599.7195	126.8192
C435-RP01124	11-33 ST JOHN ST	82143.2031	36603.645	120.5222
C435-RP01125	11-33 ST JOHN ST	82143.2211	36603.8681	129.1402
C435-RP01126	11-33 ST JOHN ST	82157.2493	36546.5369	119.1269

C435-RP01127	8-12 ST JOHN ST	82157.6666	36550.3651	119.5712
C435-RP01128	8-12 ST JOHN ST	82157.6386	36550.2766	121.7471
C435-RP01129	8-12 ST JOHN ST	82158.0749	36554.2323	119.9264
C435-RP01130	8-12 ST JOHN ST	82158.0913	36554.4764	121.8472
C435-RP01131	8-12 ST JOHN ST	82159.054	36562.7514	120.959
C435-RP01133	16 ST JOHN ST	82159.2519	36563.3479	130.0635
C435-RP01134	16 ST JOHN ST	82160.6573	36569.0718	120.9057
C435-RP01135	16 ST JOHN ST	82160.7627	36569.3225	129.3547
C435-RP01136	16 ST JOHN ST	82161.7887	36573.5454	122.2163
C435-RP01137	16 ST JOHN ST	82161.4593	36572.1287	130.8074
C435-RP01138	16 ST JOHN ST	82146.3097	36541.0143	120.7996
C435-RP01139	3-5 ST JOHN ST	82166.2988	36581.0202	121.9105

Table 1: Details of the prisms read byATS12 on Cowcross St

The prisms reading by ATS12 installed on Cowcross St are shown in the following documents:

Drawings:

- C435-BFK-C2-RGN-M123-50059-IR-RP-ATS11

Installation Reports:

- C435-BFK-C2-RGN-M123-50013
- C435-BFK-C2-RGN-M123-50059

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B.2 Location of the Instruments

The buildings where the prisms are installed are located along St John St. The prisms are installed on the façade for the building. In some case there are prisms in the same vertical but, different levels.

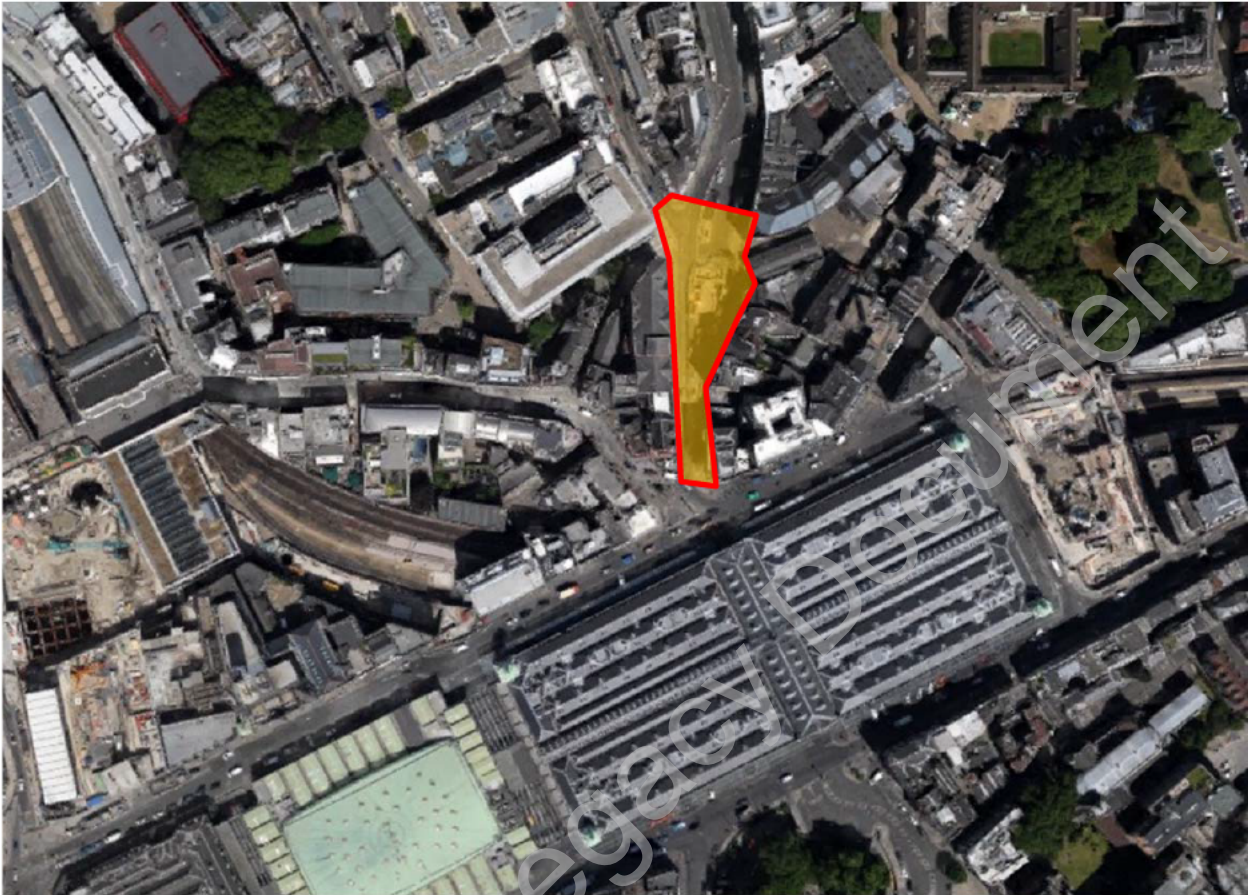


Figure 1 – Map showing the Location for the device on St John St

C. MOVIMENTS

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 tunneling works. In all cases, these comprise of the passage of a TBM (C300), platform tunnel enlargement and cross passengers tunnel. Also some areas for the prisms read by ATS 11 were been affected by different compensation grouting episode from Moorgate Shaft1.

The prisms reading by the ATS11 are installed on buildings on St John St. In some case the prisms are installed in different levels. The disposition for the façade is the best one to analyze the movements. All of them are installed perpendicular to the tunnel axis.

Prisms from ATS11 on St John St were affected by EB TBM and PT enlargement.

The closer prism to CP4 is 23m, so the influence for this tunnel is not important. Anyway, if the prisms installed on this building show movements, will be analyze in this report.

Activity	Start Date	End Date
EB TBM passage	16/01/2014	19/01/2014
PTE enlargement	19/08/2014	16/10/2014
CP4	19/09/2014	22/09/2014

C.1.2 Resulting Movements

To analyse the result for the prisms will be separate by buildings:.

- 3-5 St John St.
- 7-9 St John St.
- 11-33 St John St.
- 8-12 St John St.
- 16 St John St.
- 20 St John St.

- 3-5 ST John Street

The monitoring data for this building is showing in Appendix B. The prisms installed on this building are in two different levels.

The movements captured by the prisms installed on this building, show the different works that has been carried out closer to the building.

Before TBM affected to this building some grouting episode was carried out from Moorgate Shaft 1. The first episode was carried out on July 2013. This grouting caused 2mm maximum. The second one was carried out on August 2013 caused 4-5mm of heave. After these two episodes the movement captured by the prisms show a settlement trend. During this trending the prisms show 2mm settlement. When the building was inside the influence area for EB TBM, the prisms captured 4-5mm of settlement. After the TBM, the trend for the building was continued during 4 months, adding another 6mm of settlement, until a new grouting episode was carried out. For this episode on July 2014, 2 mm of heave was captured. After this episode, the movement for the building was stable, until a new episode was carried out on August 2014. During this episode, 10-12mm of heave was captured by the prisms. On this point in time, the building condition was proximally similar to the Pre-TBM passing.

After this episode, the building was inside of the influence area for PTE enlargement. During this construction works, the maximum settlement captured by the prisms was 16mm maximum.

At the end of the PE construction works, a grouting episode was carried out, causing 2mm of heave. After this episode, the trend of settlement was continuing adding 4mm, until September 2015. From this date, the data for the prisms show stable conditions, the rate for the movements is less than 2mm/year.

- 7-9 St John St.

The movement captured by the prisms installed on this building is showing in Appendix B.

The behaviour of the prisms installed, is very similar to the 3-5 St John St, because both buildings were affected for the same works.

Before BM arrive to the area where the prisms are installed, two grouting episode was carried out to improve the ground conditions. The prisms captured in total for both episodes, 5-6mm of heave. After these episodes, the prisms show a settlement trend, showing 2mm of settlement.

During the TBM, the prisms show 4-5mm of settlement. After the TBM, the building continues settling during 7 months, until a new grouting episode was carried out on August (before PTE works). This grouting episode caused 12mm maximum of heave.

When the building was inside the influence area for PTE, the prisms show the maximum settlement. In total, during this period, the maximum settlement was -16mm. Once the building was outside for the PTE, a new grouting episode was carried out, causing 2mm of heave.

After finish all works closer to this building, a trend of settlement was captured by the prisms, adding 2mm more, until September 2015. From this date, the prisms show stable conditions.

At the end, and with the combination for all works, the maximum movement on this building (settlement) was -18mm.

- 11-33 St John St

The result for the data for the prisms installed on this building is showing in the Appendix B.

The behaviour for the prisms installed in this building is different depending how close the prisms to the tunnel are. This building is too long, and some prisms are installed just in the tunnel limit, and the other ones are installed too far.

Before TBM arrived, some grouting episode was carried out to improve the ground conditions. The maximum movement caused by the grouting was 3-4mm of heave. After this episode, all prisms show stable conditions until the TBM cross the building. During the TBM, the prisms closer to the tunnel are the prisms that show more settlement, in this case the maximum settlement was 4-5mm. The rest of the prisms didn't show significant movements.

The prisms closer to the tunnel, after the TBM, show a settlement trend adding 2mm more.

Before the building was inside the influence area for PTE, two grouting's episodes was carried out. For the first one, the maximum movement captured by the prisms was 2mm, and for the second one was another 2mm.

The second episode was captured only by the prisms closer to the tunnel.

When the building was inside the PTE influence area, the closer prisms to the tunnel showed 12mm. The prisms installed in the middle way between the further a closer, show 4mm maximum.

After PTE, a new grouting episode was carried out to stop the trend of the movements. On the further prisms, the trend was stopped, but no on the prisms closer to the tunnel. These prisms continue settling during 6 months, until May 2015. From this date, the prisms show stable conditions. The rate for the movements is less than 2mm/year.

- 8-12 St John St.

The data for the prisms installed on this building is showing in Appendix B.

As the graphic shows, some grouting episode was carried out before the TBM in order to improve the settlement. During the first episode, 2mm was captured by the prisms. For the second episode, the prisms show another 6mm. After these episodes, the prisms show a settlement trend before the TBM. During this trend, 2mm was disappearing.

During the TBM on January 2014, 5-6mm of settlement was captured by the prisms. In this case, all the prisms show the same movement. After the TBM, the building continues settling during 4 months, adding another 6mm, until June, when a new grouting episode was carried out. During this episode, the prisms show maximum 6mm of heave in one prism. For the rest of the prisms the maximum heave was 2mm. After this episode, the prisms show stable conditions, until a new episode was carried out. For this episode, another 2mm of heave was captured by the prisms. After this episode, all heave was disappearing.

Is when the building was affected by the PTE enlargement, the movement was important. During this period, the prisms captured 8-10mm of settlement. Once the building was outside for the influence area for the PTE, all prisms shows stable conditions during 2 months. After these two months, the prisms started to show a settlement trend, adding 4mm more. No SCL works were carried out on this period to produce the trend.

On May 2015, the ATS start the long term period. The following readings during long term period confirm the trend of the movements, until September 2015, when the prisms start to show stable conditions. The last readings for the prisms carried out on December 2015 confirm that the prisms show stable conditions. From this date, the rate for the movements is less than 2mm per year.

- 16 St John St

The result, for the prisms installed on 16 St John St is presented in Appendix B.

The behaviour for this group of prisms is similar than the prisms installed on 8-10 St John St. The difference is that the movements for this prisms is less, because is quiet far from the tunnel.

Before the TBM, some grouting episode was carried out to improve the ground conditions. These episodes, caused in total 4mm of heave in all prisms installed on this building. After these episodes, all prisms show stable conditions, until TBM arrived. When the building was inside the influence area for the TBM, 3mm of settlement was captured by the prisms. After the TBM, a trend on the movements was observed, adding another 4mm more on settlement. On July, a grouting episode was carried out to try to stop the trend, caused 2mm of heave. After this episode, the prisms show stable conditions until PTE enlargement works.

During PTE works, 15-16mm of settlement maximum was captured by the prisms. The prisms that show the maximum movements are the prisms closer to the axis of the tunnel. The rest of the prisms show around 8-12mm.

After the PTE, a grouting episode was carried out to compensate the settlement, caused 2mm of heave in all prisms. After this episode, a trend was captured by the prisms, adding 2mm maximum on settlement.

After all works, and from June 2015, the prisms show stable conditions. From this date, the rates on the movements are less than 2mm/year.

- 20 St John St

The result, for the prisms installed on 20 St John St is presented in Appendix B.

The behaviour for this group of prisms is similar than the prisms installed on 16 St John St., but the magnitude for the movements are less because the building is too far for the tunnel.

Before the TBM, the grouting episode was carried out to improve the ground conditions, caused around 2-3mm of heave. After this episode, all prisms show stable conditions, until TBM arrived. When the building was inside the influence area for the TBM, 3-4mm of settlement was captured by the prisms. After the TBM, a trend on the movements was observed, adding another 5mm more on settlement. On July, a grouting episode was carried out to try to stop the trend, caused 2mm of heave. After this episode, and before the PTE, the prisms show stable conditions, until a new grouting episode was carried out, caused 2-3mm of heave.

During PTE works, 4-5mm of settlement maximum was captured by the prisms. The prisms that show the maximum movements are the prisms closer to the axis of the tunnel. The rest of the prisms show around 2-3mm.

After the PTE, a grouting episode was carried out on December 2014 to compensate the settlement, caused 1-2mm of heave in all prisms. After this episode, a trend was captured by the prisms, adding 2mm maximum on settlement.

After all works, and from April 2015, the prisms show stable conditions. From this date, the rates on the movements are less than 2mm/year.

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. Green trigger (-24mm. Green trigger is less (80%) that the predicted movement.

Most of the buildings where the prisms are installed are inside the compensation grouting area, so in this case, the triggers criteria for this building is based on the slopes.

If some prisms are outside the compensation grouting area, but part of the building are inside the compensation area, the criteria for these prisms are the slopes as well.

POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
					WORST HISTORICAL STATUS	CURRENT STATUS
C435-RP01101	AUTOMATIC RP	Settlement	09/12/2015 12:21	-2.1	Clear	Clear
C435-RP01102	AUTOMATIC RP	Settlement	09/12/2015 12:21	-4.7	Clear	Clear
C435-RP01103	AUTOMATIC RP	Settlement	09/12/2015 12:21	-9	Clear	Clear
C435-RP01104	AUTOMATIC RP	Settlement	09/12/2015 12:21	-8	Clear	Clear
C435-RP01107	AUTOMATIC RP	Settlement	09/12/2015 12:21	-16.1	Default Alert	Default Alert
C435-RP01108	AUTOMATIC RP	Settlement	09/12/2015 12:21	-16.2	Default Alert	Default Alert
C435-RP01110	AUTOMATIC RP	Settlement	09/12/2015 12:21	-16.3	Default Alert	Default Alert
C435-RP01111	AUTOMATIC RP	Settlement	09/12/2015 12:21	-15.5	Default Alert	Default Alert
C435-RP01112	AUTOMATIC RP	Settlement	09/12/2015 12:21	-15.8	Default Alert	Default Alert
C435-RP01113	AUTOMATIC RP	Settlement	09/12/2015 12:21	-17.4	Default Alert	Default Alert
C435-RP01114	AUTOMATIC RP	Settlement	09/12/2015 12:21	-18.2	Default Alert	Default Alert
C435-RP01115	AUTOMATIC RP	Settlement	09/12/2015 12:21	-17.3	Default Alert	Default Alert
C435-RP01116	AUTOMATIC RP	Settlement	09/12/2015 12:21	-18	Default Alert	Default Alert
C435-RP01117	AUTOMATIC RP	Settlement	09/12/2015 12:21	-7	Clear	Clear
C435-RP01118	AUTOMATIC RP	Settlement	09/12/2015 12:21	-6.2	Clear	Clear
C435-RP01119	AUTOMATIC RP	Settlement	09/12/2015 12:21	-2.5	Clear	Clear
C435-RP01120	AUTOMATIC RP	Settlement	09/12/2015 12:21	-1.8	Clear	Clear
C435-RP01121	AUTOMATIC RP	Settlement	09/12/2015 12:21	0.9	Clear	Clear
C435-RP01122	AUTOMATIC RP	Settlement	09/12/2015 12:21	0.9	Clear	Clear
C435-RP01123	AUTOMATIC RP	Settlement	09/12/2015 12:21	1.7	Clear	Clear
C435-RP01124	AUTOMATIC RP	Settlement	09/12/2015 12:21	1.2	Clear	Clear
C435-RP01125	AUTOMATIC RP	Settlement	09/12/2015 12:21	3.3	Clear	Clear
C435-RP01126	AUTOMATIC RP	Settlement	09/12/2015 12:21	3	Clear	Clear
C435-RP01127	AUTOMATIC RP	Settlement	09/12/2015 12:21	-20.7	Default Alert	Default Alert
C435-RP01128	AUTOMATIC RP	Settlement	09/12/2015 12:21	-20.6	Default Alert	Default Alert
C435-RP01129	AUTOMATIC RP	Settlement	09/12/2015 12:21	-20.7	Default Alert	Default Alert
C435-RP01130	AUTOMATIC RP	Settlement	09/12/2015 12:21	-15	Default Alert	Default Alert
C435-RP01131	AUTOMATIC RP	Settlement	09/12/2015 12:21	-21.3	Default Alert	Default Alert
C435-RP01133	AUTOMATIC RP	Settlement	09/12/2015 12:21	-16	Default Alert	Default Alert
C435-RP01134	AUTOMATIC RP	Settlement	09/12/2015 12:21	-16.2	Default Alert	Default Alert
C435-RP01135	AUTOMATIC RP	Settlement	09/12/2015 12:21	-12.6	Default Alert	Default Alert
C435-RP01136	AUTOMATIC RP	Settlement	09/12/2015 12:21	-11.4	Default Alert	Default Alert
C435-RP01137	AUTOMATIC RP	Settlement	09/12/2015 12:21	-8.1	Clear	Clear
C435-RP01138	AUTOMATIC RP	Settlement	09/12/2015 12:21	-10.3	Default Alert	Default Alert
C435-RP01139	AUTOMATIC RP	Settlement	09/12/2015 12:21	-16.9	Default Alert	Default Alert

C.3 Significant Issues with the Instrumentation

No issues with these devices.

C.4 Residual Risks

The rates of residual settlement for the prisms have been determined and in all cases these rates are less than 2mm/year.

D. CONCLUSIONS

Following the EB TBM passage, of the SCL enlargement of PTE, the maximum measured settlement on the prisms remains less than the expected.

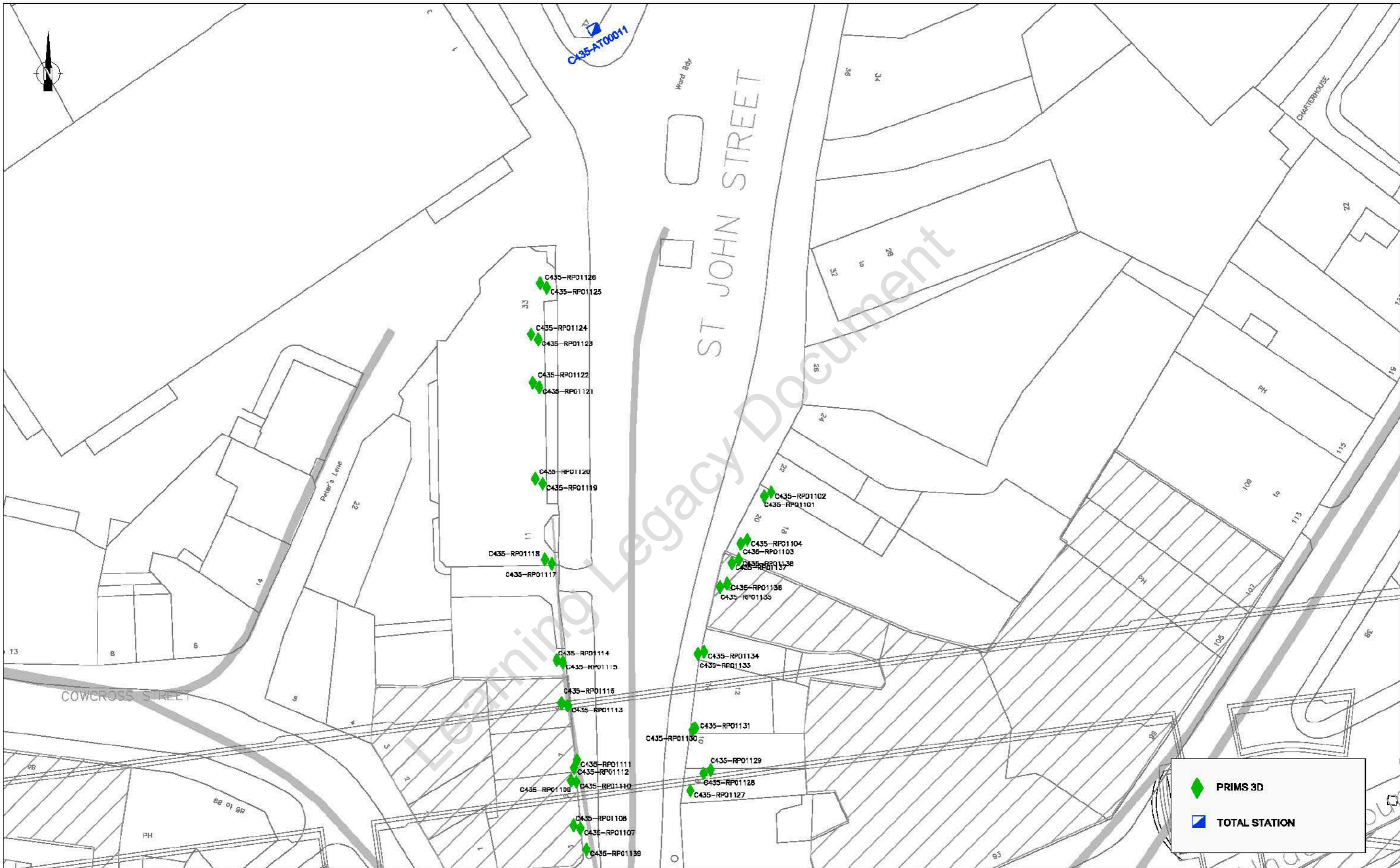
After the works, all devices do not show any significant movement, therefore these devices are considered stabilized.

At the moment, this area monitored by these prisms should be in a Long Term basis with readings every three months, but per C435-PMI-00549 Long Term has being ceased in this area, being the last measure carried out for these devices on 09/12/2015.

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APPENDIX A: DRAWINGS

Learning Legacy Document




Rev.	Date	Description	By	Chkd	App	Auth
1	20-05-2013					

Notes:




 C/ Los Llanos de Jerez 10-12
 28823- MADRID
 www.geocisa.com

Contract : C435 I&M FARRINGTON
 Originator : GEOCISA
 Location : CROSSRAIL GENERAL
 Title :
 3D PRIMS ATS11
 Drg No : C435-BFK-C2-RGN-M123-50059-IR-RP-ATS11

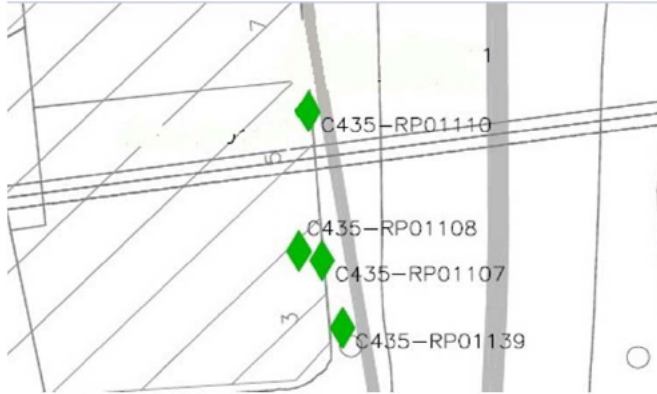
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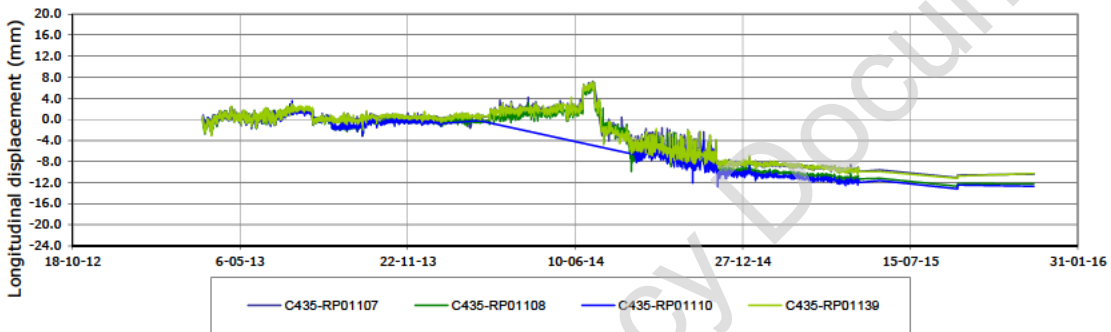
APPENDIX B: GRAPHS

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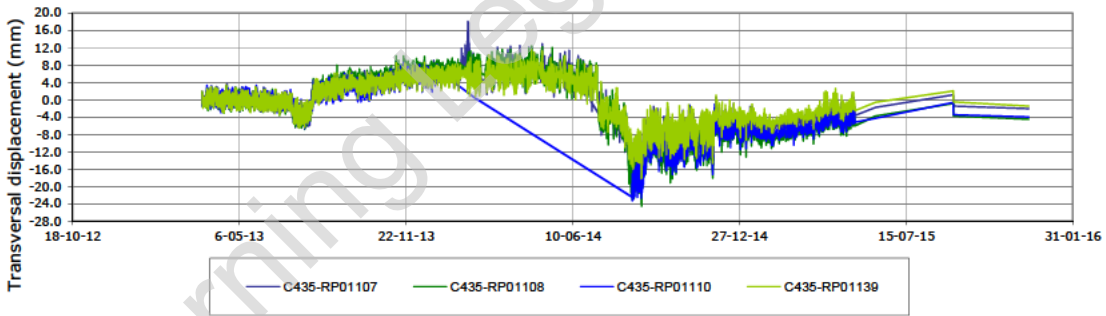
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



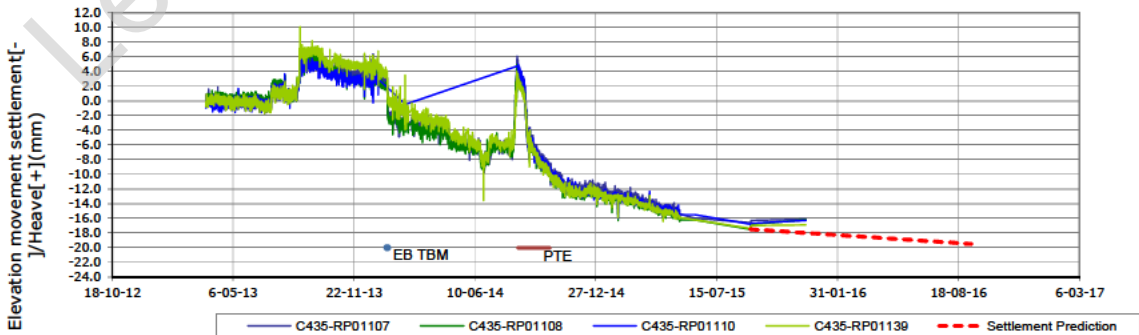
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Building: 3-5 ST JOHN STREET



Building: 3-5 ST JOHN STREET

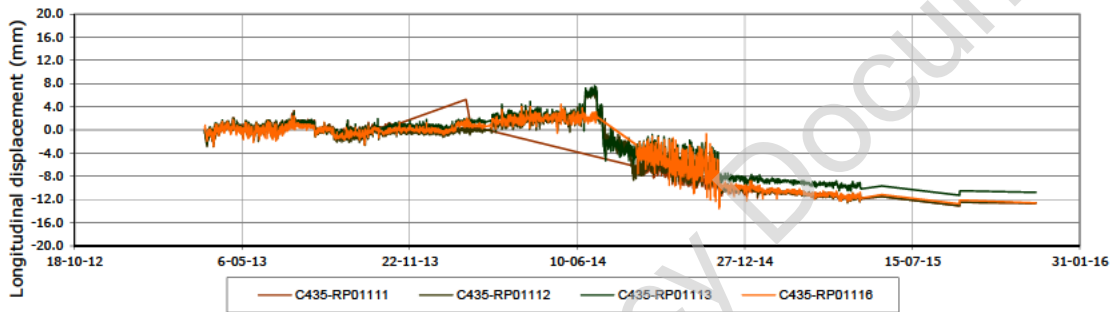


REMARKS

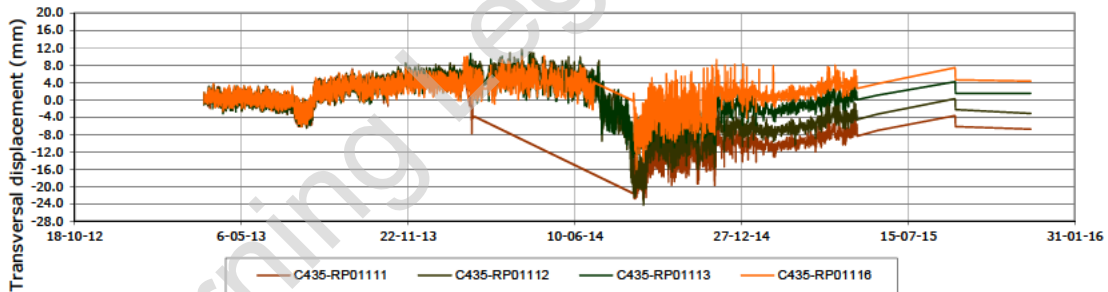
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 DEVICE 3D Target



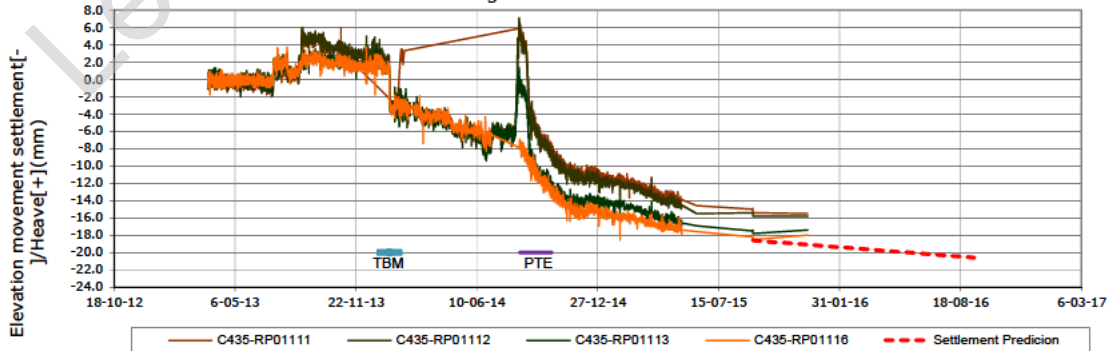
Building: 7-9 ST JOHN STREET



Building: 7-9 ST JOHN STREET

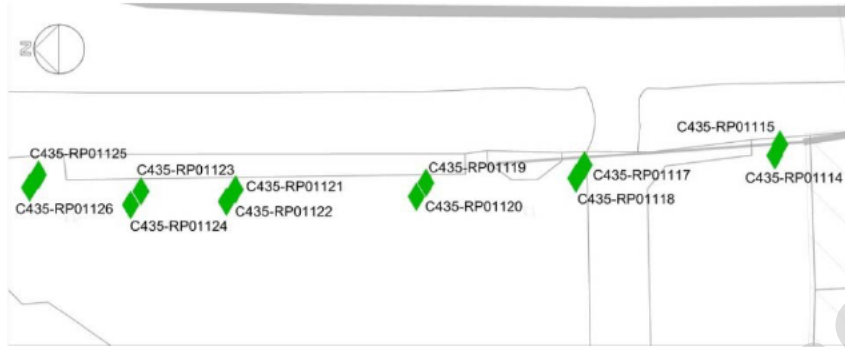


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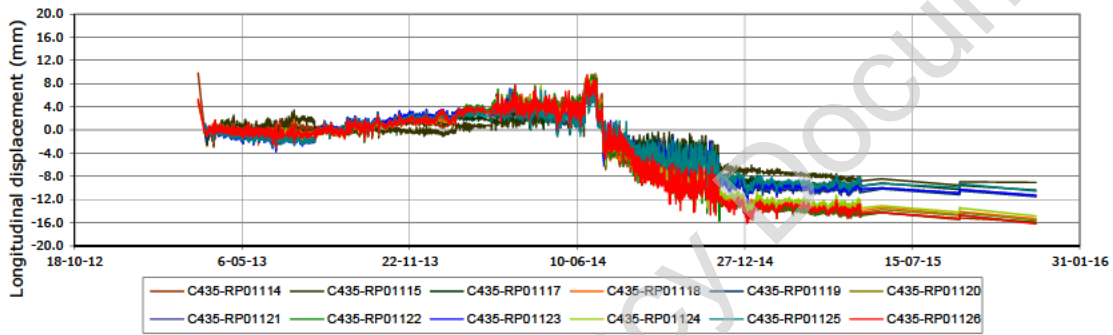


REMARKS

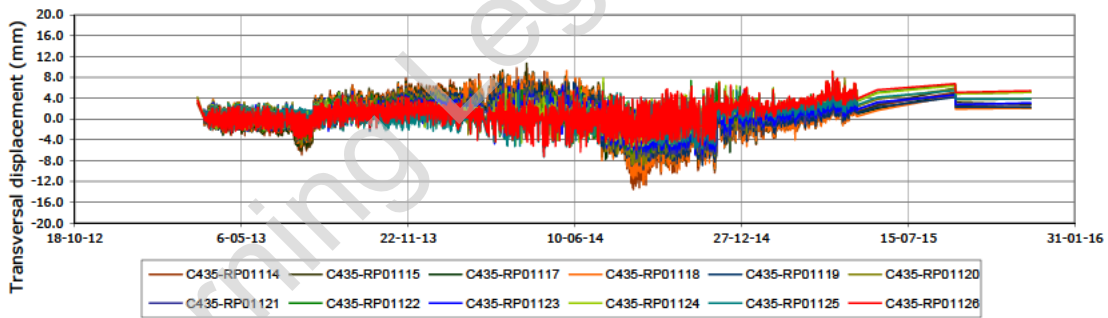
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



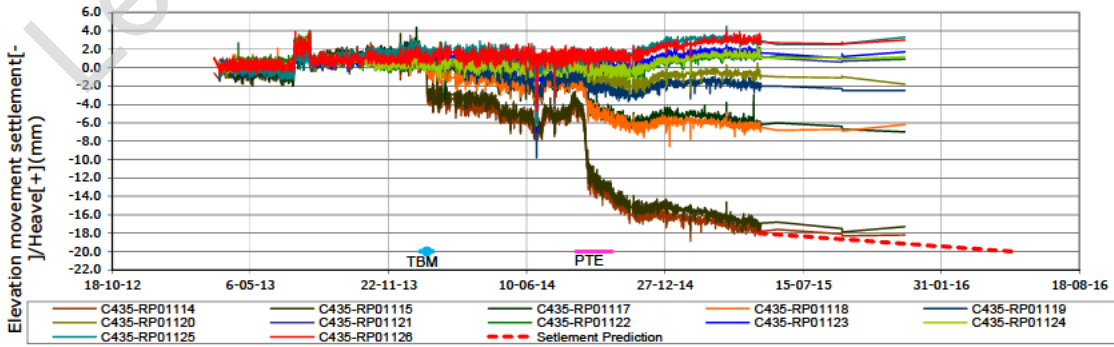
Building: 11-33 ST JOHN STREET



Building: 11-33 ST JOHN STREET

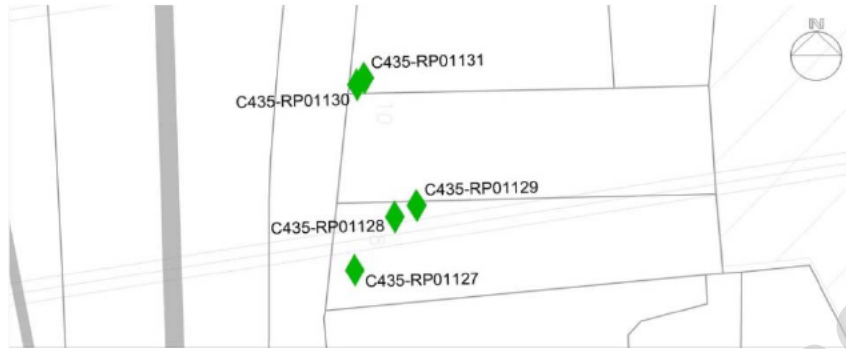


Building: 11-33 ST JOHN STREET

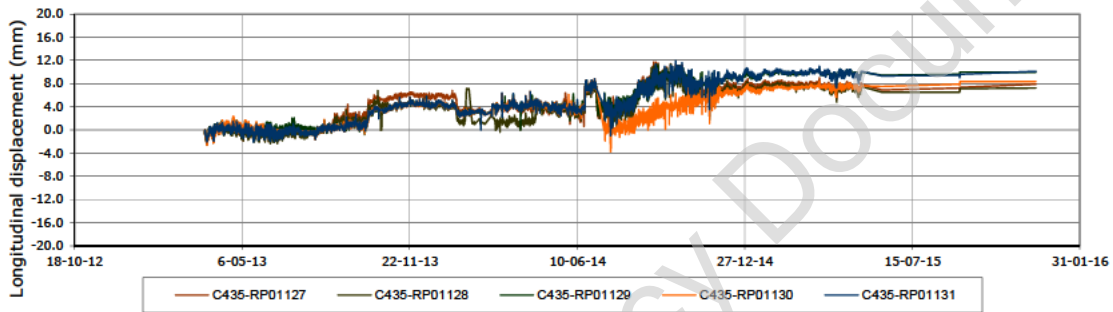


REMARKS

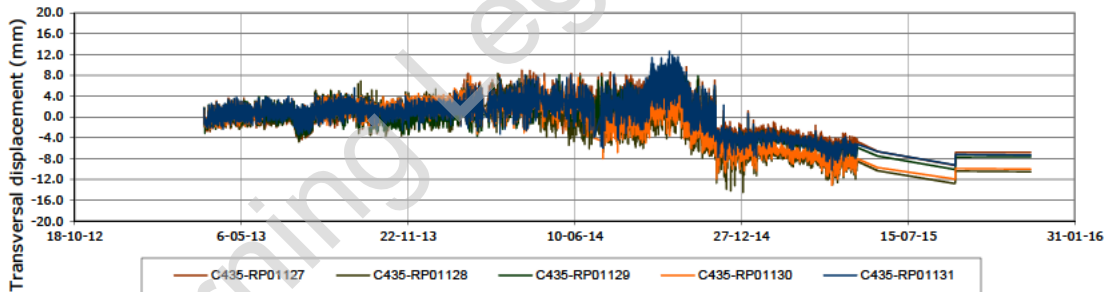
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



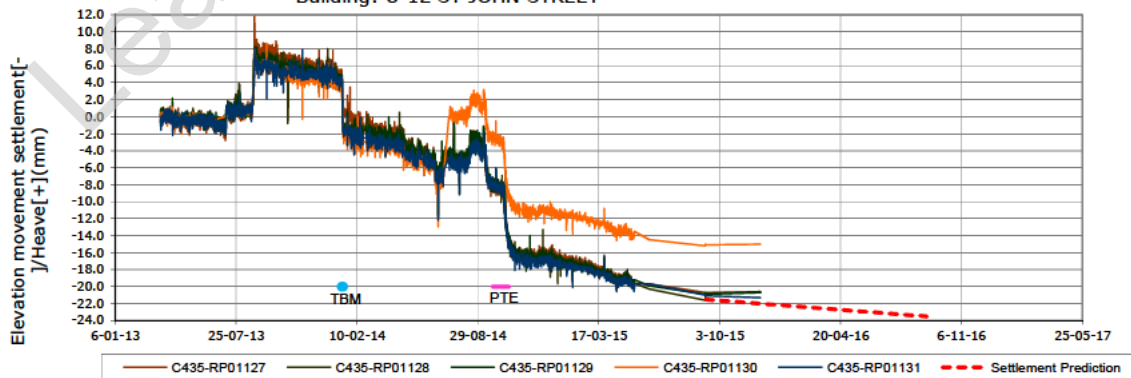
Building: 8-12 ST JOHN STREET



Building: 8-12 ST JOHN STREET

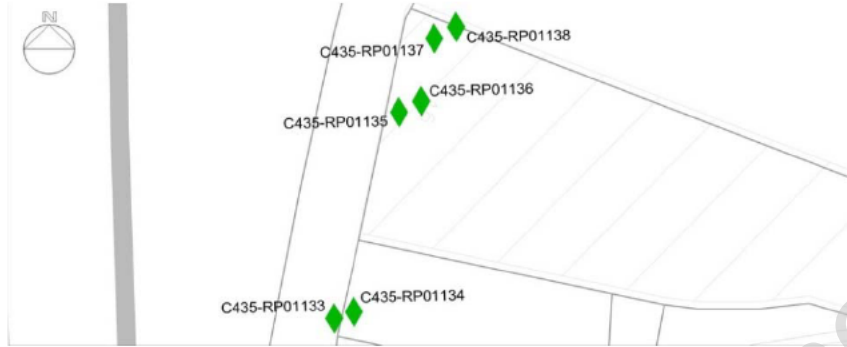


Building: 8-12 ST JOHN STREET

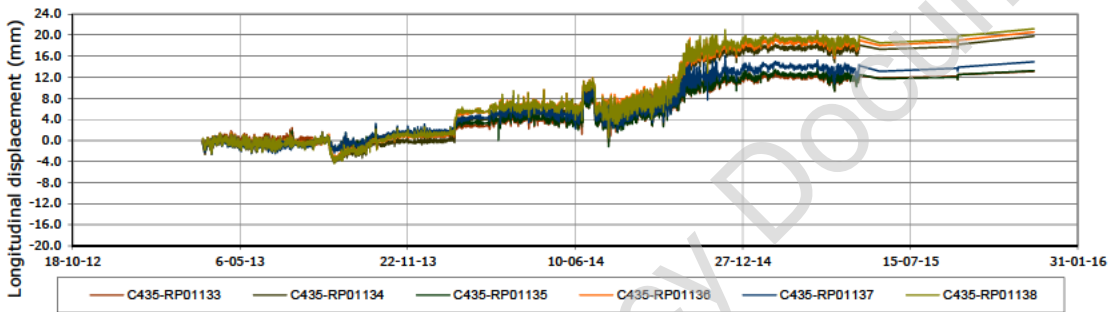


REMARKS

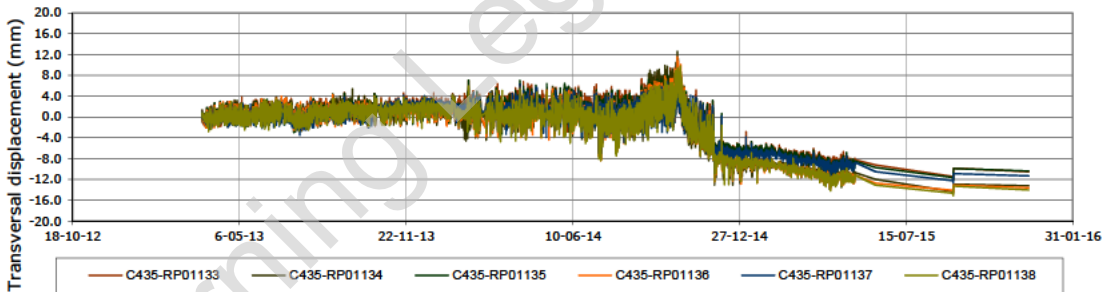
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



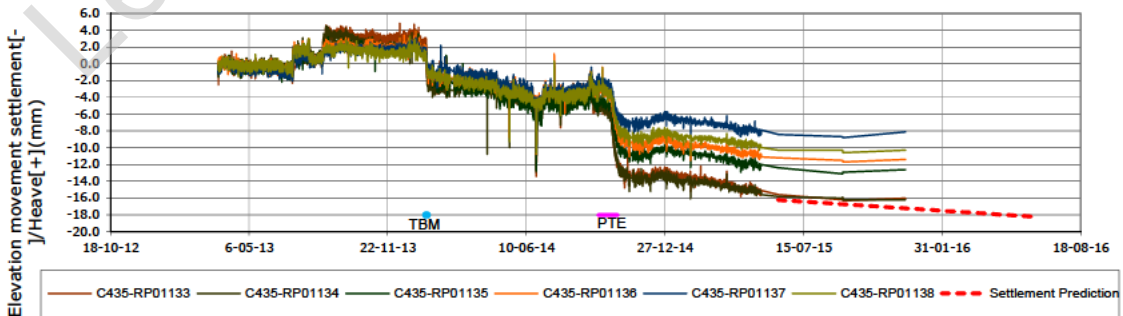
Building: 16 ST JOHN STREET



Building: 16 ST JOHN STREET



Building: 16 ST JOHN STREET

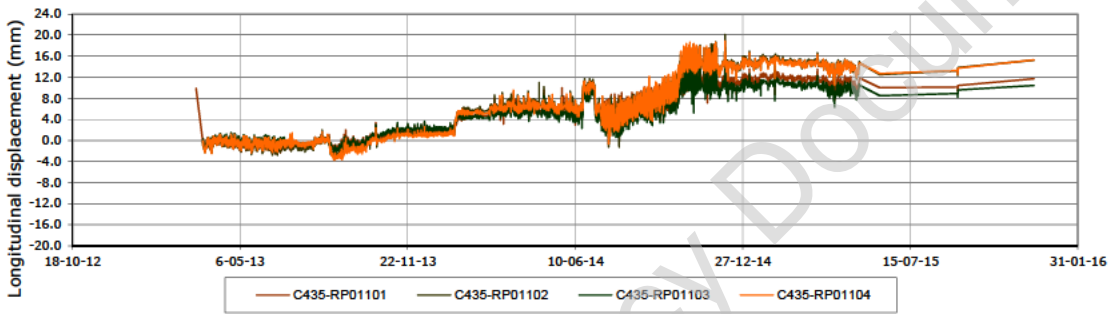


REMARKS

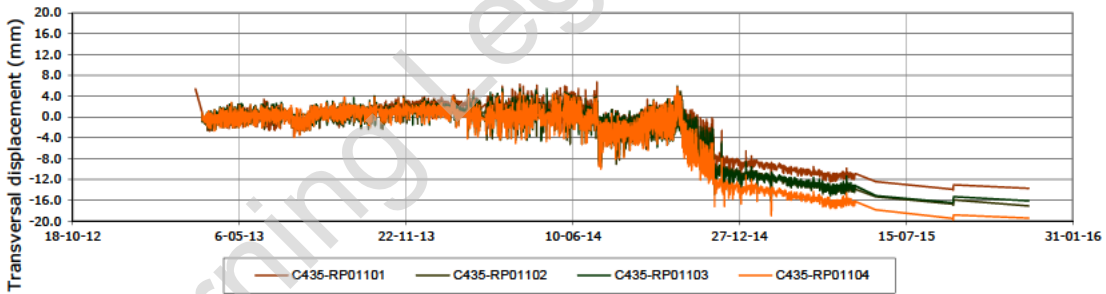
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



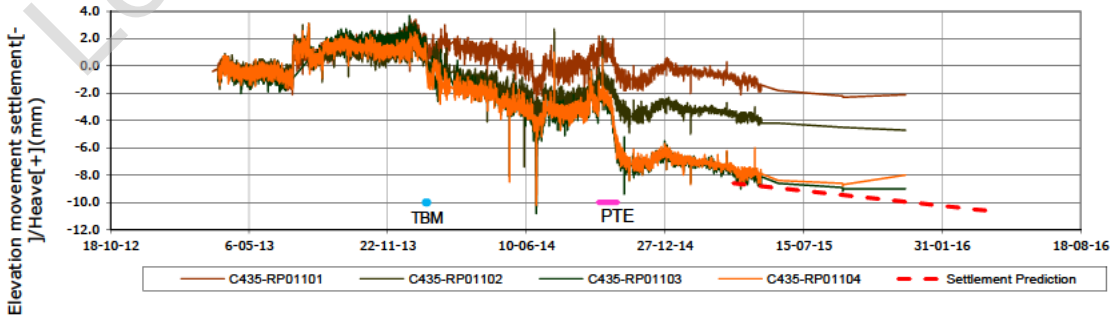
Building: 20 ST JOHN STREET



Building: 20 ST JOHN STREET



Building: 20 ST JOHN STREET



REMARKS