



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

C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer:

Monitoring Close-Out Report: Manual prisms

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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.

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2b. Review by Stakeholder (if required):

Stakeholder Organisation	Job Title	Name	Signature	Date	Acceptance
[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	<input type="checkbox"/>
[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	<input type="checkbox"/>
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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 prisms read manually. The prisms included on this report are the only ones that are reading manually at the moment. Most of the prisms read manually were installed by C430. When the contract C435 started, most of these prisms were change to be read automatically.

There are more manual prisms installed on the EDF cable Tunnel. The prisms installed in the EDF tunnel are included on the close out report for EDF, Ref C435-BFK-C2-RGN-M123-51584.

See Table 1 below with the details for the prisms.

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-RP03812	West Market, North façade	82097.467	36468.210	120.545
C435-RP03814	West Market, North façade	82122.126	36480.742	120.557
C435-RP03815	West Market, North façade	82133.766	36486.659	120.554
C435-RP03816	West Market, North façade	82144.460	36492.079	120.569
C435-RP03817	West Market, North façade	82158.407	36499.157	120.265
C435-RP03818	East Market, North façade	82172.134	36506.142	120.300
C435-RP03819	East Market, North façade	82177.101	36508.640	120.619
C435-RP03820	East Market, North façade	82181.005	36510.637	120.616
C435-RP03821	East Market, North façade	82184.915	36512.618	120.623
C435-RP03824	East Market, North façade	82204.746	36522.869	119.636
C435-RP03825	East Market, North façade	82208.474	36524.597	120.622
C435-RP03826	East Market, North façade	82221.126	36531.016	119.583
C435-RP03827	East Market, North façade	82225.119	36533.046	119.591
C435-RP03828	East Market, North façade	82228.768	36535.073	119.416
C435-RP03829	East Market, North façade	82232.982	36537.047	119.587
C435-RP03830	East Market, North façade	82236.976	36539.087	119.593
C435-RP03831	East Market, North façade	82240.807	36541.038	119.592
C435-RP03832	East Market, North façade	82244.197	36543.099	119.634
C435-RP03833	East Market, North façade	82248.971	36545.374	119.588
C435-RP03834	East Market, East façade	82251.944	36544.340	119.585
C435-RP03835	East Market, East façade	82254.417	36539.062	120.616

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-RP03836	East Market, East façade	82258.279	36531.488	120.628
C435-RP03837	East Market, East façade	82262.093	36523.947	120.629
C435-RP03838	East Market, East façade	82266.530	36515.495	120.139
C435-RP03839	East Market, East façade	82269.959	36508.419	120.695
C435-RP03840	East Market, East façade	82273.728	36500.974	120.630
C435-RP03841	East Market, East façade	82277.627	36493.341	120.624
C435-RP03842	East Market, East façade	82282.175	36484.776	120.620
C435-RP03843	East Market, East façade	82283.956	36481.279	120.617
C435-RP03908	East Market, South façade	82279.580	36476.959	120.627
C435-RP03909	East Market, South façade	82266.635	36470.568	120.639
C435-RP03910	East Market, South façade	82254.891	36464.598	120.644
C435-RP03911	East Market, South façade	82243.155	36458.634	120.636
C435-RP03912	East Market, South façade	82231.367	36452.639	120.629
C435-RP03913	East Market, South façade	82219.458	36446.437	119.641
C435-RP03914	East Market, South façade	82206.838	36439.874	120.052
C435-RP03915	East Market, South façade	82191.725	36432.192	119.688
C435-RP03916	East Market, South façade	82182.471	36427.643	119.543
C435-RP03504	4-5 Cowcross St	82110.99	36558.8861	125.9413
C435-RP03505	4-5 Cowcross St	82112.1187	36562.9112	126.0121
C435-RP03506	4-5 Cowcross St	82114.336	36568.7996	123.4531
C430-RP25001	3 Hayne St	82315.579	36542.241	120.403
C430-RP25002	3 Hayne St	82317.571	36534.550	120.319
C430-RP25003	3 Hayne St	82327.117	36539.714	124.170
C430-RP25004	3 Hayne St	82325.985	36542.956	125.271
C430-RP25005	3 Hayne St	82316.897	36537.347	120.343
C430-RP25021	3 Hayne St	82315.534	36542.295	126.254
C430-RP25022	3 Hayne St	82317.530	36537.400	127.350
C430-RP25023	3 Hayne St	82327.135	36539.714	128.520
C430-RP25024	3 Hayne St	82326.024	36542.883	128.528
C430-RP26001	18-19 Long Lane	82317.990	36534.683	121.673
C430-RP26002	18-19 Long Lane	82320.921	36526.926	121.555
C430-RP26003	18-19 Long Lane	82323.371	36519.995	121.573
C430-RP26004	18-19 Long Lane	82325.842	36513.071	121.548
C430-RP26005	18-19 Long Lane	82328.772	36506.280	121.541
C430-RP26006	18-19 Long Lane	82330.455	36503.427	121.536
C430-RP26007	18-19 Long Lane	82333.113	36504.787	121.547
C430-RP26008	18-19 Long Lane	82338.264	36507.417	121.559
C430-RP26009	18-19 Long Lane	82332.487	36524.478	123.896
C430-RP26010	18-19 Long Lane	82327.921	36537.184	123.483

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C430-RP26019	18-19 Long Lane	82332.438	36524.583	128.958
C430-RP26021	18-19 Long Lane	82317.958	36534.687	128.791
C430-RP26022	18-19 Long Lane	82320.898	36526.955	128.837
C430-RP26023	18-19 Long Lane	82323.369	36519.976	134.151
C430-RP26024	18-19 Long Lane	82325.842	36513.018	134.153
C430-RP26025	18-19 Long Lane	82328.830	36506.081	134.154
C430-RP26026	18-19 Long Lane	82330.442	36503.429	134.135
C430-RP26027	18-19 Long Lane	82332.797	36504.627	134.395
C430-RP26028	18-19 Long Lane	82338.218	36507.375	134.429
C430-RP26029	18-19 Long Lane	82332.381	36524.586	135.656
C430-RP26030	18-19 Long Lane	82327.902	36537.201	128.787

Table 1: Details of the prisms read manually

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

Drawings:

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

Installation Reports:

- C435-BFK-C2-RGN-M123-50032. Installation Report of 3D Targets read manually.
- C435-BFK-C-RGN-M123-50247. Handover Report ETH.
- C435-BFK-C2-RGN-M123-51584 .Close Out Report EDF Tunnel

B.2 Location of the Instruments

Prisms read manually are located on the plan below highlighted in yellow.



Figure 1 – Map showing the Location for the manual prisms

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	21-03-2013	29-08-2014
WB TBM	28-09-2013	07-10-2013
PTW Enlargement	25-06-2014	11-11-2014
EB TBM	15-01-2014	16-01-2014
PTE Enlargement	03-08-2014	20-08-2014
CH2	28-05-2015	06-06-2015
CP4	17-09-2014	19-09-2014
ES2	04-06-2015	18-07-2015
RTE2	18-10-2014	11-11-2014
CP6	12-11-2015	20-11-2015
CP7	23-02-2015	25-02-2015

Table 2 – Construction Activities associated with prisms read manually

C.1.2 Resulting Movements

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

- West Market building, north façade.
- 4-5 Cowcross St.
- East Market building, north façade.
- East Market building, east façade.
- East Market building, south façade.
- 3 Hayne St.
- 18-19 Long Lane.

- West Market building, north façade

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

- WB TBM caused 3-4mm of settlement maximum from 27-09-2013 to 02-10-2013
- Compensation grouting from Moorgate Shaft 3 caused 5mm maximum of heave between 17-10-2013 and 28-07-2014.
- PTW works caused maximum 3-4mm of settlement from 23-06-2014 to 16-08-2014.
- Compensation grouting caused 8-9mm of heave from 19-08-2014 to 27-10-2014
- Maximum movement in X direction -35mm
- Maximum movement in Y direction -20mm
- Maximum movement in Z direction +18mm

- 4-5 Cowcross St.

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

- EB TBM caused maximum 3mm of settlement from 13-01-2014 to 16-01-2014
- PTE enlargement works caused 8mm of settlement from 30-07-2014 to 16-08-2014.
- CP4 construction caused 2-3mm of settlement from 16-09-2014 to 22-09-2014
- Maximum movement in X direction -6mm
- Maximum movement in Y direction -8mm
- Maximum movement in Z direction +10mm

- East Market Building, North façade

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

- Compensation grouting from Moorgate Shaft 1 and 3 caused 4-5mm of heave from 29-07-2013 to 25-09-2013
- WB TBM caused maximum 3-4mm of settlement from 02-10-2013 to 19-10-2013.
- Compensation grouting caused maximum 10-12mm of heave from 08-08-2014 to 07-10-2014.
- PTW construction caused 6-7mm of settlement from 16-08-2014 to 18-10-2014.
- RTE2 works caused maximum 3mm of settlement from 18-10-2014 to 11-11-2014.
- CP6 tunnel caused maximum 2mm of settlement from 13-11-2014 to 19-11-2014.
- CH2 construction caused 4mm of settlement from 28-05-2015 to 06-06-2015.
- Maximum movement in X direction -36mm
- Maximum movement in Y direction +26mm
- Maximum movement in Z direction -25mm

- East Market Building, East Façade.

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

- TAM's drilling from Moorgate Shaft 2 caused maximum 8-10mm of heave from 29-04-2013 to 11-06-2013.
- PTW construction caused 12-14mm of settlement from 16-08-2014 to 06-10-2014.
- RTE2 tunnel caused maximum 2mm of settlement from 25-10-2014 to 11-11-2014.
- CH2 construction caused 2-3mm of settlement from 28-05-2015 to 06-06-2015.
- Maximum movement in X direction +20mm
- Maximum movement in Y direction -18mm
- Maximum movement in Z direction -22mm

- East Market Building, South Façade.

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

- PTW construction caused maximum 10-12mm of settlement from 16-08-2014 to 11-11-2014.
- Compensation grouting from Moorgate Shaft 2 caused 5-6mm of heave from 05-12-2014 to 06-01-2015.
- CH2 construction caused 2mm of settlement from 28-05-2015 to 06-06-2015.
- Maximum movement in X direction -14mm
- Maximum movement in Y direction +24mm
- Maximum movement in Z direction -16mm

- 3 Hayne St.

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

- ETH excavation caused 8mm of settlement from 08-04-2013 to 26-09-2014.
- STE1 tunnel caused 3mm maximum of settlement from 13-02-2015 to 02-03-2015.
- Maximum movement in X direction -14mm
- Maximum movement in Y direction +14mm
- Maximum movement in Z direction -10mm

- 18-19 Long Lane.

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

- ETH excavation works caused 7-8mm of settlement from 25-03-2013 to 02-09-2014.
- Maximum movement in X direction -18mm
- Maximum movement in Y direction -6mm
- Maximum movement in Z direction -10mm

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C.2 Trigger/Default Alerts 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.

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-RP03812	Manual Prisms	Settlement	16/12/2015 11:00	14.2	Default Alert	Default Alert
	C435-RP03814	Manual Prisms	Settlement	16/12/2015 11:00	18.1	Default Alert	Default Alert
	C435-RP03815	Manual Prisms	Settlement	03/05/2013 10:00	0	Clear	Clear
	C435-RP03816	Manual Prisms	Settlement	29/04/2013 10:00	0	Clear	Clear
	C435-RP03817	Manual Prisms	Settlement	16/12/2015 11:00	13.4	Default Alert	Default Alert
	C435-RP03818	Manual Prisms	Settlement	03/10/2014 14:00	4.3	Clear	Clear
	C435-RP03819	Manual Prisms	Settlement	16/12/2015 11:00	11.1	Default Alert	Default Alert
	C435-RP03820	Manual Prisms	Settlement	16/12/2015 11:00	10.5	Default Alert	Default Alert
	C435-RP03821	Manual Prisms	Settlement	16/12/2015 11:00	16.5	Default Alert	Default Alert
	C435-RP03824	Manual Prisms	Settlement	09/10/2014 12:00	6.6	Clear	Clear
	C435-RP03825	Manual Prisms	Settlement	23/10/2014 12:00	7.4	Clear	Clear
	C435-RP03826	Manual Prisms	Settlement	16/12/2015 11:00	-16.4	Default Alert	Default Alert
	C435-RP03827	Manual Prisms	Settlement	16/12/2015 11:00	-17.8	Default Alert	Default Alert
	C435-RP03828	Manual Prisms	Settlement	16/12/2015 11:00	-17.7	Default Alert	Default Alert
	C435-RP03829	Manual Prisms	Settlement	16/12/2015 11:00	-18	Default Alert	Default Alert
	C435-RP03830	Manual Prisms	Settlement	16/12/2015 11:00	-18.3	Clear	Clear
	C435-RP03831	Manual Prisms	Settlement	16/12/2015 11:00	-16.8	Clear	Clear
	C435-RP03832	Manual Prisms	Settlement	16/12/2015 11:00	-16.6	Default Alert	Default Alert
C435-RP03833	Manual Prisms	Settlement	16/12/2015 11:00	-14.9	Default Alert	Default Alert	
C435-RP03834	Manual Prisms	Settlement	16/12/2015 11:00	-19.9	Default Alert	Default Alert	
C435-RP03835	Manual Prisms	Settlement	16/12/2015 11:00	-17	Clear	Clear	
C435-RP03836	Manual Prisms	Settlement	16/12/2015 11:00	-14.7	Default Alert	Default Alert	
C435-RP03837	Manual Prisms	Settlement	16/12/2015 11:00	-11.7	Default Alert	Default Alert	
C435-RP03838	Manual Prisms	Settlement	16/12/2015 11:00	-6.6	Clear	Clear	
C435-RP03839	Manual Prisms	Settlement	16/12/2015 11:00	-7.8	Clear	Clear	
C435-RP03840	Manual Prisms	Settlement	16/12/2015 11:00	-6	Clear	Clear	
C435-RP03841	Manual Prisms	Settlement	16/12/2015 11:00	-6.3	Clear	Clear	
C435-RP03842	Manual Prisms	Settlement	16/12/2015 11:00	-6.5	Clear	Clear	
C435-RP03843	Manual Prisms	Settlement	13/01/2015 16:00	-8.9	Clear	Clear	
C435-RP03908	Manual Prisms	Settlement	16/12/2015 11:00	5.3	Default Alert	Default Alert	
C435-RP03909	Manual Prisms	Settlement	16/12/2015 11:00	7	Clear	Clear	
C435-RP03910	Manual Prisms	Settlement	16/12/2015 11:00	8	Clear	Clear	
C435-RP03911	Manual Prisms	Settlement	16/12/2015 11:00	9.3	Clear	Clear	
C435-RP03912	Manual Prisms	Settlement	16/12/2015 11:00	9.7	Clear	Clear	
C435-RP03913	Manual Prisms	Settlement	16/12/2015 11:00	11.1	Default Alert	Default Alert	
C435-RP03914	Manual Prisms	Settlement	16/12/2015 11:00	9.8	Clear	Clear	
C435-RP03915	Manual Prisms	Settlement	16/12/2015 11:00	1.1	Clear	Clear	
C435-RP03916	Manual Prisms	Settlement	18/09/2015 13:00	-3.9	Clear	Clear	
C435-RP03504	Manual Prisms	Settlement	16/06/2015 09:00	2.8	Clear	Clear	
C435-RP03505	Manual Prisms	Settlement	16/06/2015 09:00	11	Default Alert	Default Alert	
C435-RP03506	Manual Prisms	Settlement	16/06/2015 09:00	17.4	Default Alert	Default Alert	
C430-RP25001	Manual Prisms	Settlement	04/04/2013 10:30	-1.22	Clear	Clear	
C430-RP25002	Manual Prisms	Settlement	16/10/2015 14:00	-5.8	Clear	Clear	
C430-RP25003	Manual Prisms	Settlement	16/10/2015 14:00	-8.76	Clear	Clear	
C430-RP25004	Manual Prisms	Settlement	16/10/2015 14:00	-7.46	Clear	Clear	
C430-RP25005	Manual Prisms	Settlement	30/05/2013 12:00	-2.88	Clear	Clear	
C430-RP25021	Manual Prisms	Settlement	30/05/2013 12:00	-3.89	Clear	Clear	
C430-RP25022	Manual Prisms	Settlement	30/05/2013 12:00	-4.1	Clear	Clear	
C430-RP25023	Manual Prisms	Settlement	16/10/2015 14:00	-8.46	Clear	Clear	
C430-RP25024	Manual Prisms	Settlement	16/10/2015 14:00	-7.33	Clear	Clear	
C430-RP26001	Manual Prisms	Settlement	16/10/2015 14:00	-8.86	Clear	Clear	
C430-RP26002	Manual Prisms	Settlement	16/10/2015 14:00	-6.06	Clear	Clear	
C430-RP26003	Manual Prisms	Settlement	16/10/2015 14:00	-3.7	Clear	Clear	
C430-RP26004	Manual Prisms	Settlement	16/10/2015 14:00	-6.2	Clear	Clear	
C430-RP26005	Manual Prisms	Settlement	16/10/2015 14:00	1.1	Clear	Clear	
C430-RP26006	Manual Prisms	Settlement	02/09/2014 14:00	-4.57	Clear	Clear	
C430-RP26007	Manual Prisms	Settlement	02/09/2014 14:00	-2.28	Clear	Clear	
C430-RP26008	Manual Prisms	Settlement	16/10/2015 14:00	1.18	Clear	Clear	
C430-RP26009	Manual Prisms	Settlement	16/10/2015 14:00	0.73	Clear	Clear	
C430-RP26010	Manual Prisms	Settlement	16/10/2015 14:00	-4.66	Clear	Clear	
C430-RP26019	Manual Prisms	Settlement	16/10/2015 14:00	0.89	Clear	Clear	
C430-RP26021	Manual Prisms	Settlement	16/10/2015 14:00	-8.69	Clear	Clear	
C430-RP26022	Manual Prisms	Settlement	16/10/2015 14:00	-4.3	Clear	Clear	
C430-RP26023	Manual Prisms	Settlement	16/10/2015 14:00	-2.97	Clear	Clear	
C430-RP26024	Manual Prisms	Settlement	16/10/2015 14:00	-0.47	Clear	Clear	
C430-RP26025	Manual Prisms	Settlement	16/10/2015 14:00	1.15	Clear	Clear	
C430-RP26026	Manual Prisms	Settlement	16/10/2015 14:00	0.95	Clear	Clear	
C430-RP26027	Manual Prisms	Settlement	16/10/2015 14:00	1.79	Clear	Clear	
C430-RP26028	Manual Prisms	Settlement	16/10/2015 14:00	1.41	Clear	Clear	
C430-RP26029	Manual Prisms	Settlement	16/10/2015 14:00	0.9	Clear	Clear	
C430-RP26030	Manual Prisms	Settlement	16/10/2015 14:00	-3.7	Clear	Clear	

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

C.3 Significant Issues with the Instrumentation

No issues with these devices.

C.4 Residual Risks

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

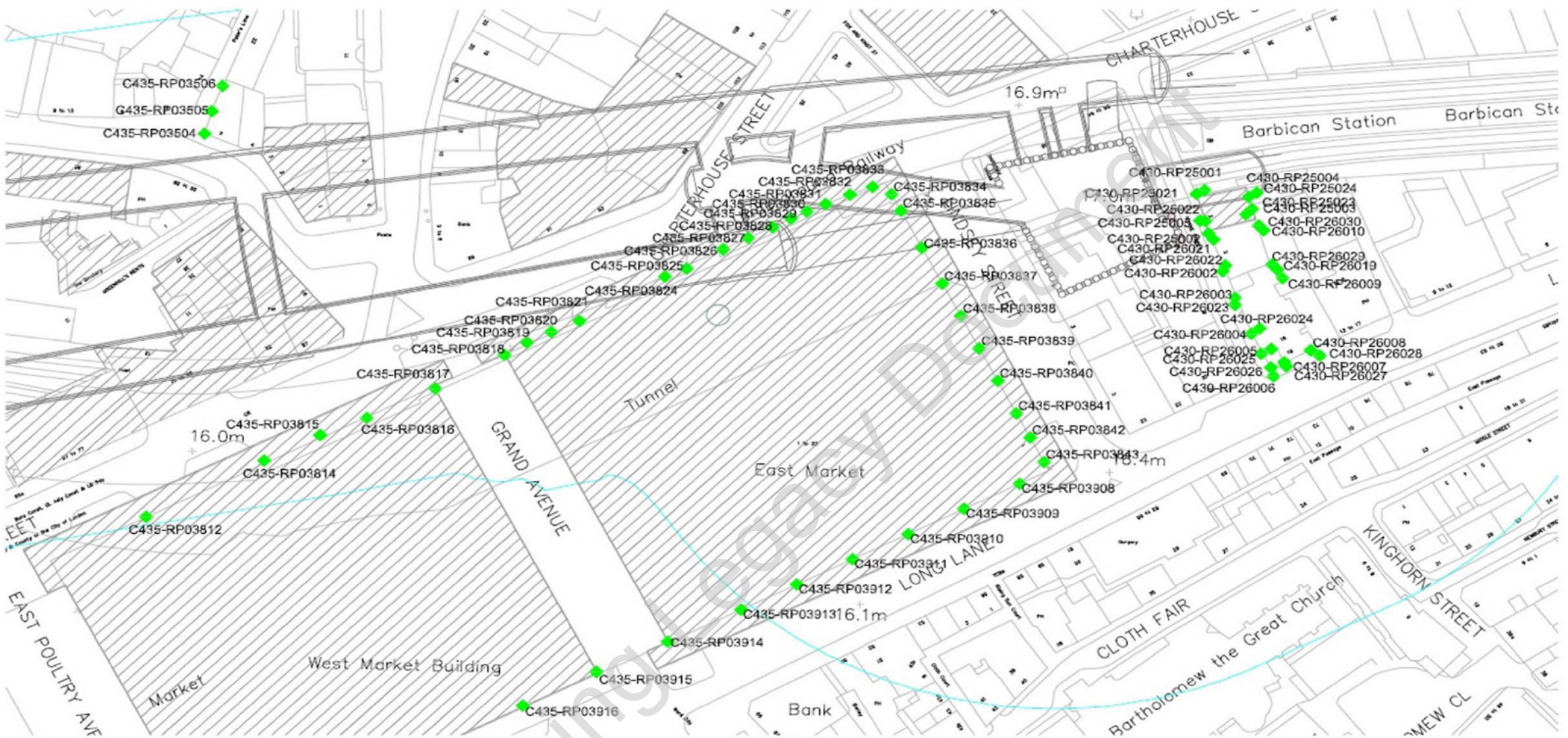
D. CONCLUSIONS

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

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APPENDIX A: DRAWINGS

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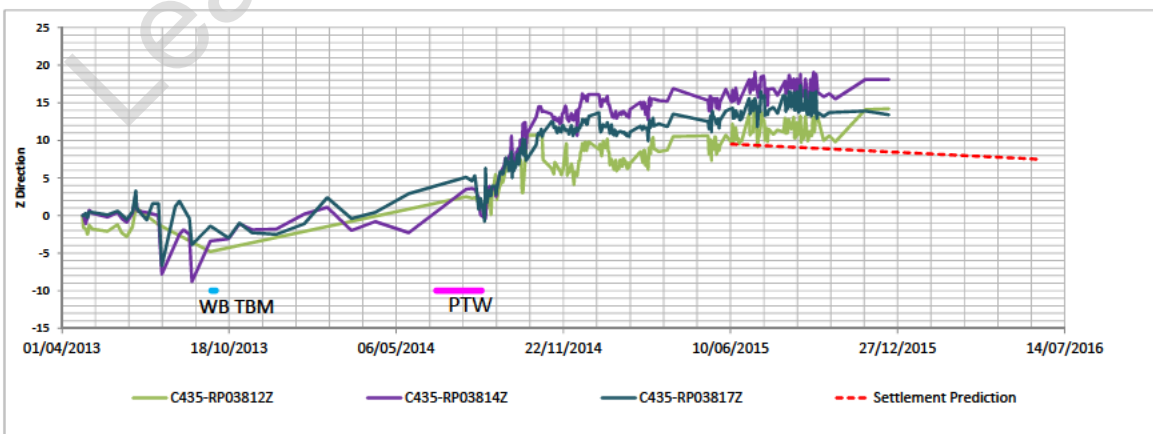
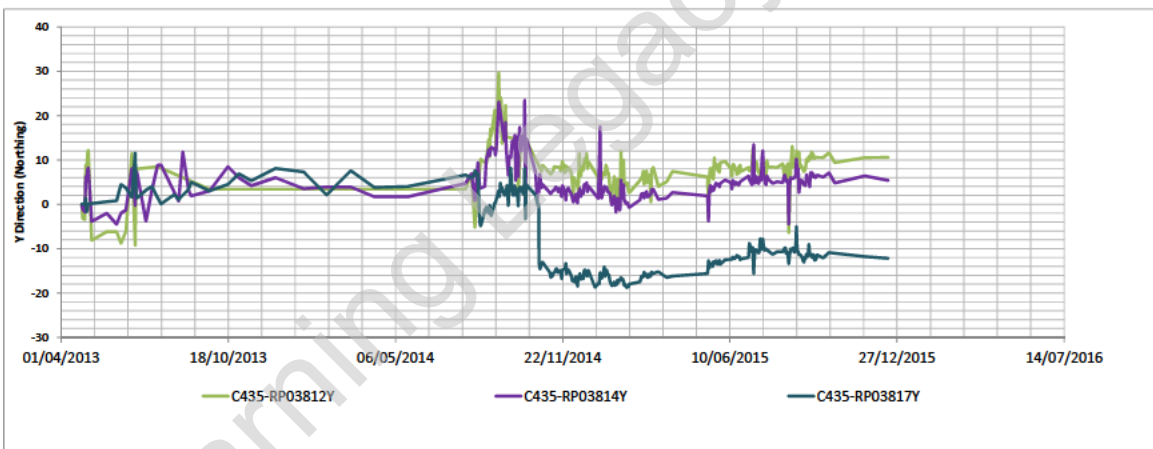
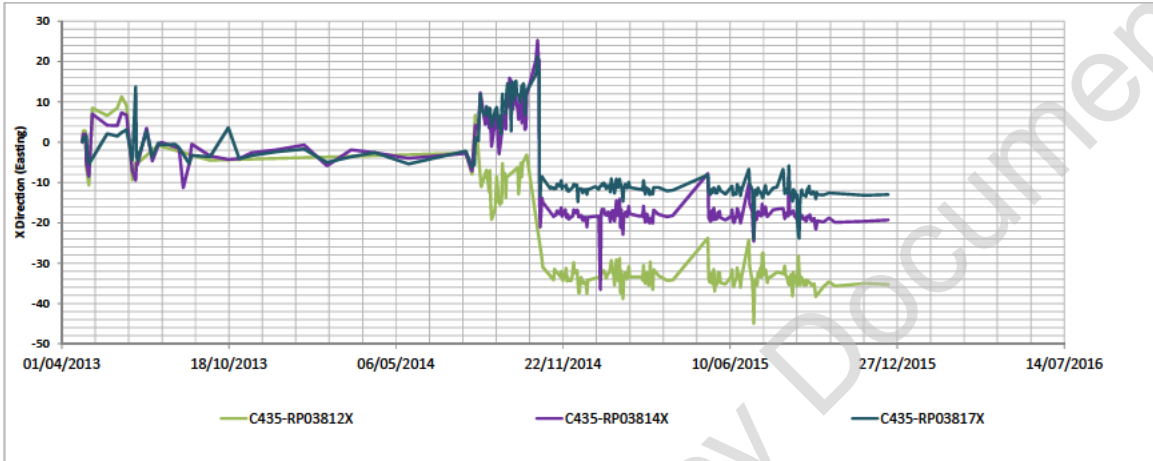
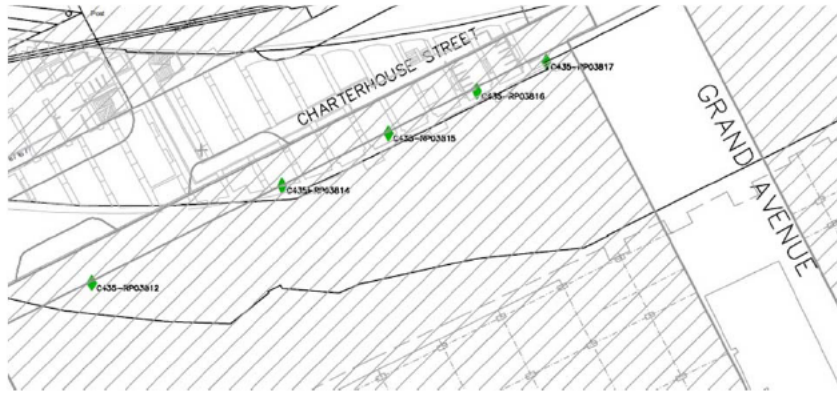
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1	20-03-2014					

Notes:

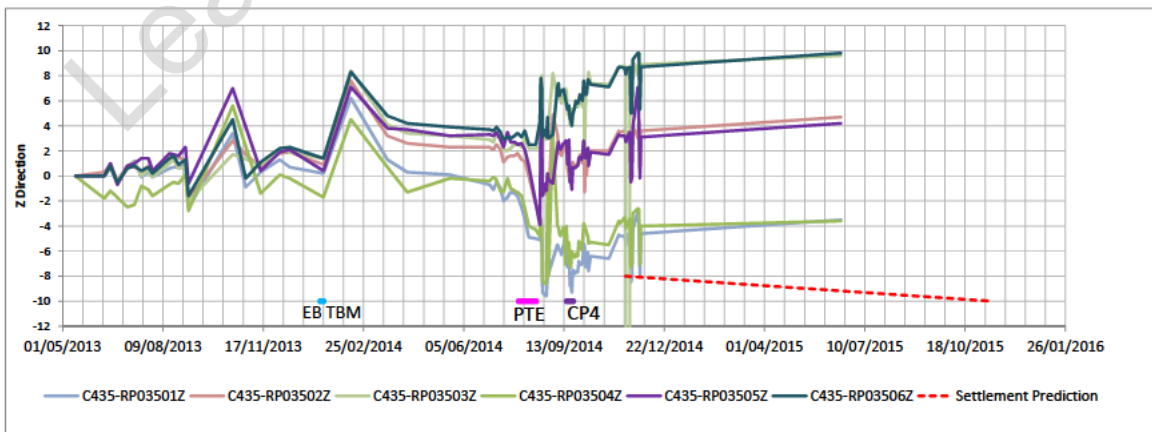
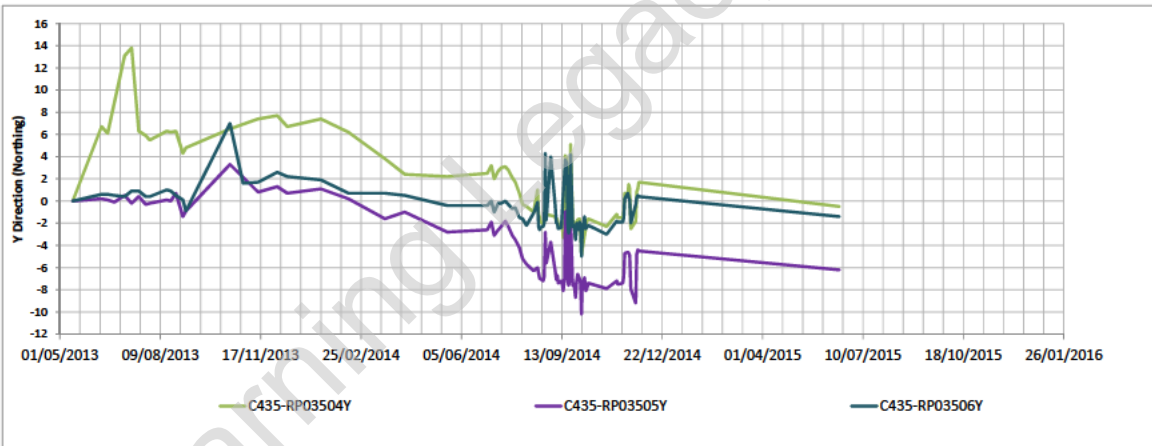
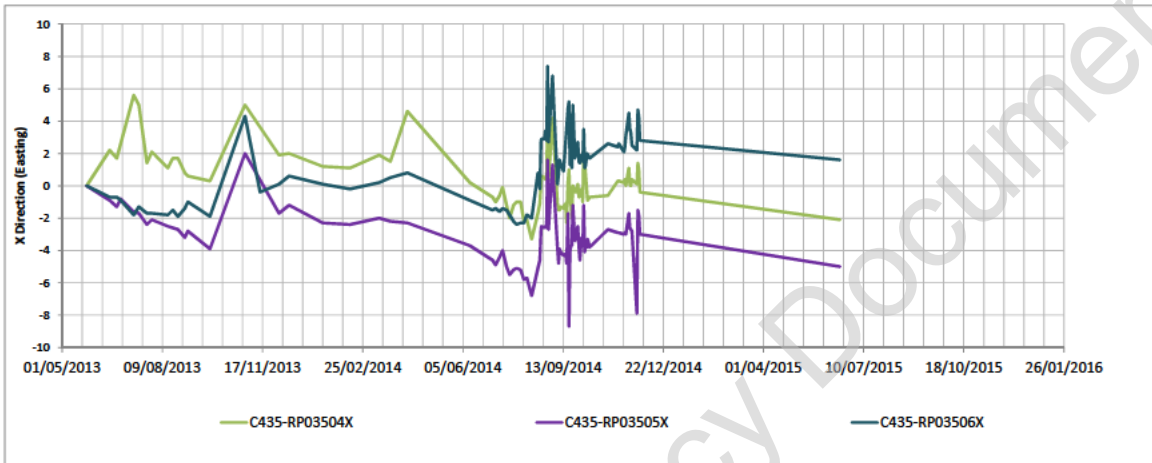
		Contract : C435 ISM FARRINGDON	By :
		Originator : GEOCISA	Chk :
		Location : CROSSRAIL GENERAL	App :
		Title :	Auth :
		3D TARGETS INSTALLED FOR FARRINGDON STATION	
Scale :	© A3	Org No : C435-BFK-C2-DWG-M123-50045	

APPENDIX B: GRAPHS

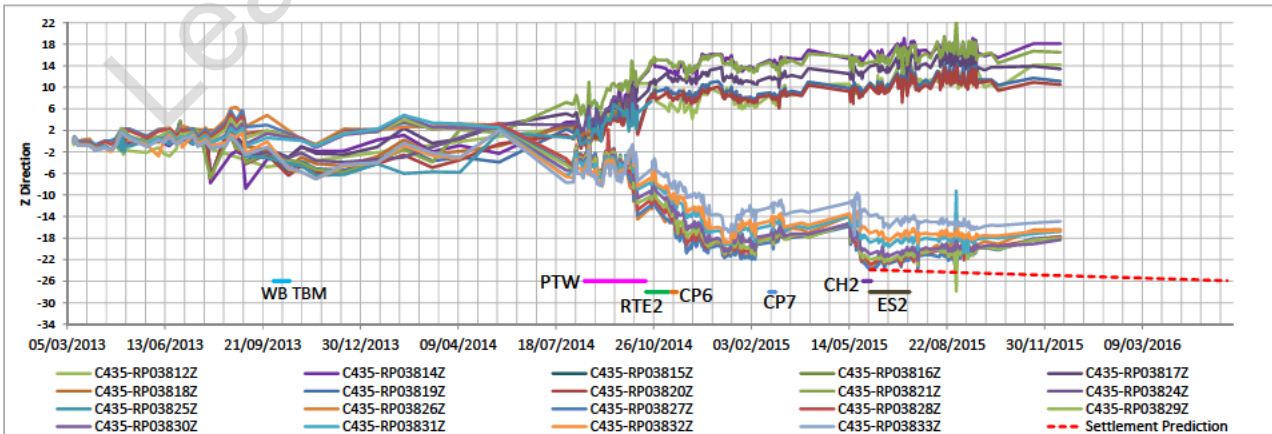
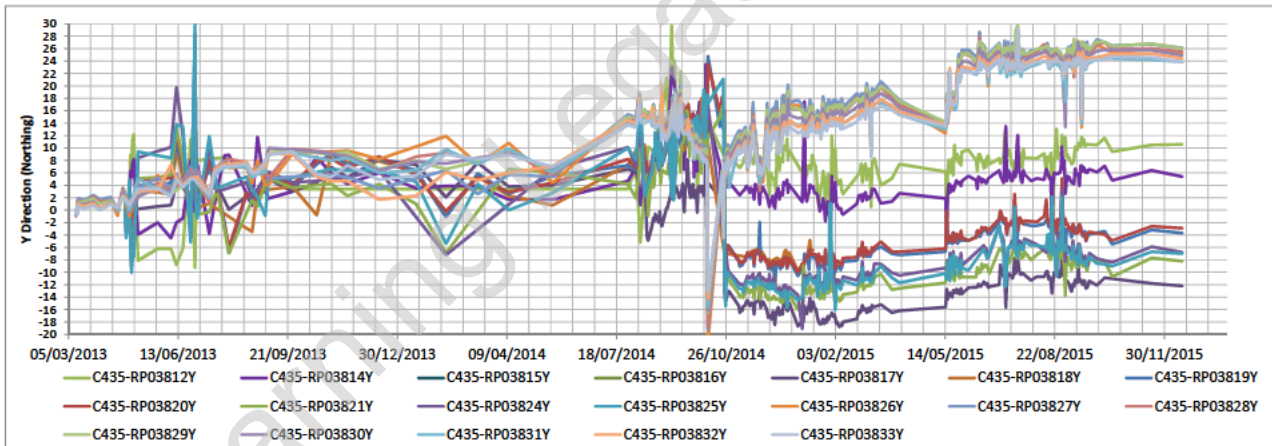
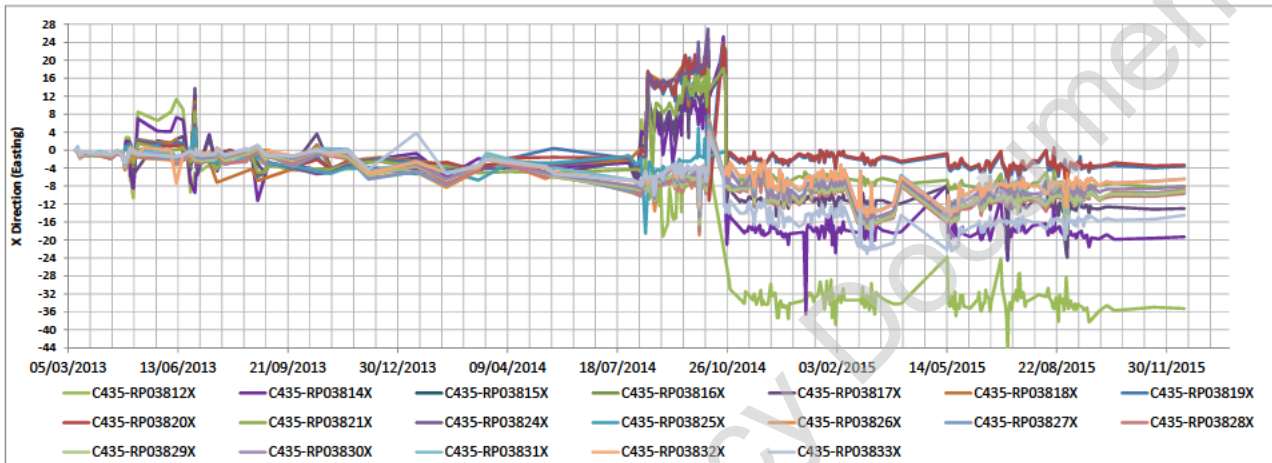
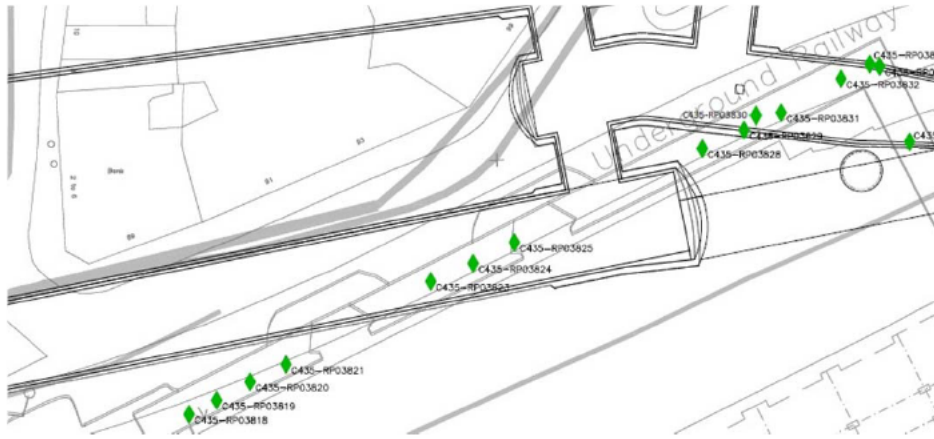
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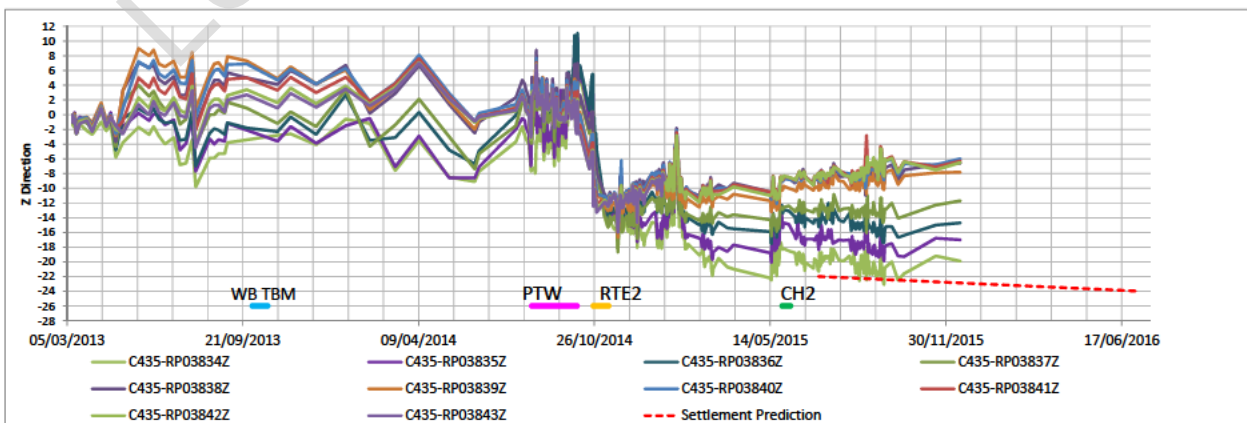
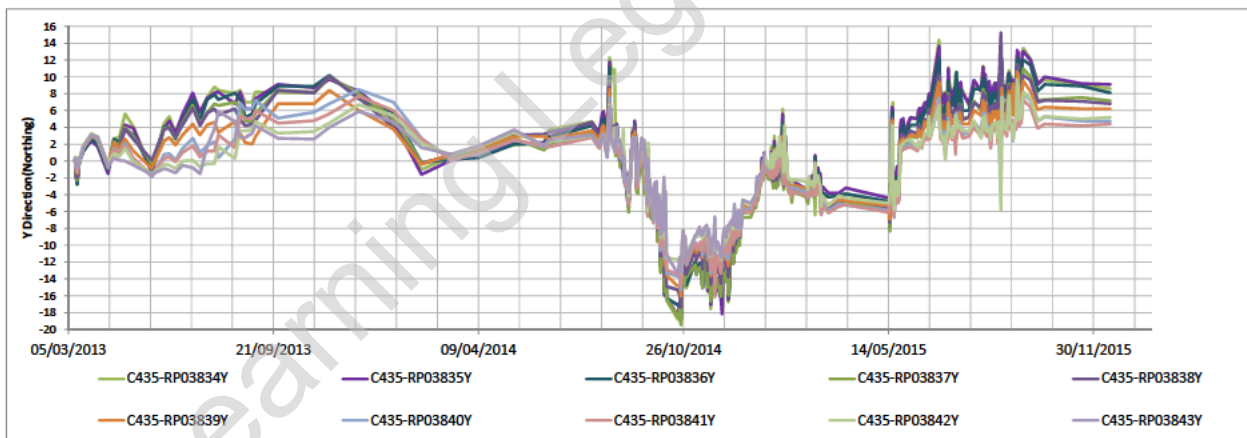
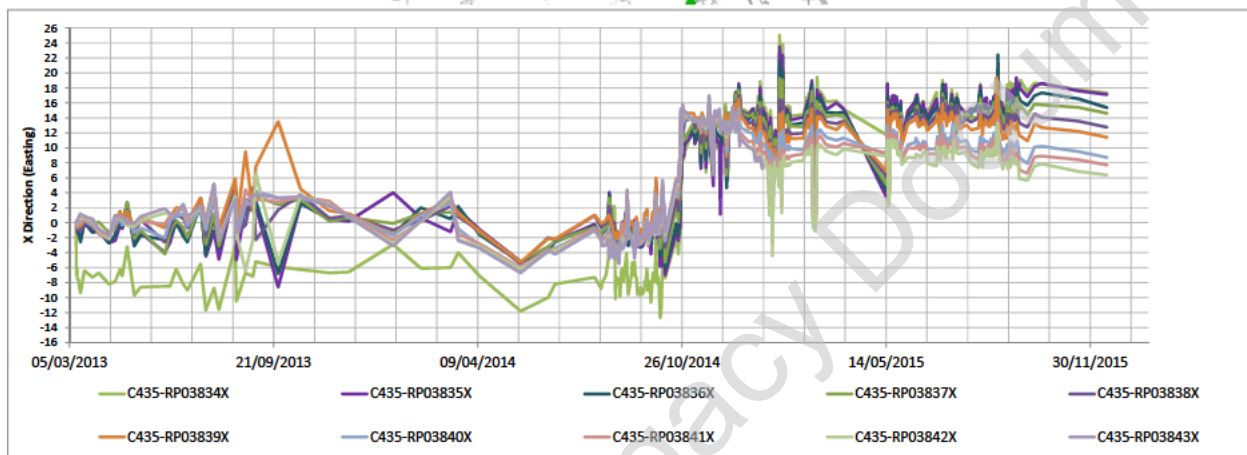
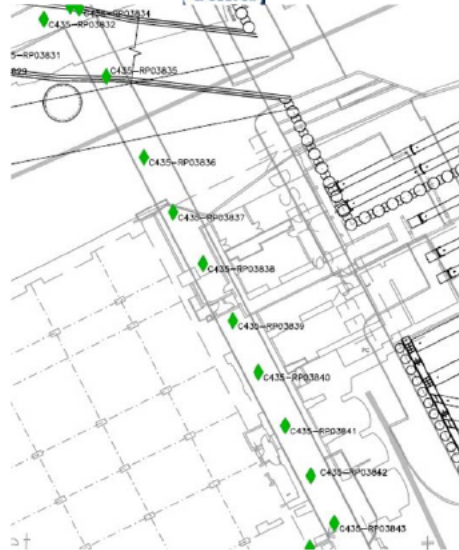
Remarks: Prisms C435-RP03815 and C435-RP03816 were installed but never reading because lack of visual from the set-up point.



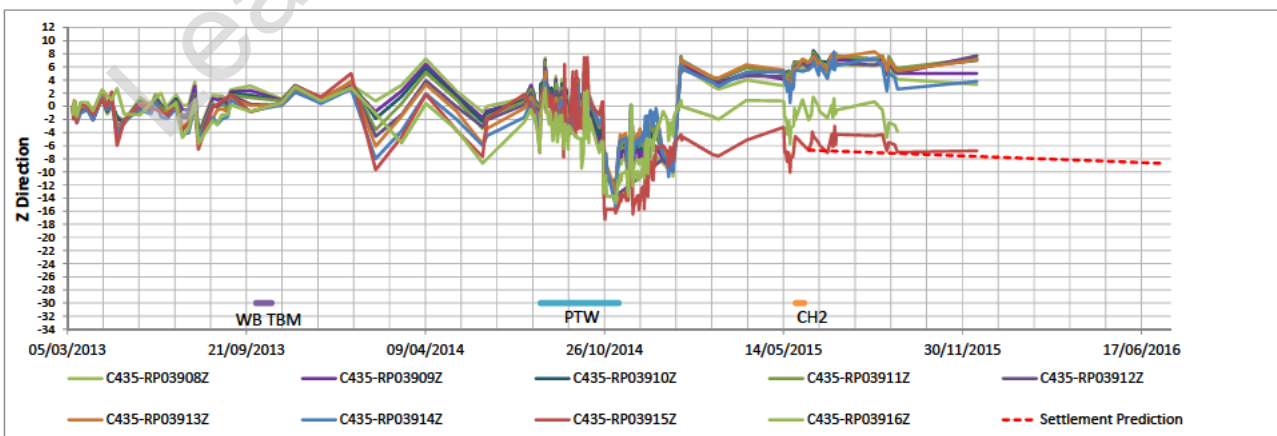
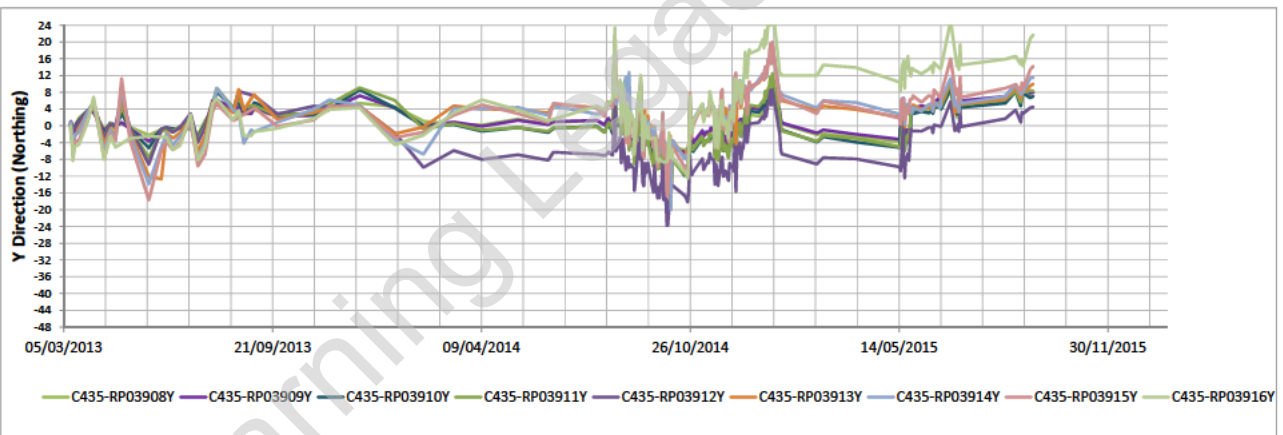
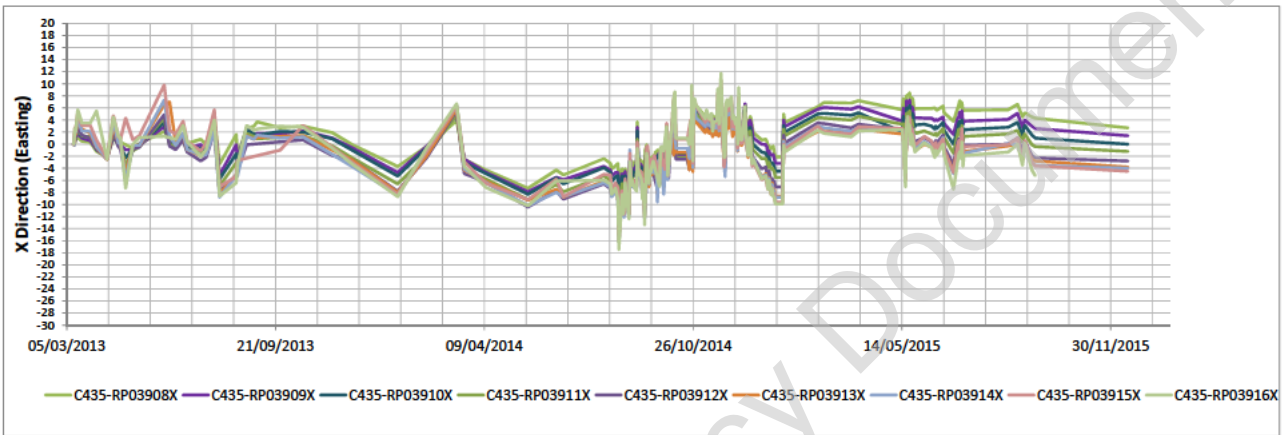
Remarks: Prisms C435-RP03501, C435-RP03502 and C435-RP03503 were never installed.



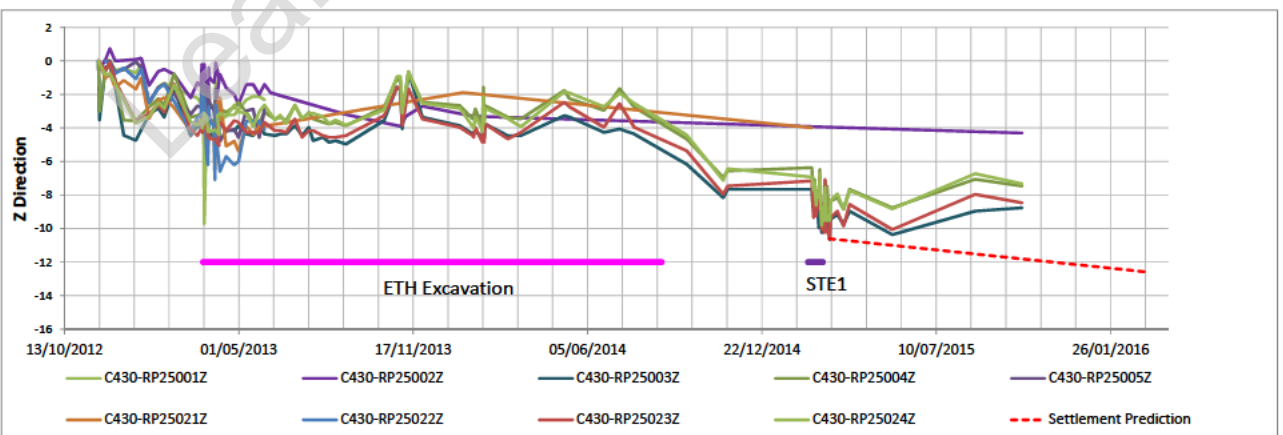
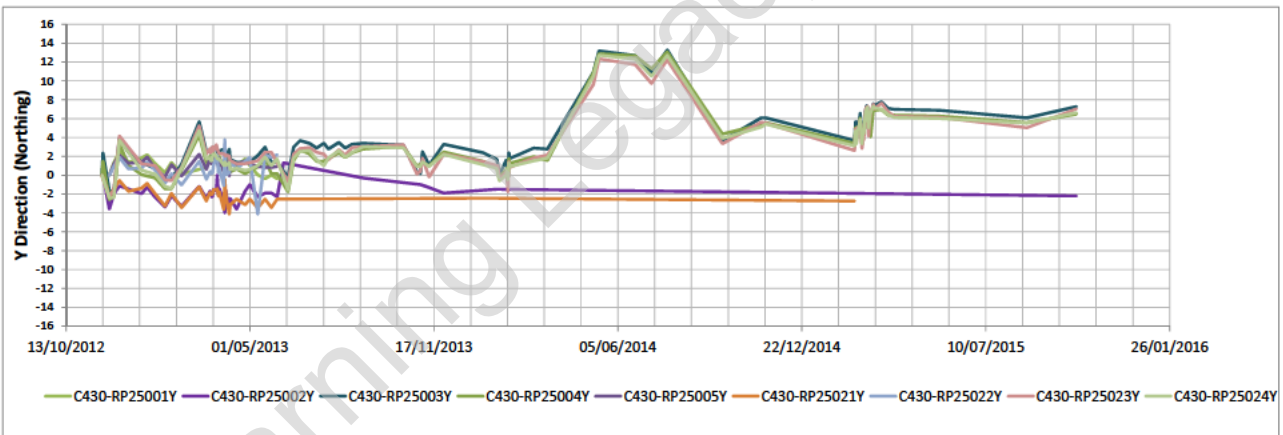
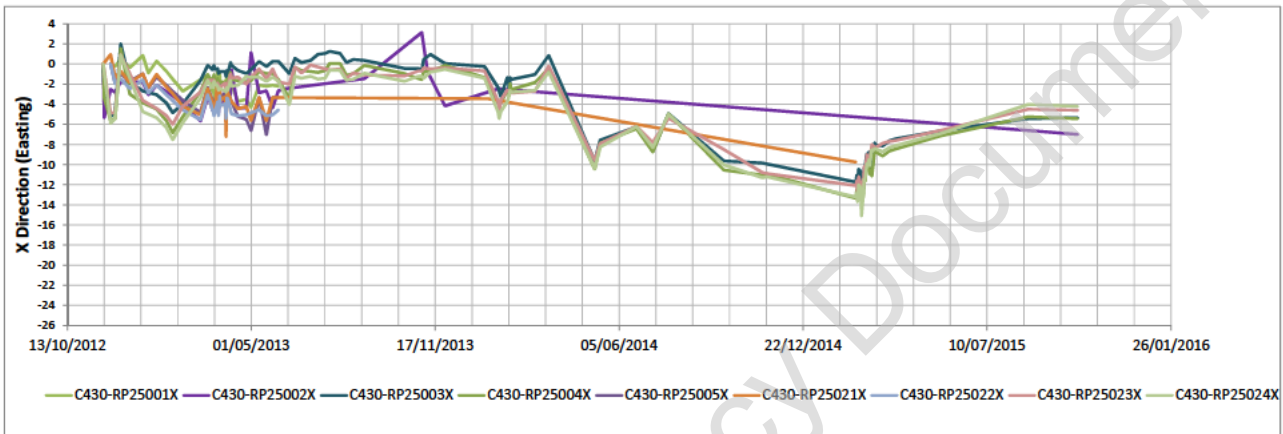
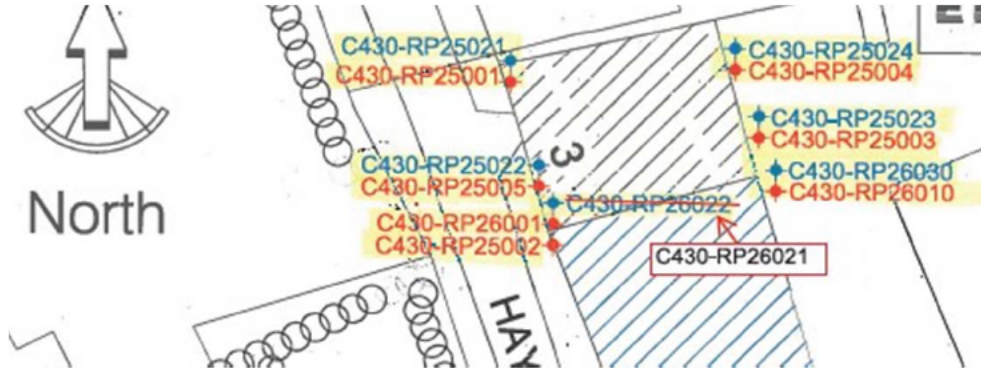
Remarks: Prisms



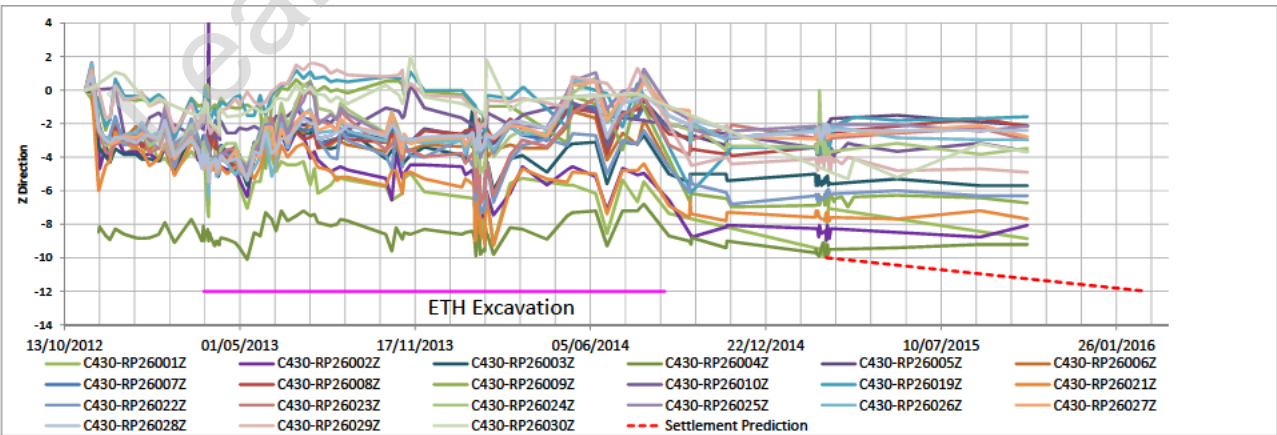
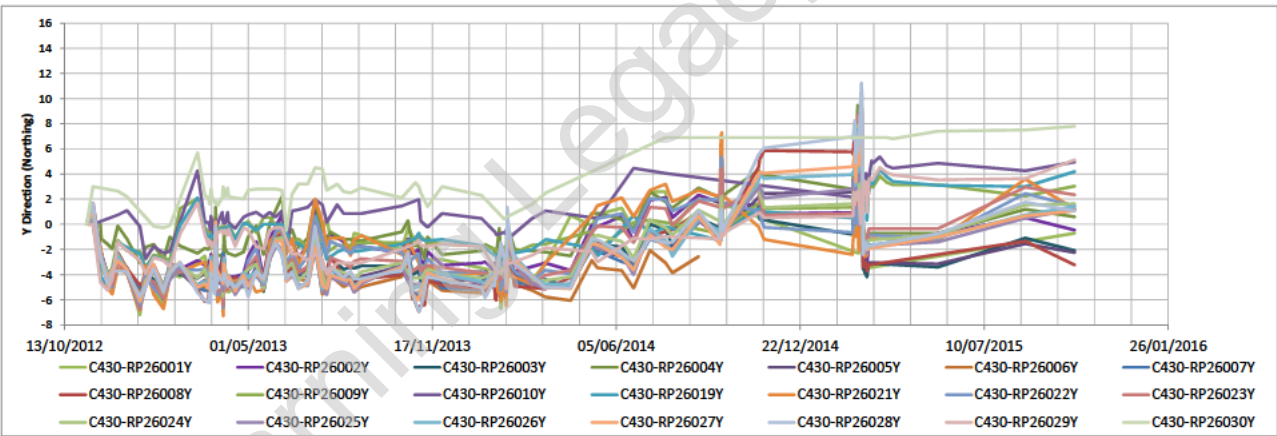
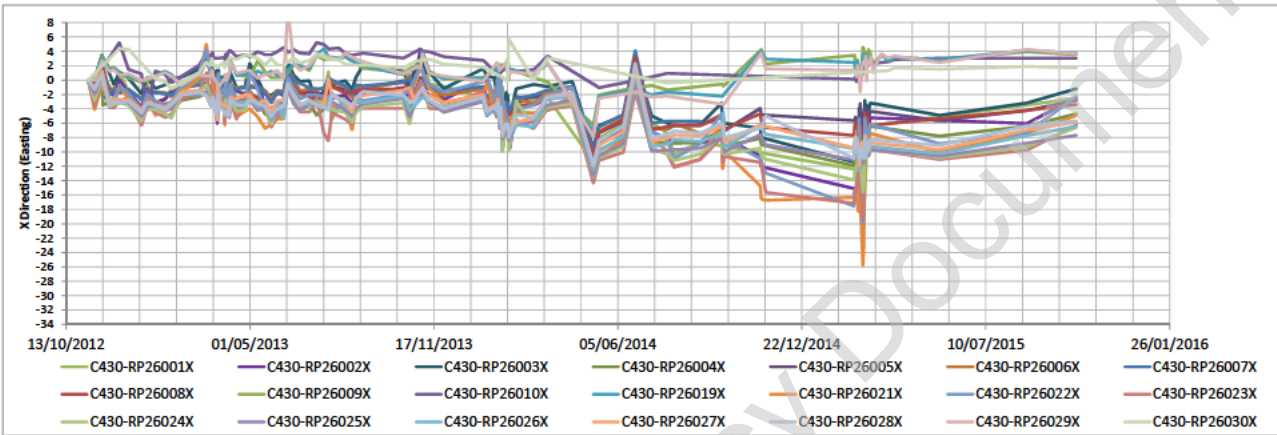
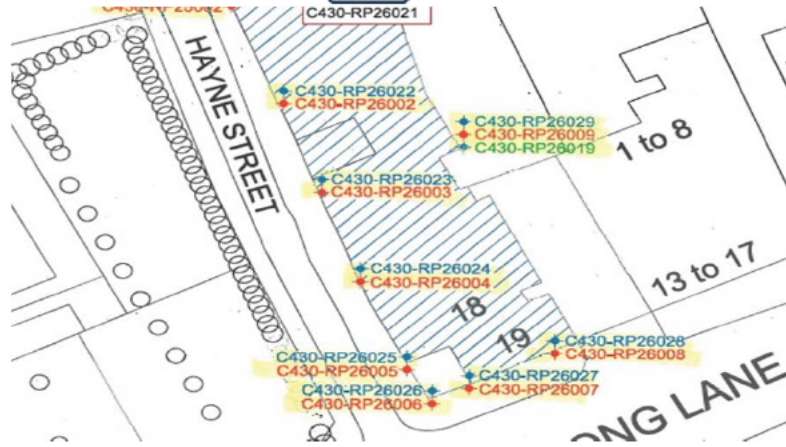
Remarks: Prisms



Remarks:



Remarks: Prisms



Remarks: Prisms

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
- RTE Running Tunnel East.
- ES Escalator Shaft
- TaM Tube a Manchette

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