



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

# C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
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## Monitoring Close-Out Report: Sockets & Studs Installed on Cowcross St. CRL Document Number: C435-BFK-C2-RGN-M123-51664

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### 1. Contractor Document Submittal History:

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### 2a. Stakeholder Review Required? YES NO

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 NR  LO  For information   
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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.

Sign: \_\_\_\_\_ Role: \_\_\_\_\_ Name: \_\_\_\_\_ Date: \_\_\_\_\_  
 Sign: \_\_\_\_\_ Role: \_\_\_\_\_ Name: \_\_\_\_\_ Date: \_\_\_\_\_

### 2b. Review by Stakeholder (if required):

Stakeholder Organisation	Job Title	Name	Signature	Date	Acceptance
			<small>compliance with their contractual obligations and does not constitute ds or materials developed or selected by the designer/supplier.</small>		<input type="checkbox"/>
	[Redacted]				<input type="checkbox"/>
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### 3. Acceptance by Crossrail:

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## A. INTRODUCTION

In line with the C122 – M&W Specification K10 – Instrumentation & Monitoring C122-OVE-4-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 sockets and studs installed on Cowcross St. See Table 1 below with the details for the sockets, and Table 2 with the details for the studs

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C430-LB00501	66 COWCROSS ST	82004.0190	36553.4780	113.3591
C430-LB00502	66 COWCROSS ST	82000.5120	36553.7380	112.9943
C430-LB00503	66 COWCROSS ST	82000.1390	36553.6590	112.978
C430-LB00504	64-65 COWCROSS ST	81988.9040	36553.0649	112.966
C430-LB00505	32-33 COWCROSS ST	81993.3320	36564.6770	112.6808
C430-LB00506	32-33 COWCROSS ST	81988.6270	36564.8470	112.5605
C430-LB00507	32-33 COWCROSS ST	81983.8880	36565.3090	112.6411
C430-LB00508	34-35 COWCROSS ST	81983.5010	36565.0250	112.5116
C430-LB00509	34-35 COWCROSS ST	81977.4880	36567.7840	112.3827
C430-LB00510	34-35 COWCROSS ST	81973.5570	36570.4340	112.3316
C430-LB00511	101-102 TURNMILL ST	81973.5810	36570.9160	112.2944
C430-LB00512	101-102 TURNMILL ST	81970.6150	36574.5990	112.5218
C430-LB00513	101-102 TURNMILL ST	81968.2750	36578.7620	112.5153
C430-LB00534	64-65 COWCROSS ST	81988.3467	36555.6797	112.808
C430-LB00535	61-63 COWCROSS ST	81982.0555	36555.5522	112.6
C430-LB00552	61-63 COWCROSS ST	81980.0650	36555.1760	113.0702
C430-LB00553	61-63 COWCROSS ST	81972.3060	36555.2820	112.4381
C435-LB13049	87 CHARTERHOUSE ST	82139.7150	36511.9190	115.7406
C435-LB13050	87 CHARTERHOUSE ST	82134.1480	36518.1670	115.7122
C435-LB13051	94 COWCROSS ST	82133.6320	36518.8650	115.4175
C435-LB13052	94 COWCROSS ST	82129.5780	36524.2720	115.4026
C435-LB13053	90-93 COWCROSS ST	82129.0960	36524.5860	115.3955
C435-LB13054	90-93 COWCROSS ST	82123.2940	36531.4410	115.3592

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-LB13055	90-93 COWCROSS ST	82117.8760	36537.8700	115.3391
C435-LB13093	86-89 COWCROSS ST	82111.0360	36544.2360	115.6233
C435-LB13094	86-89 COWCROSS ST	82107.7880	36545.9090	115.6264
C435-LB13095	86-89 COWCROSS ST	82100.5350	36548.3310	115.6265
C435-LB13100	79-85 COWCROSS ST	82095.6550	36548.9990	115.3598
C435-LB13101	79-85 COWCROSS ST	82090.0950	36549.7190	115.3491
C435-LB13102	79-85 COWCROSS ST	82082.9490	36550.6390	115.1676
C435-LB13103	79-85 COWCROSS ST	82073.4150	36551.8300	115.1074
C435-LB13104	78 COWCROSS ST	82072.5880	36551.8950	115.1184
C435-LB13105	78 COWCROSS ST	82067.4530	36552.5250	114.8842
C435-LB13106	78 COWCROSS ST	82061.9240	36553.3230	114.8824
C435-LB13107	78 COWCROSS ST	82060.4811	36553.0076	114.682
C435-LB13111	70-77 COWCROSS ST	82051.2720	36553.7920	114.6308
C435-LB13112	70-77 COWCROSS ST	82043.2766	36554.5614	114.6176
C435-LB13113	70-77 COWCROSS ST	82030.4670	36554.5940	113.7447
C435-LB13114	67-69 COWCROSS ST	82018.9700	36553.3390	113.7048
C435-LB13115	67-69 COWCROSS ST	82009.4381	36554.7297	113.491
C435-LB13116	67-69 COWCROSS ST	82009.1331	36554.6879	113.3612
C435-LB13117	30-31 COWCROSS ST	81995.3600	36563.4080	112.7138
C435-LB13118	30-31 COWCROSS ST	82000.6870	36563.4240	112.9415
C435-LB13119	30-31 COWCROSS ST	82007.3780	36563.6590	113.0796
C435-LB13120	30-31 COWCROSS ST	82011.0290	36563.9820	113.223
C435-LB13121	26-27 COWCROSS ST	82012.7504	36564.3933	113.38
C435-LB13122	26-27 COWCROSS ST	82016.1698	36563.8514	113.3768
C435-LB13123	26-27 COWCROSS ST	82025.8230	36564.5200	113.7988
C435-LB13124	19-25 COWCROSS ST	82027.6780	36564.6610	113.5421
C435-LB13125	19-25 COWCROSS ST	82035.1460	36565.3090	113.8935
C435-LB13126	19-25 COWCROSS ST	82043.7460	36565.5070	114.0036
C435-LB13127	19-25 COWCROSS ST	82047.2910	36565.4650	114.0824
C435-LB13128	18 COWCROSS ST	82051.9330	36565.4980	114.3668
C435-LB13129	18 COWCROSS ST	82053.7570	36565.1720	114.1978
C435-LB13130	18 COWCROSS ST	82055.8540	36565.0180	114.3169
C435-LB13131	14-16 COWCROSS ST	82057.4450	36564.8360	114.5229
C435-LB13132	14-16 COWCROSS ST	82061.1130	36563.9080	114.6906
C435-LB13133	14-16 COWCROSS ST	82062.5500	36563.4780	114.7798
C435-LB13134	14-16 COWCROSS ST	82064.6040	36563.0010	114.7826
C435-LB13135	14-16 COWCROSS ST	82071.1990	36561.4270	114.8258
C435-LB13136	9-13 COWCROSS ST	82072.9640	36561.1280	114.9905
C435-LB13137	9-13 COWCROSS ST	82080.7550	36560.6240	115.2509

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-LB13138	9-13 COWCROSS ST	82091.0000	36559.9930	115.1952
C435-LB13139	7-8 COWCROSS ST	82092.7090	36559.9480	115.1189
C435-LB13140	7-8 COWCROSS ST	82096.7390	36560.2870	115.4111
C435-LB13141	7-8 COWCROSS ST	82100.7290	36560.6240	115.4678
C435-LB13146	4-5 COWCROSS ST	82111.7600	36556.1440	115.382
C435-LB13147	4-5 COWCROSS ST	82117.3610	36554.2340	115.5116
C435-LB13148	4-5 COWCROSS ST	82120.7870	36552.7160	115.6018
C435-LB13149	2-3 COWCROSS ST	82122.2610	36551.7060	115.399
C435-LB13150	2-3 COWCROSS ST	82125.5260	36546.3550	115.384
C435-LB13151	1 COWCROSS ST	82126.5840	36545.0530	115.3843
C435-LB13152	1 ST. JOHN ST	82128.6670	36540.6340	115.3639
C435-LB13153	1 ST. JOHN ST	82129.9680	36539.2860	115.531
C435-LB13154	1 ST. JOHN ST	82131.8360	36537.0680	115.4071
C435-LB13155	3-5 ST JOHN ST	82137.0120	36537.1930	115.432
C435-LB13156	3-5 ST JOHN ST	82141.3540	36537.6840	115.3716
C435-LB13157	3-5 ST JOHN ST	82144.3360	36538.5280	115.3922

Table 1: Details of the sockets.

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-LP13203	Cowcross St	82142.605	36513.237	115.5683
C435-LP13202	Cowcross St	82143.519	36518.174	115.549
C435-LP13201	Cowcross St	82144.458	36523.082	115.5283
C435-LP13166	Cowcross St	82141.381	36513.746	115.5774
C435-LP13165	Cowcross St	82137.983	36517.793	115.458
C435-LP13164	Cowcross St	82134.737	36521.605	115.3847
C435-LP13163	Cowcross St	82131.494	36525.401	115.3405
C435-LP13162	Cowcross St	82128.234	36529.158	115.2898
C435-LP13161	Cowcross St	82125.038	36532.996	115.259
C435-LP13160	Cowcross St	82121.947	36536.919	115.2436
C435-LP13159	Cowcross St	82117.454	36541.680	115.1707
C435-LP13158	Cowcross St	82112.807	36546.285	115.2713
C435-LP13157	Cowcross St	82108.238	36548.415	115.2126
C435-LP13156	Cowcross St	82103.551	36550.053	115.1658
C435-LP13155	Cowcross St	82098.636	36550.649	115.1275
C435-LP13154	Cowcross St	82093.717	36551.228	115.077
C435-LP13153	Cowcross St	82088.895	36551.876	114.9968
C435-LP13152	Cowcross St	82083.957	36552.465	114.9079
C435-LP13151	Cowcross St	82079.035	36553.123	114.8061

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-LP13150	Cowcross St	82074.125	36553.829	114.7113
C435-LP13149	Cowcross St	82069.212	36554.466	114.5724
C435-LP13148	Cowcross St	82065.547	36555.261	114.5166
C435-LP13147	Cowcross St	82060.637	36556.096	114.422
C435-LP13146	Cowcross St	82055.657	36555.699	114.2913
C435-LP13145	Cowcross St	82050.839	36555.949	114.189
C435-LP13144	Cowcross St	82045.832	36556.196	114.0156
C435-LP13143	Cowcross St	82040.839	36556.076	113.8755
C435-LP13142	Cowcross St	82035.869	36555.945	113.7232
C435-LP13141	Cowcross St	82030.874	36555.998	113.5731
C435-LP13133	Cowcross St	82019.258	36555.120	113.2454
C435-LP13132	Cowcross St	82014.243	36554.897	113.0959
C435-LP13131	Cowcross St	82009.233	36554.724	112.9622
C430-LP00041	Cowcross St	81981.809	36556.130	112.2263
C430-LP00052	Cowcross St	81926.303	36546.115	111.9417
C430-LP00051	Cowcross St	81932.499	36549.202	111.9831
C430-LP00050	Cowcross St	81939.000	36552.513	111.9076
C430-LP00049	Cowcross St	81954.617	36549.249	111.999
C430-LP00048	Cowcross St	81957.178	36550.595	111.9897
C430-LP00047	Cowcross St	81959.987	36551.947	111.9367
C430-LP00046	Cowcross St	81962.003	36553.148	111.9714
C430-LP00045	Cowcross St	81964.626	36554.424	111.9975
C430-LP00044	Cowcross St	81968.580	36556.540	112.0327
C430-LP00043	Cowcross St	81973.507	36556.305	112.0814
C430-LP00042	Cowcross St	81978.468	36556.026	112.148
C430-LP00040	Cowcross St	81986.001	36555.716	112.3317
C430-LP00039	Cowcross St	81990.897	36555.605	112.4672
C430-LP00038	Cowcross St	81995.333	36555.793	112.5933
C430-LP00037	Cowcross St	81999.728	36555.633	112.6354
C430-LP00036	Cowcross St	82004.134	36556.113	112.743
C430-LP00035	Turnmill St	81971.962	36567.099	112.0374

Table 2: Details of the studs.

The sockets and studs on Cowcross St are shown in the following documents:

Drawings:

- C435-BFK-C2-DWG-M123-50043. Sockets Installed for Farringdon Station
- C435-BFK-C2-DWG-M123-50044. Studs Installed for Farringdon Station

Installation Reports:

- C435-BFK-C2-RGN-M123-50137. Installation Report-Manual Precise Levelling Points. Studs, sockets and invar scale.

- C435-BFK-C-RGN-M123-50136. Handover Report-WTH North area. Cowcross St and Farringdon Rd.

## B.2 Location of the Instruments

Sockets and studs are located on the plan below highlighted in yellow.

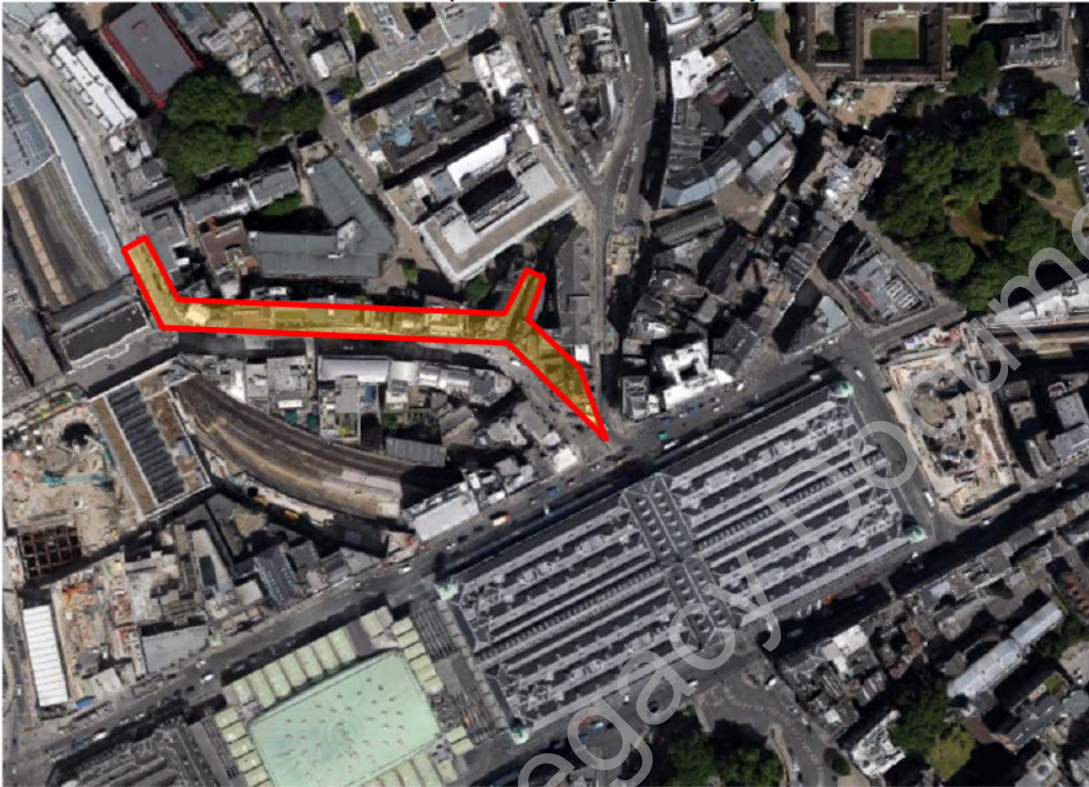


Figure 1 – Plan showing the Location of the sockets and studs

## 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 3 below.

Activity	Start Date	End Date
EB TBM	08-01-2014	16-01-2014
WB TBM	30-09-2013	01-10-2013
PTE Enlargement	15-05-2014	20-08-2014
PTW Enlargement	24-07-2014	11-08-2014
CP4	12-10-2015	17-09-2015
CP2a	06-09-2014	14-09-2014
CP3a	24-05-2014	27-08-2014

Table 3 – Construction Activities associated to the instruments

### C.1.2 Resulting Movements

To analyse the result for the sockets will be separate by buildings:

- 1-5 Cowcross St
- 4-8 Cowcross St.
- 9-18 Cowcross St.
- 19-30 Cowcross St.
- 32-33 Cowcross St.
- 64-65 Cowcross St.
- 66 Cowcross St
- 67-69 Cowcross St.
- 70-77 Cowcross St.
- 78 Cowcross St.
- 79-85 Cowcross St.
- 86-89 Cowcross St.
- 87-92 Cowcross St.

- 1-5 Cowcross St.

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

- Compensation grouting from Moorgate Shaft 1 caused 4mm maximum of heave on 10-07-2013.
- EB TBM caused 6mm maximum of settlement from 15-01-2014 to 17-01-2014.
- PTE enlargements works caused 10mm of settlement from 03-08-2014 to 01-09-2014.
- CP4 construction caused 3-4mm of settlement from 17-09-2014 to 29-09-2014.
- Maximum settlement at the end of the works was 22mm.

- 4-8 Cowcross St

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

- EB TBM caused maximum 3-4mm of settlement from 13-01-2014 to 16-01-2014.
- PTE enlargement caused 8-9mm of settlement maximum from 17-07-2014 to 10-08-2014.
- Maximum settlement at the end of the works was 11mm

- 9-18 Cowcross St.

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

- EB TBM caused maximum 2mm of settlement from 12-01-2014 to 15-01-2014.
- PTE works caused maximum 10mm of settlement from 06-07-2014 to 04-08-2014.
- Maximum settlement at the end of the works was 10mm

- 19-30 Cowcross St

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

- EB TBM caused maximum 2-3mm of settlement from 09-01-2014 to 12-01-2014.
- PTE caused 2mm maximum of settlement from 01-06-2014 to 05-07-2014.
- Maximum settlement at the end of the works was 2mm

- 32-33 Cowcross St.

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



- EB TBM caused maximum 1-1.5mm of settlement from 08-01-2014 to 09-01-2014.
- PTE enlargement works caused 3-4mm of settlement from 15-05-2014 to 07-06-2014.
- Maximum settlement at the end of the works was 4mm

- 64-65 Cowcross St.

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

- EB TBM caused maximum 1-1.5mm of settlement from 08-01-2014 to 10-01-2014.
- PTE enlargement works caused 2-3mm of settlement from 15-05-2014 to 18-06-2014.
- Maximum settlement at the end of the works was 5mm

- 66 Cowcross St.

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

- Compensation grouting from Butcher's Ramp Shaft caused 2mm of heave on 13-11-2013.
- EB TBM caused 3-4mm of settlement from 09-01-2014 to 11-01-2014.
- PTE enlargement works caused 5-6mm of settlement from 20-05-2014 to 21-06-2014.
- Maximum settlement at the end of the works was 4mm

- 67-69 Cowcross St.

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

- Compensation grouting caused 2mm of heave on 13-11-2013.
- EB TBM caused 2mm maximum of settlement from 09-01-2014 to 11-01-2014.
- Compensation grouting caused 2-3mm of heave on 10-06-2014.
- CP3a, CP2a and PTE combination caused maximum 3-4mm of settlement from 24-05-2014 to 14-09-2014.
- Maximum settlement at the end of the works was 5mm

- 70-77 Cowcross St.

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

- Compensation grouting caused 2-2.5mm of heave on 04-11-2013.
- EB TBM caused maximum 2-3mm of settlement from 10-01-2014 to 12-01-2014.
- Compensation grouting caused 2-3mm of heave on 07-05-2014.
- PTE enlargement works caused 18mm of settlement from 18-06-2014 to 09-07-2014.
- Maximum settlement at the end of the works was 21mm

- 78 Cowcross St.

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

- Compensation grouting caused 2-3mm of heave on 08-01-2014.
- EB TBM caused 4-5mm of settlement on 12-01-2014.
- Residual settlement caused 1-1.5mm of settlement.
- PTE enlargements works caused maximum 10mm of settlement from 02-07-2014 to 17-07-2014.
- Maximum settlement at the end of the works was 21mm

- 79-85 Cowcross St.

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

- 3-4mm of heave captured caused by the EB TBM pressure on 08-01-2014.
- EB TBM caused 6mm of settlement from 12-01-2014 to 15-01-2014.

- PTE enlargement works caused 30mm maximum of settlement from 13-07-2014 to 03-08-2014.
- Maximum settlement at the end of the works was 34mm

- **86-89 Cowcross St.**

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

- 3-4mm of heave captured caused by EB TBM pressure on 08-01-2014.
- EB TBM caused maximum 4-6mm of settlement from 13-01-2014 to 16-01-2014.
- PTE works caused 28mm of settlement from 27-07-2014 to 14-08-2014.
- CP4 caused 2-3mm of settlement from 17-09-2014 to 21-09-2014.
- Maximum settlement at the end of the works was 35mm

- **87-92 Cowcross St.**

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

- Compensation grouting from Moorgate Shaft 1 caused 4-6mm of heave on 21-08-2013.
- WB TBM caused maximum 5-6mm of settlement from 30-09-2013 to 01-10-2013.
- Compensation grouting caused maximum 2-3mm of heave on 14-11-2013.
- EB TBM caused 6-7mm of settlement on 15-01-2014.
- PTW works caused 6mm of settlement from 22-07-2014 to 10-08-2014.
- PTE enlargement caused 8mm of settlement from 01-08-2014 to 14-08-2014.
- Compensation grouting caused 3-4mm of heave on 31-08-2014.
- CP4 construction caused 10mm of settlement from 17-09-2014 to 12-10-2014.
- Maximum settlement at the end of the works was 26mm

To analyse the result for the studs will be separate by sections:

- From C430-LP00030 to C430-LP00035 and from C430-LP00047 to C430-LP00052
- From C430-LP00036 to C435-LP13133
- From C435-LP13134 to C435-LP13140
- From C435-LP13141 to C435-LP13149
- From C435-LP13150 to C435-LP13158
- From C435-LP13159 to C435-LP13166
- From C435-LP13179 to C435-LP13186
- From C435-LP13201 to C435-LP13203

- **From C430-LP00030 to C430-LP00035 and from C430-LP00047 to C430-LP00052**

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

- EB TBM caused 1-2mm of settlement from 08-01-2014 to 10-01-2014.
- PTE enlargement works caused 2mm of settlement from 06-05-2014 to 29-05-2014.
- Maximum settlement at the end of the works was 6mm

- **From C430-LP00036 to C435-LP13133**

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

- EB TBM caused 2-3mm of settlement from 08-01-2014 to 11-01-2014.
- PTE enlargement caused 6-7mm of settlement from 15-05-2014 to 21-06-2014.
- Maximum settlement at the end of the works was 8mm

- **From C435-LP13134 to C435-LP13140**

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

- Compensation grouting from Butcher's Ramp Shaft caused 2-3mm of heave from 06-09-2013 to 17-10-2013.

- EB TBM caused maximum 7-8mm of settlement on 10-01-2014.
- Compensation grouting caused 3-4mm of heave from 12-05-2014 to 10-06-2014.
- PTE works caused 18mm maximum of settlement from 09-06-2014 to 26-06-2014.
- Compensation grouting caused 3-4mm of heave on 26-07-2014.
- Maximum settlement at the end of the works was 22mm

- **From C435-LP13141 to C435-LP13149**

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

- EB TBM head pressure caused 2-3mm on 08-01-2014.
- EB TBM caused 7-8mm of settlement maximum from 10-01-2014 to 13-01-2014.
- PTE works caused 12mm of settlement from 19-06-2014 to 16-07-2014.
- Maximum settlement at the end of the works was 16mm

- **From C435-LP13150 to C435-LP13158**

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

- 2-3mm of heave captured caused by the head pressure on 08-01-2014.
- EB TBM caused 9-10mm of settlement maximum from 13-01-2014 to 16-01-2014
- PTE enlargement caused maximum 25mm of settlement from 13-07-2014 to 16-08-2014.
- CP4 construction caused 5-6mm of settlement from 17-09-2014 to 21-09-2014.
- Maximum settlement at the end of the works was 35mm

- **From C435-LP13159 to C435-LP13166**

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

- Compensation grouting from Moorgate Shaft 1 caused 9mm of heave from 04-07-2013 to 23-08-2013.
- WB TBM caused maximum 2mm of settlement on 30-09-2013.
- EB TBM caused maximum 3-4mm of settlement on 15-01-2015.
- PTE and PTW combination caused maximum 14mm of settlement between 30-07-2014 to 16-08-2014.
- Compensation grouting caused 2-3mm of heave on 18-09-2014.
- CP4 construction caused 3-4mm of settlement from 17-09-2014 to 12-10-2014.
- Maximum settlement at the end of the works was 33mm

- **From C435-LP13179 to C435-LP13186**

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

- 3-4mm of heave caused by EB TBM head pressure captured on 08-01-2014.
- EB TBM caused maximum 4mm of settlement from 13-01-2014 to 16-01-2014.
- PTE enlargement construction caused 10mm of settlement from 02-08-2014 to 18-08-2014.
- Maximum settlement at the end of the works was 14mm

- **From C435-LP13201 to C435-LP13203**

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

- Compensation grouting caused 9-10mm of heave from 19-04-2013 to 24-08-2013.
- WB TBM caused 4-5mm maximum of settlement on 01-10-2014.
- Compensation grouting caused 2mm of heave from 20-07-2014 to 05-08-2014.
- PTW construction caused 14-15mm of settlement maximum from 30-07-2014 to 16-08-2014.
- Maximum settlement at the end of the works was 28mm

## 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.

Most of the buildings where the sockets and studs are installed are inside the compensation grouting area, so in this case, the triggers criteria for this building is based on the slopes. More references included in the Close Out Report for Moorgate Shaft 1 C435-BFK-C2-RGN-M123-51608. Only 10mm alerts are associated with the instrumentation inside the compensation grouting area.

For the devices installed outside of the compensation grouting area, the criteria for the triggers is the settlement:

- Green Trigger, -24mm.
- Amber trigger, -30mm.
- Red trigger, -38mm.

## C.3 Significant Issues with the Instrumentation

No issues with these devices.

## C.4 Residual Risks

No risks remain.

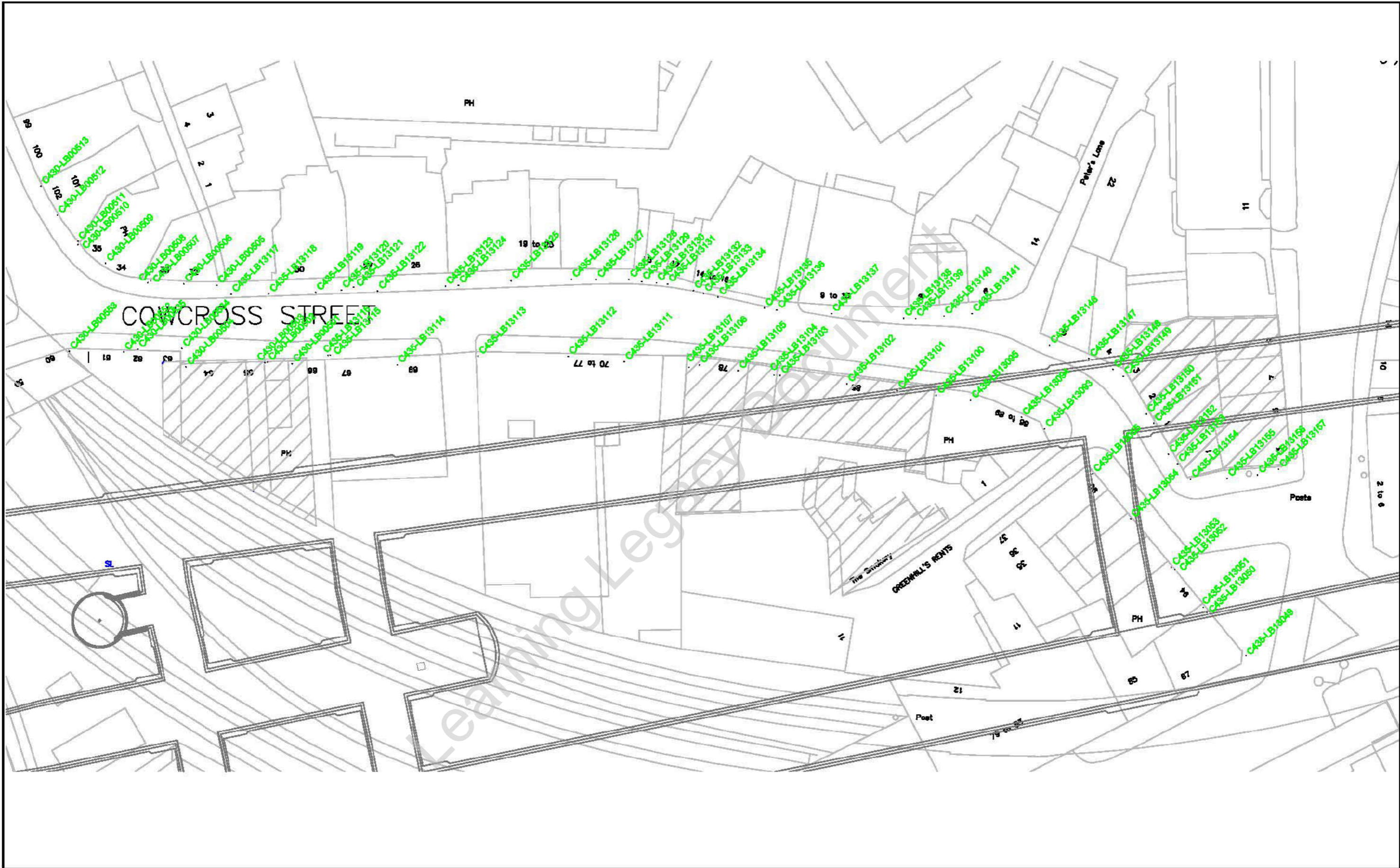
## D. CONCLUSIONS

No residual risks remain. Long term monitoring to be completed by InSar/Crossrail.

As per C435-PMI-00549 the long term monitoring has been ceased in this area and subsequently all monitoring associated is no longer undertaken by BFK.

APPENDIX A: DRAWINGS

Learning Legacy Document



Notes:

Rev.	Date	Description	By	Chkd	App	Auth



C/ Los Llanos de Jerez 10-12  
28023 - MADRID  
www.geocisa.com



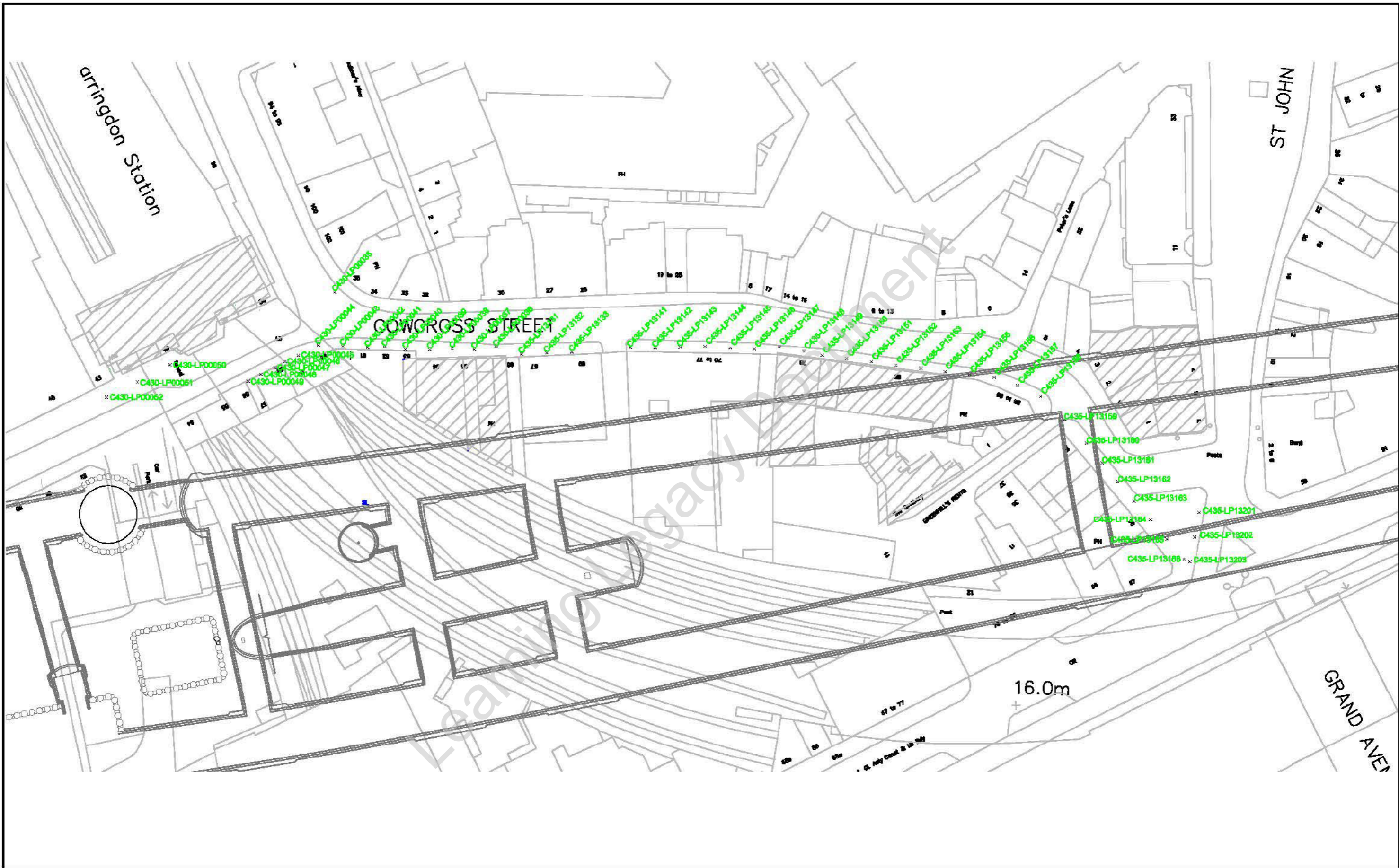
Contract : BORED TUNNELS (ALIGNMENT AND TRACK)  
Originator : OVE ARUP & PARTNERS LIMITED  
Location : CROSSRAIL GENERAL  
Title :

Scale : @ A3

Dwg No : C435-BFK-C2-DWG-M123-50043-SOCKETS

Rev : Sult : Auth : **GEOCISA**

sPbys



Rev.	Date	Description	By	Chkd	App	Auth

Notes:

Contract : BORED TUNNELS (ALIGNMENT AND TRACK)  
 Originator : OVE ARUP & PARTNERS LIMITED  
 Location : CROSSRAIL GENERAL  
 Title :   
 Drg No : C435-BFK-C2-DWG-M123-50044-STUDS  
 Rev :   
 Sult :   
 Auth : **GROCISA**

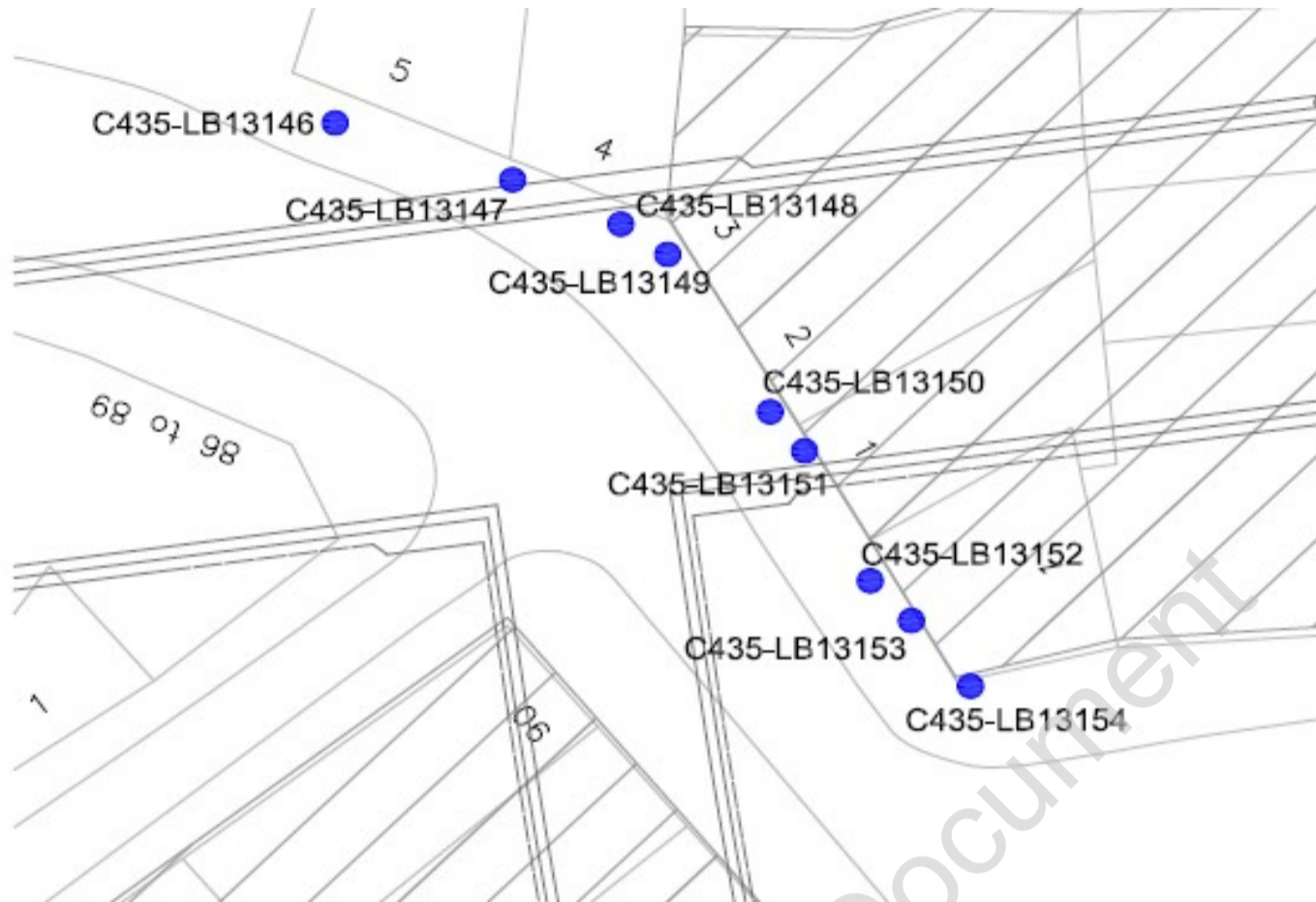
sPbys

APPENDIX B: GRAPHS

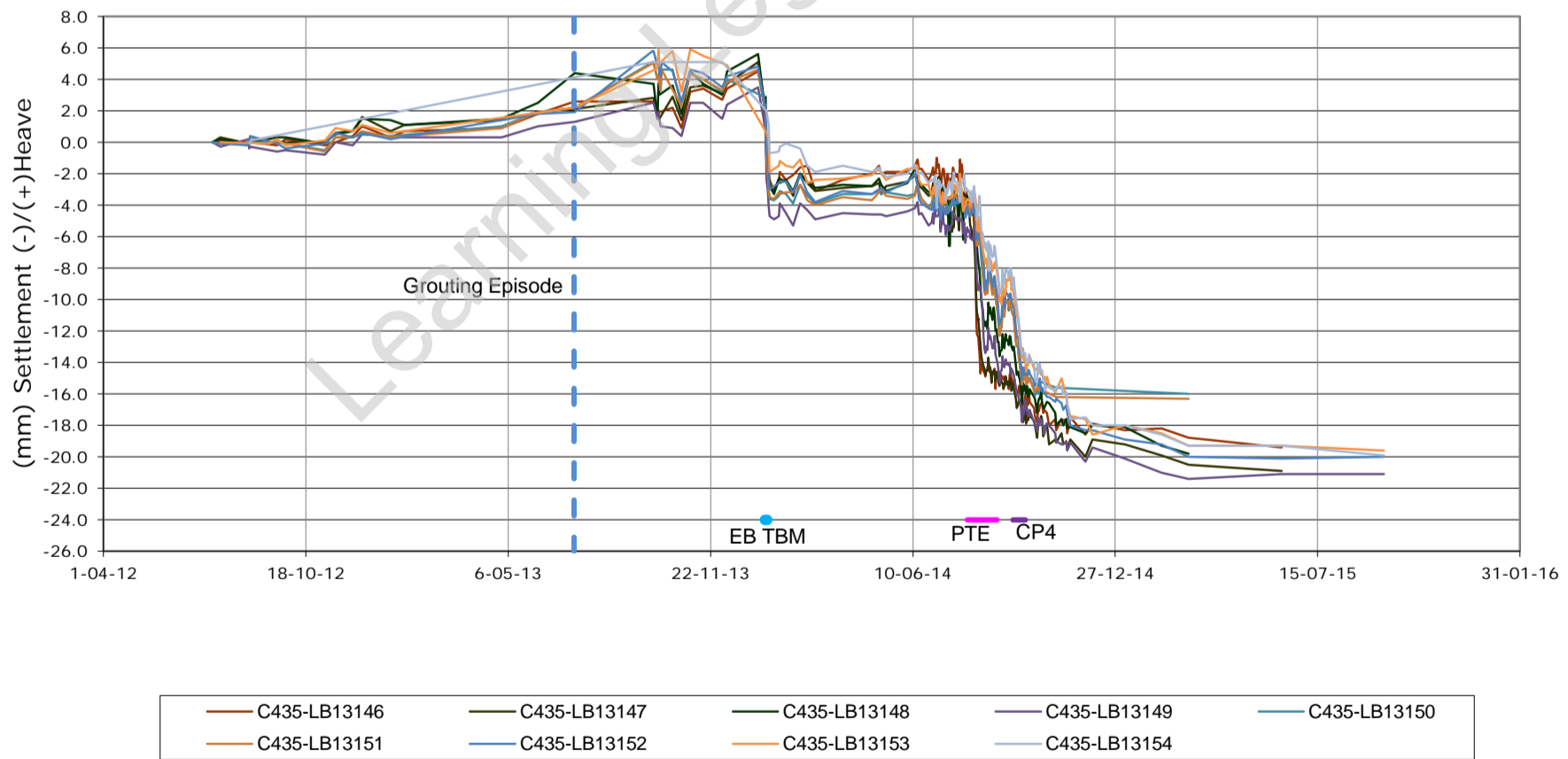
Learning Legacy Document



REPORT                   LEVELLING  
 AREA                    1-5 COWCROSS STREET  
 DEVICE                 Precise Levelling Points



Building: 1-5 COWCROSS STREET

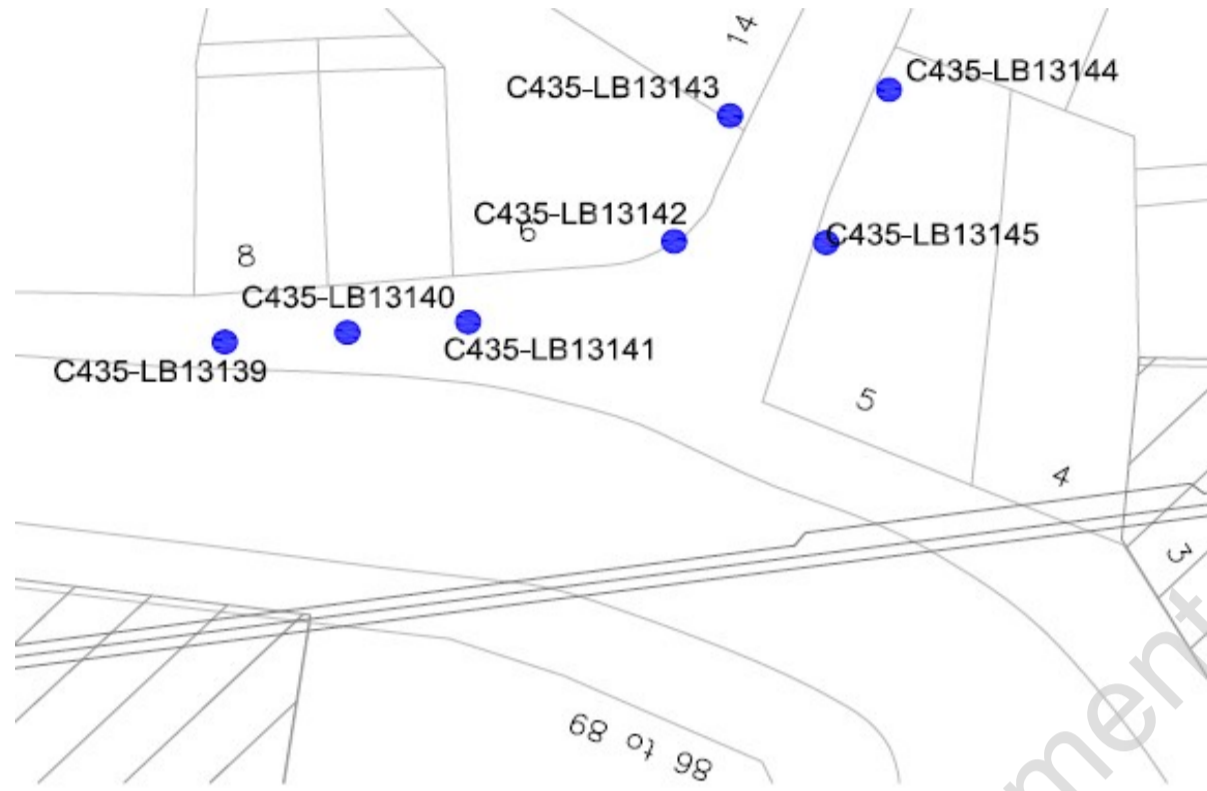


**REMARKS:**  
 Sockets inside the Compensation Grouting Area. No triggers breached.

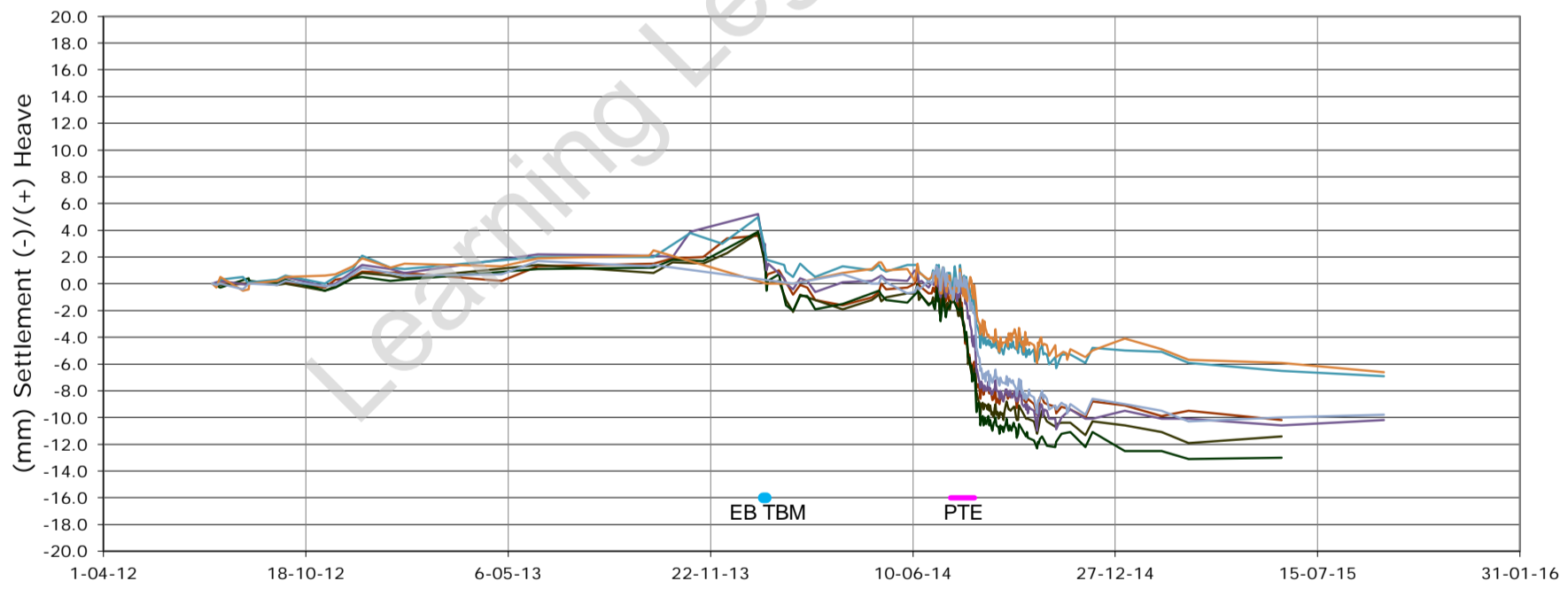


**GEOCISA UK**

REPORT                    LEVELLING  
AREA                        4-8 COWCROSS ST  
DEVICE                    Precise Levelling Points



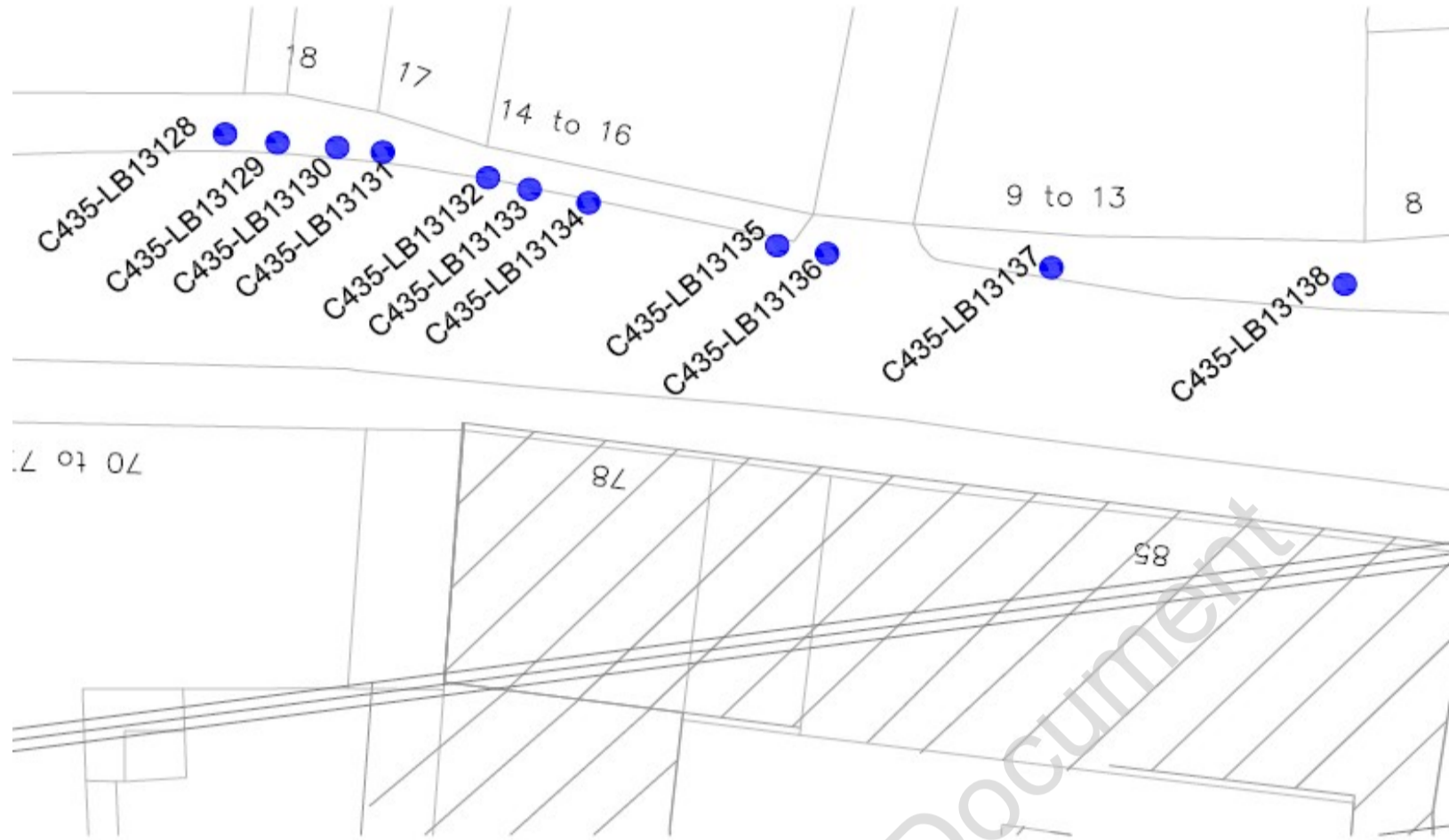
Building: 4-8 COWCROSS ST



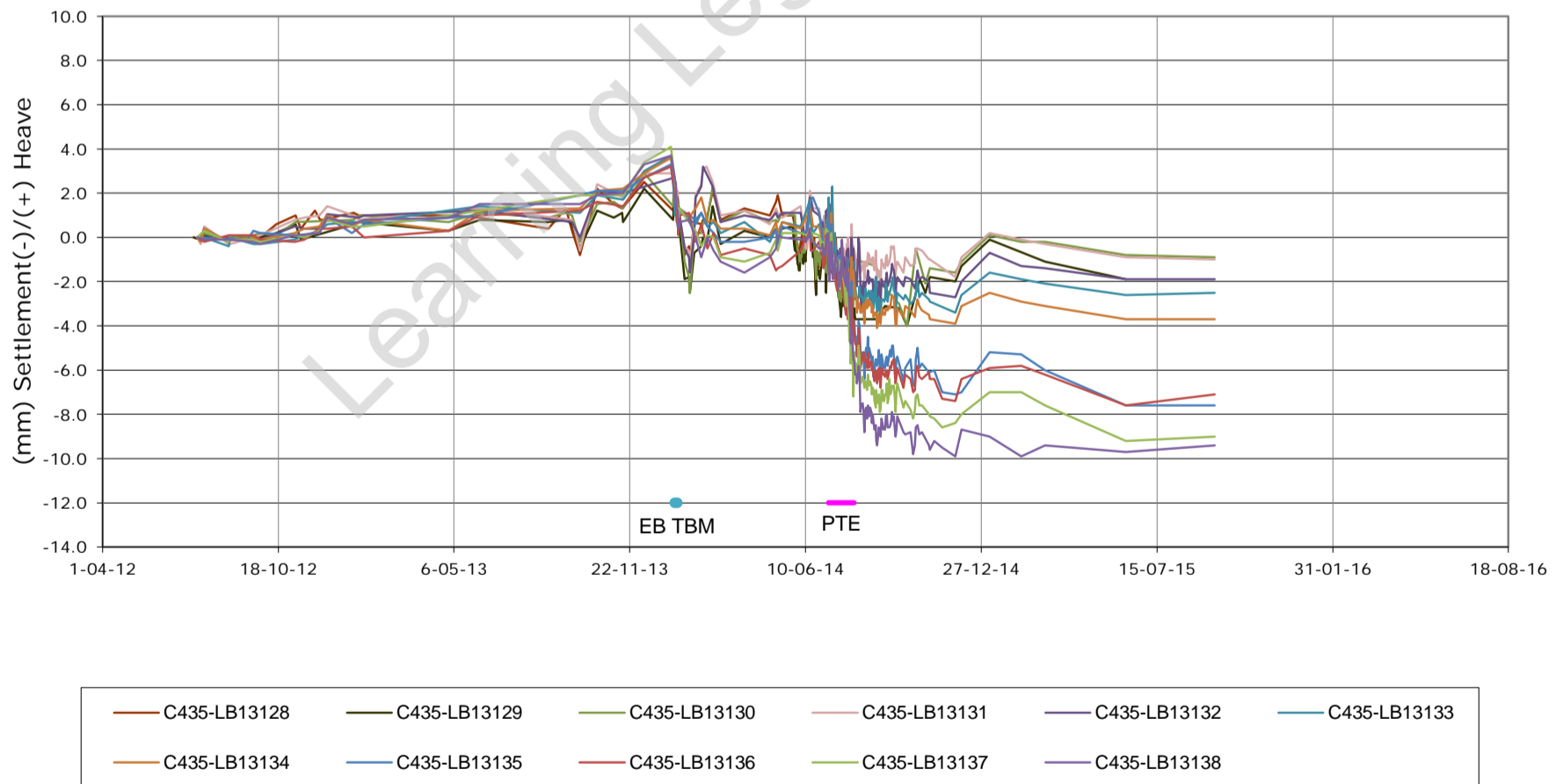
— C435-LB13139    — C435-LB13140    — C435-LB13141    — C435-LB13142    — C435-LB13143    — C435-LB13144    — C435-LB13145

**REMARKS:**  
Sockets outside Compensation Grouting Area. No triggers breached.

REPORT                      LEVELLING  
 AREA                        9-18 COWCROSS ST  
 DEVICE                      Precise Levelling Points



Building: 9-18 COWCROSS ST



**REMARKS:**  
 Sockets outside Compensation Grouting Area. No triggers breached.



**GEOCISA UK**

REPORT

LEVELLING

AREA

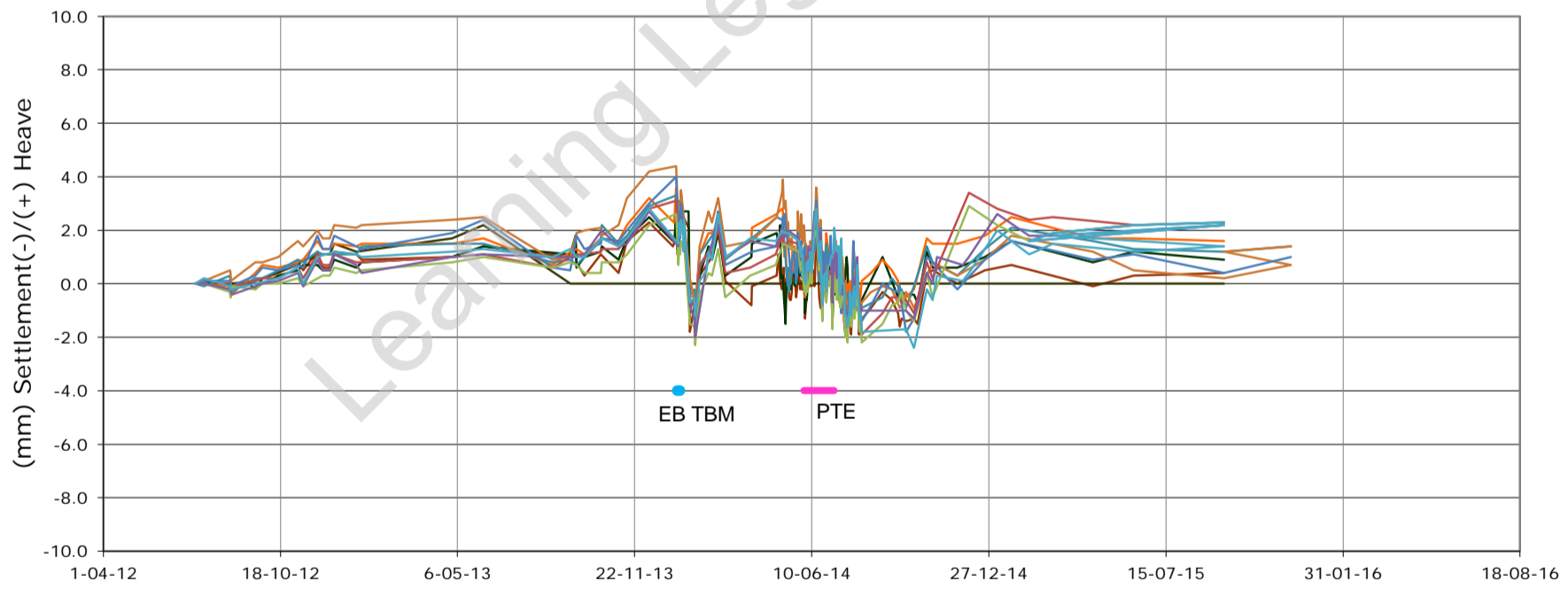
19-30 COWROSS ST

DEVICE

Precise Levelling Points



Building: 19-30 COWROSS ST



C435-LB13117	C435-LB13118	C435-LB13119	C435-LB13120	C435-LB13121	C435-LB13122
C435-LB13123	C435-LB13124	C435-LB13125	C435-LB13126	C435-LB13127	

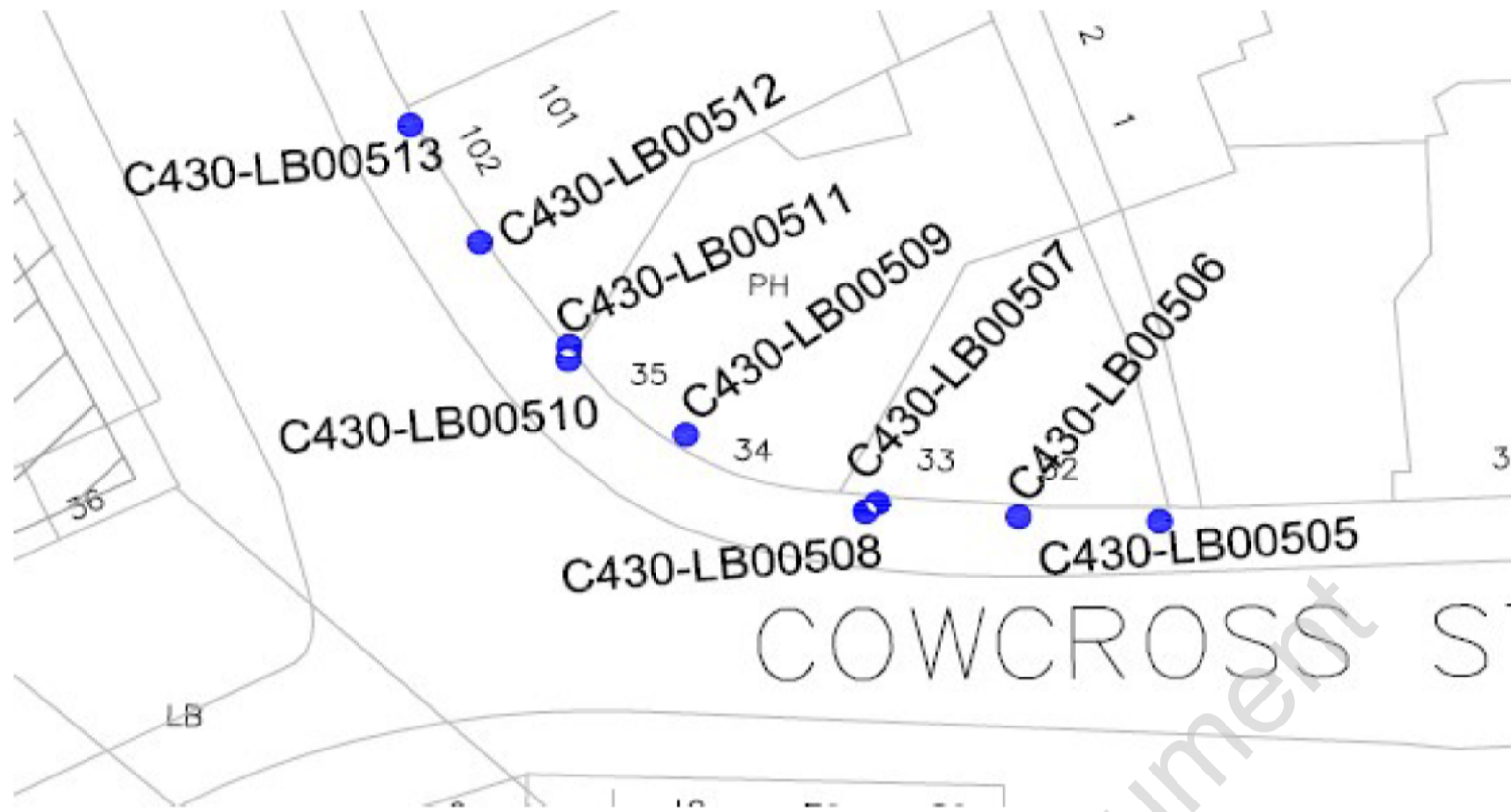
**REMARKS:**

Sockets outside Compensation Grouting Area. No triggers breached.

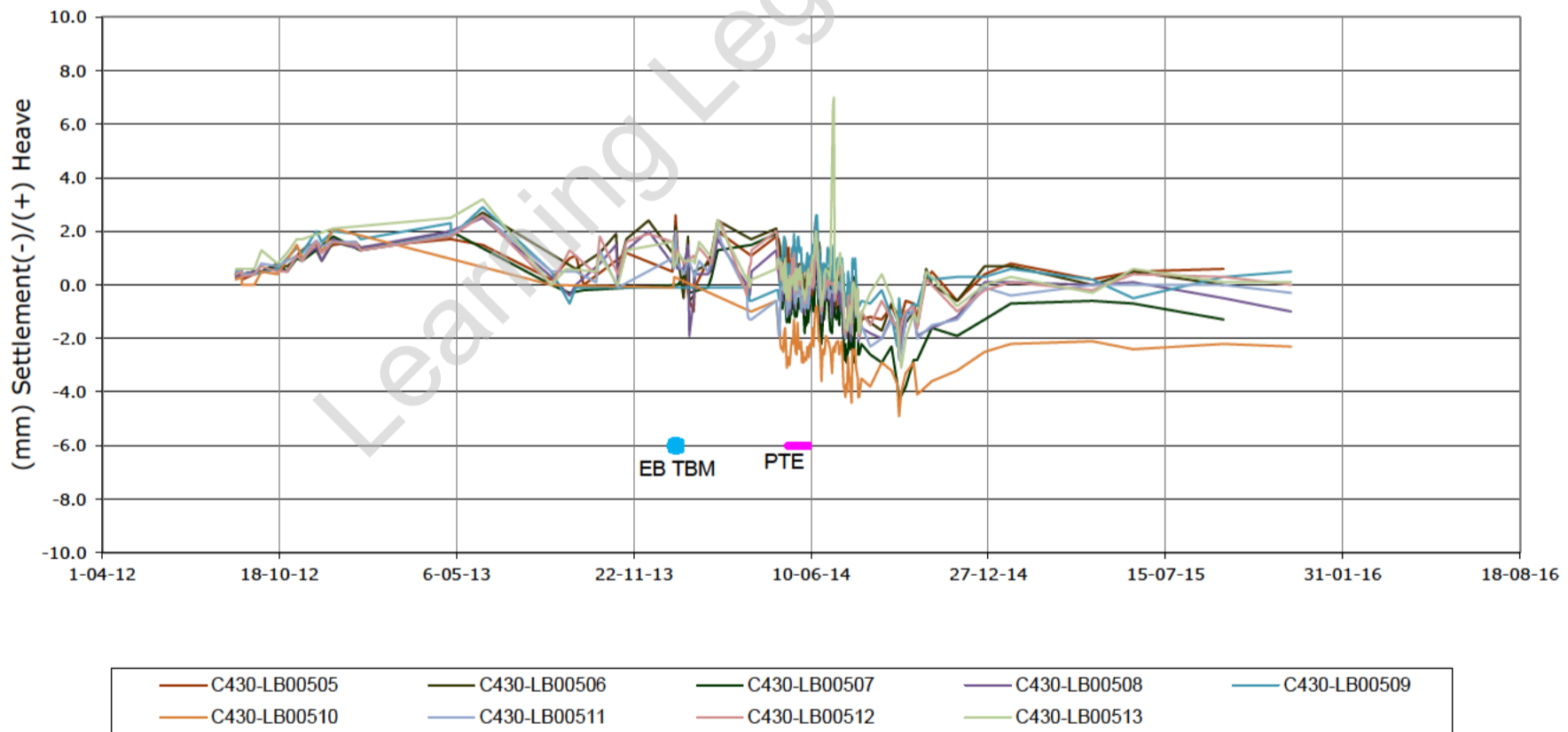


**GEOCISA UK**

REPORT                      LEVELLING  
AREA                         32-33 COWCROSS ST  
DEVICE                     Precise Levelling Points



Building: 32-33 COWCROSS ST

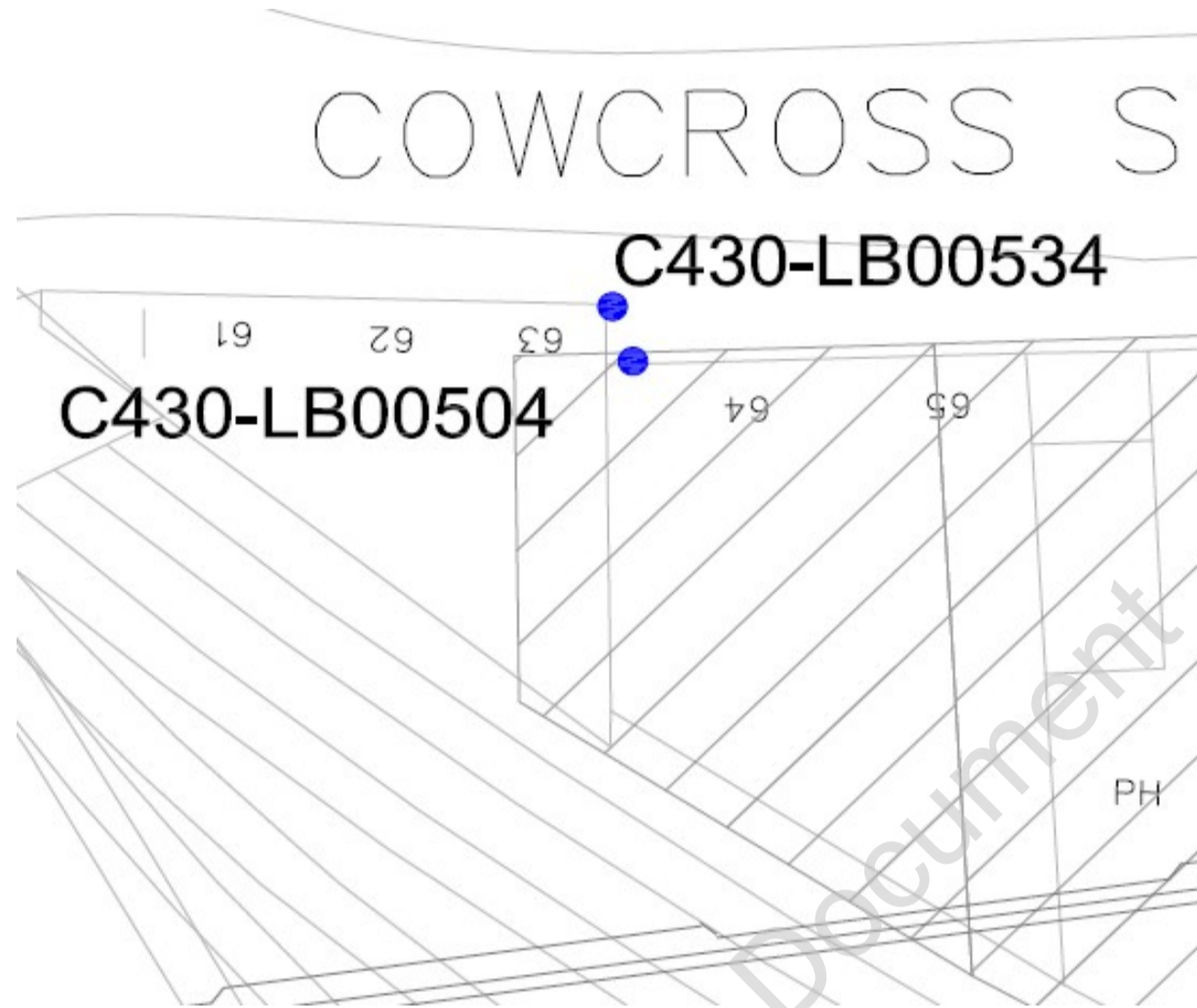


**REMARKS:**  
Sockets outside Compensation Grouting Area. No triggers breached.

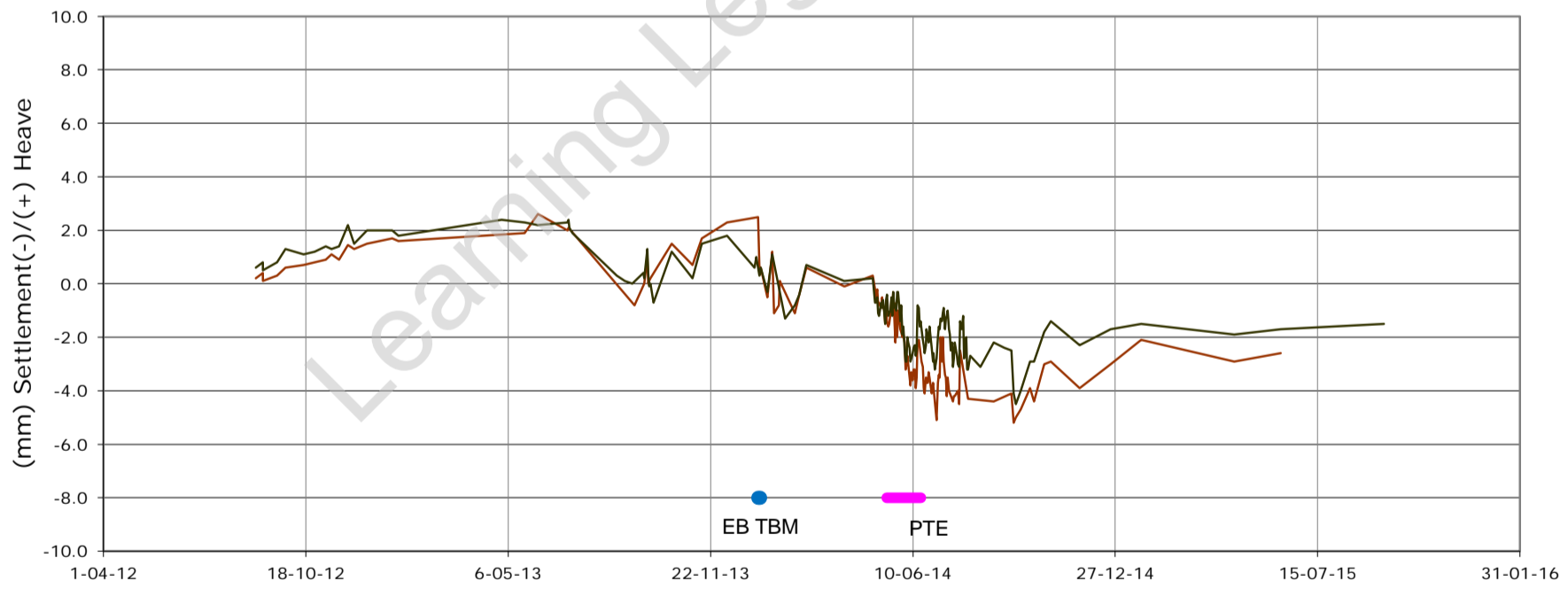


**GEOCISA UK**

REPORT                   LEVELLING  
AREA                     64-65 COWCROSS ST  
DEVICE                 Precise Levelling Points



Building: 64-65 COWCROSS ST



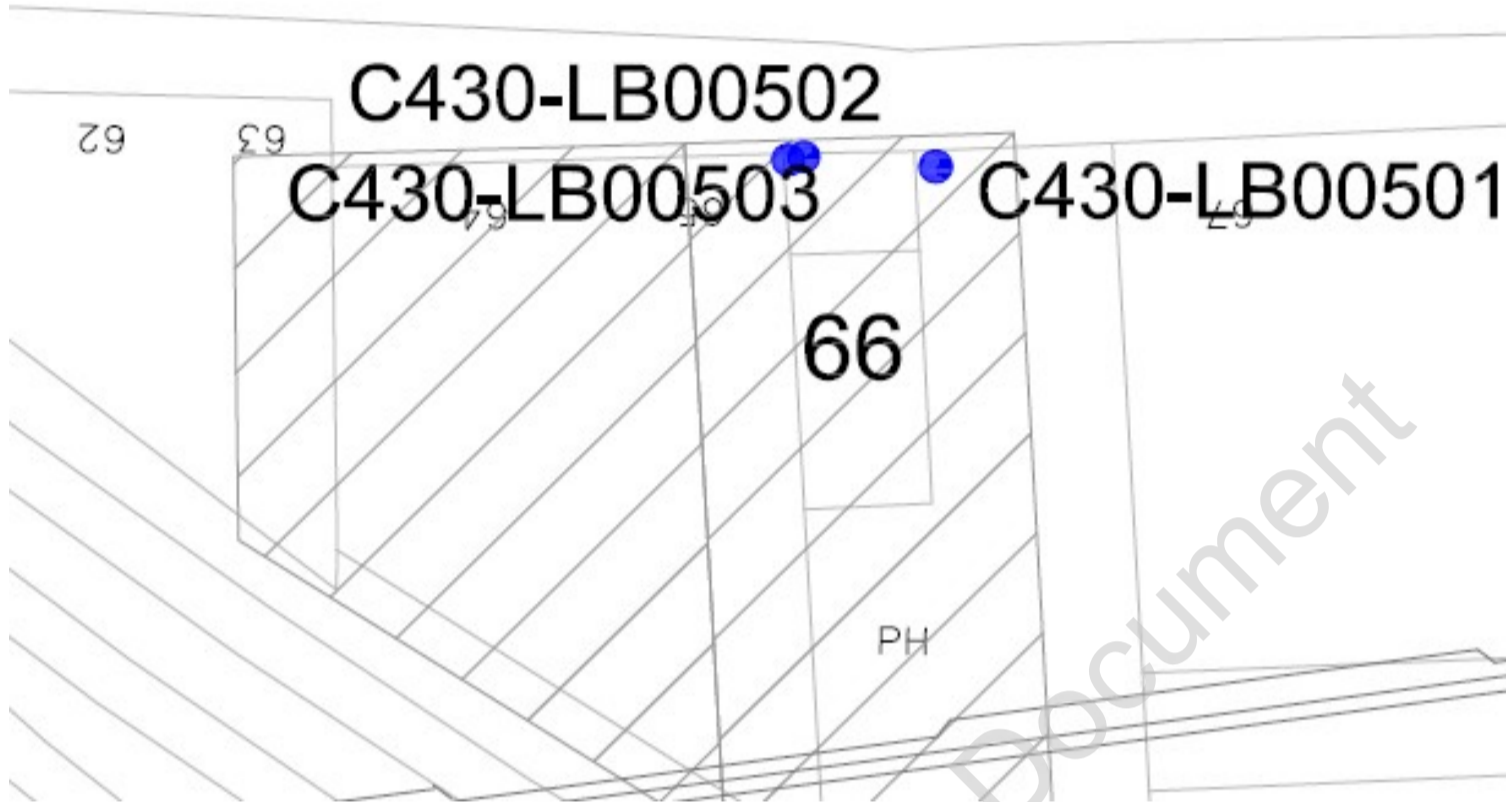
**REMARKS:**  
Sockets outside Compensation Grouting Area. No triggers breached.



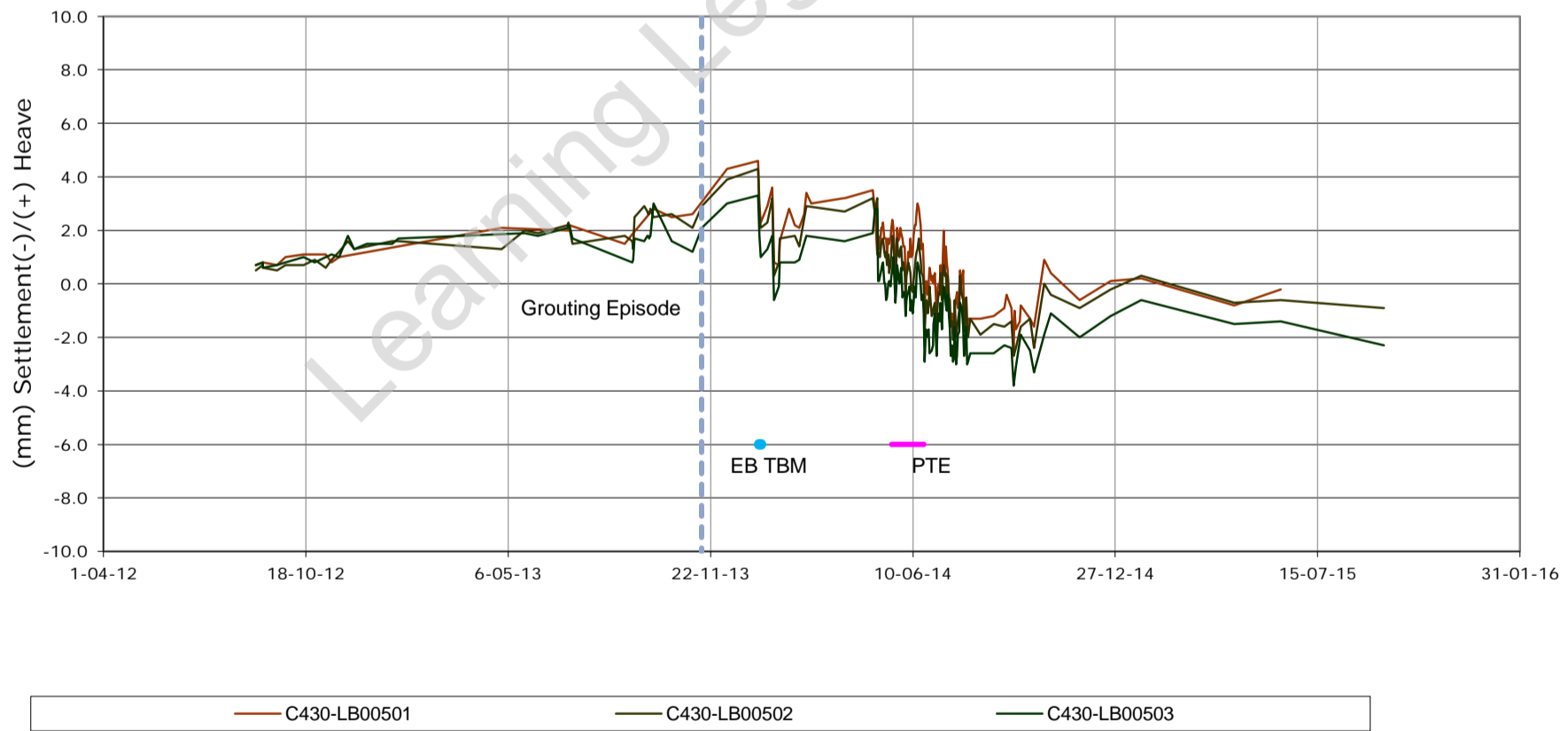
**GEOCISA UK**

REPORT                      LEVELLING  
AREA                         66 COWCROSS ST  
DEVICE                     Precise Levelling Points

# COWCROSS STREET



Building: 66 COWCROSS ST



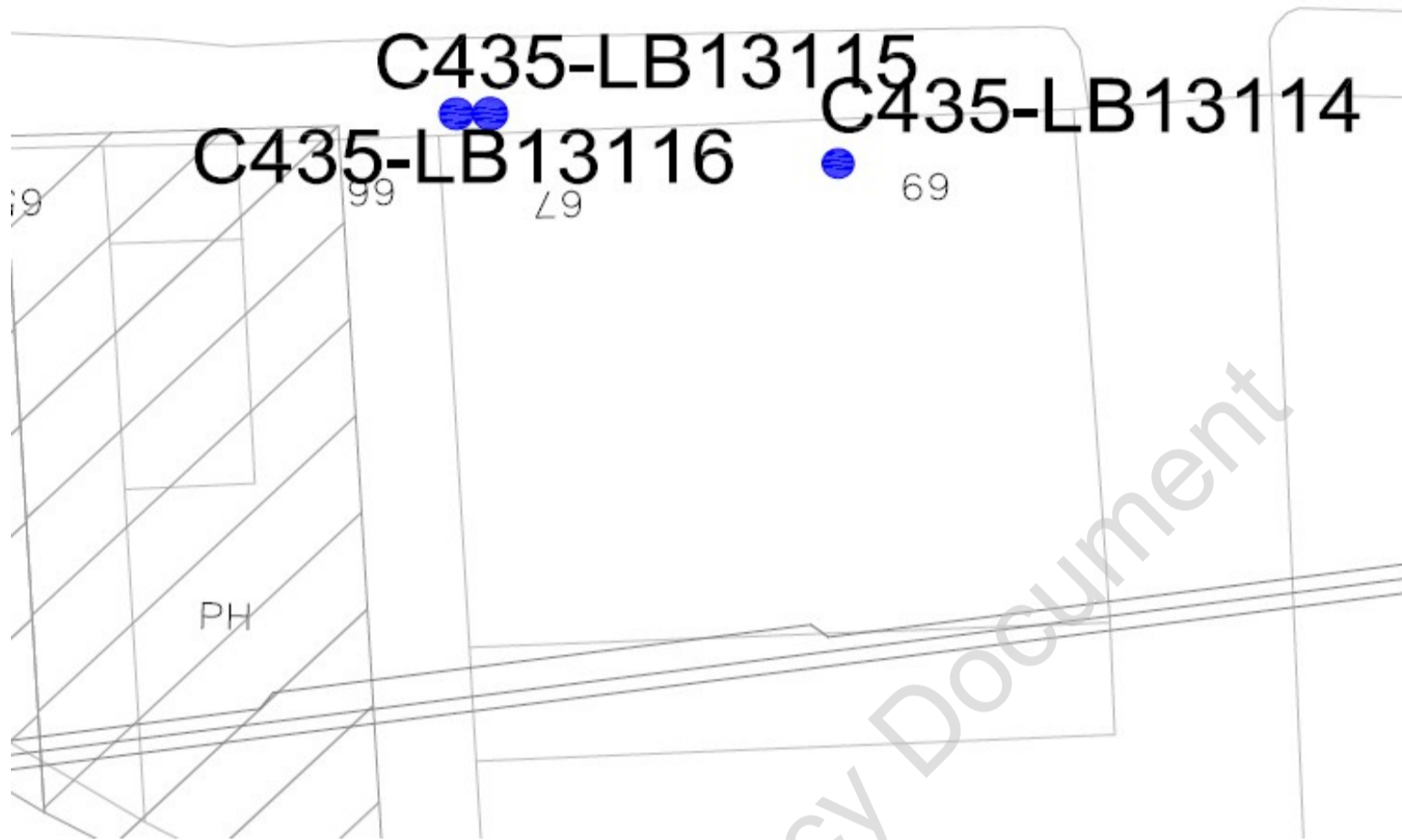
**REMARKS:**  
Sockets outside Compensation Grouting Area. No triggers breached.



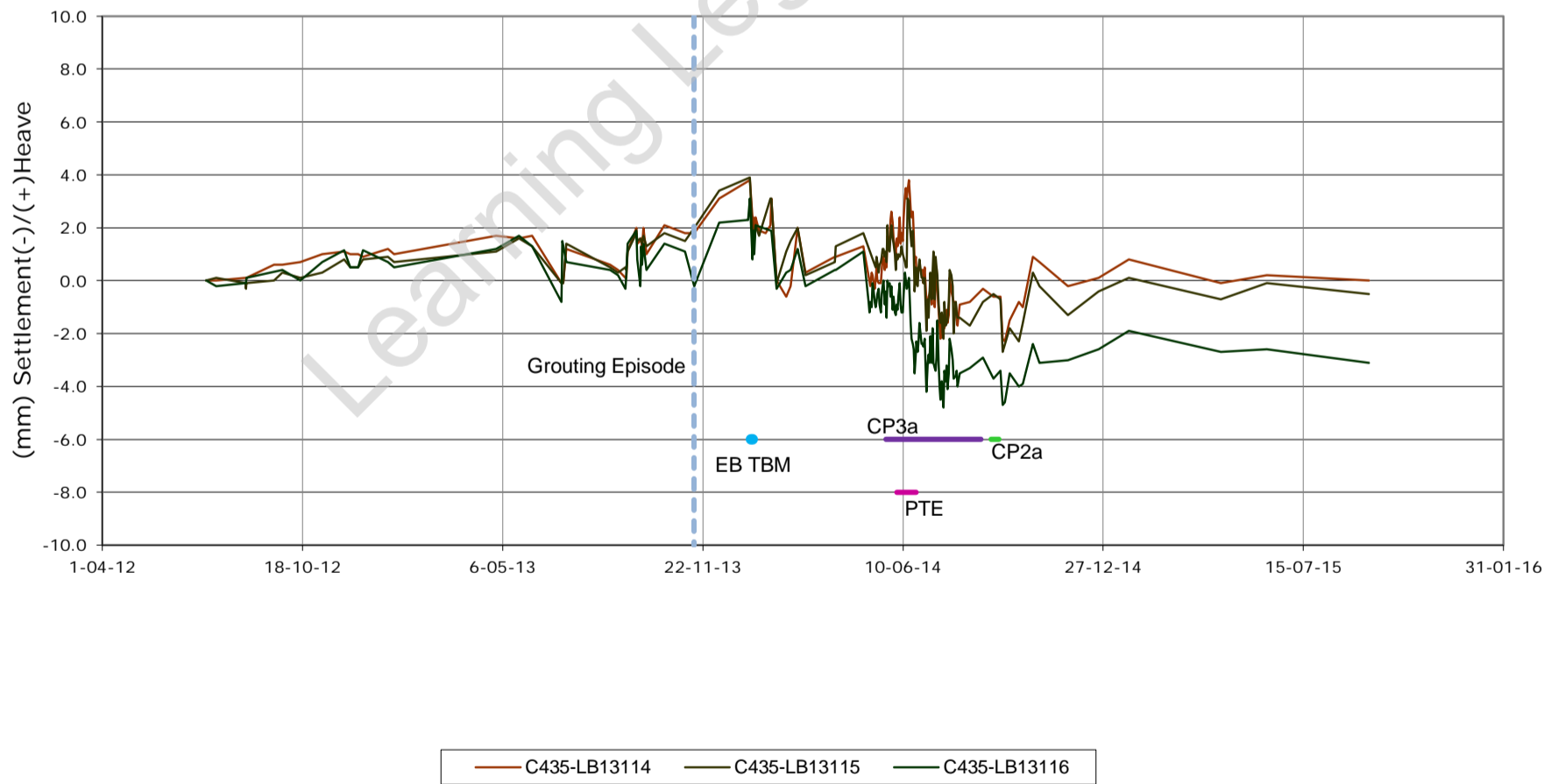
**GEOCISA UK**

REPORT                      LEVELLING  
AREA                         67-69 COWCROSS ST  
DEVICE                     Precise Levelling Points

# COWCROSS STREET



Building: 67-69 COWCROSS ST

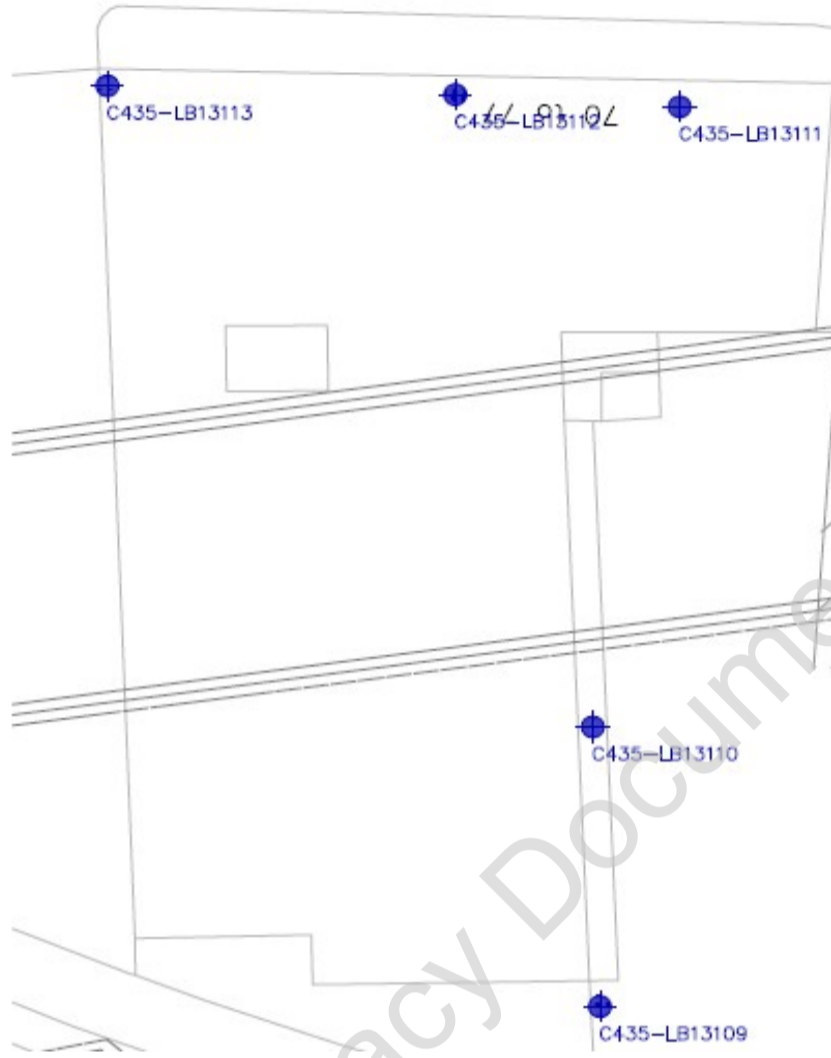


REMARKS:  
Sockets outside Compensation Grouting Area. No triggers breached.

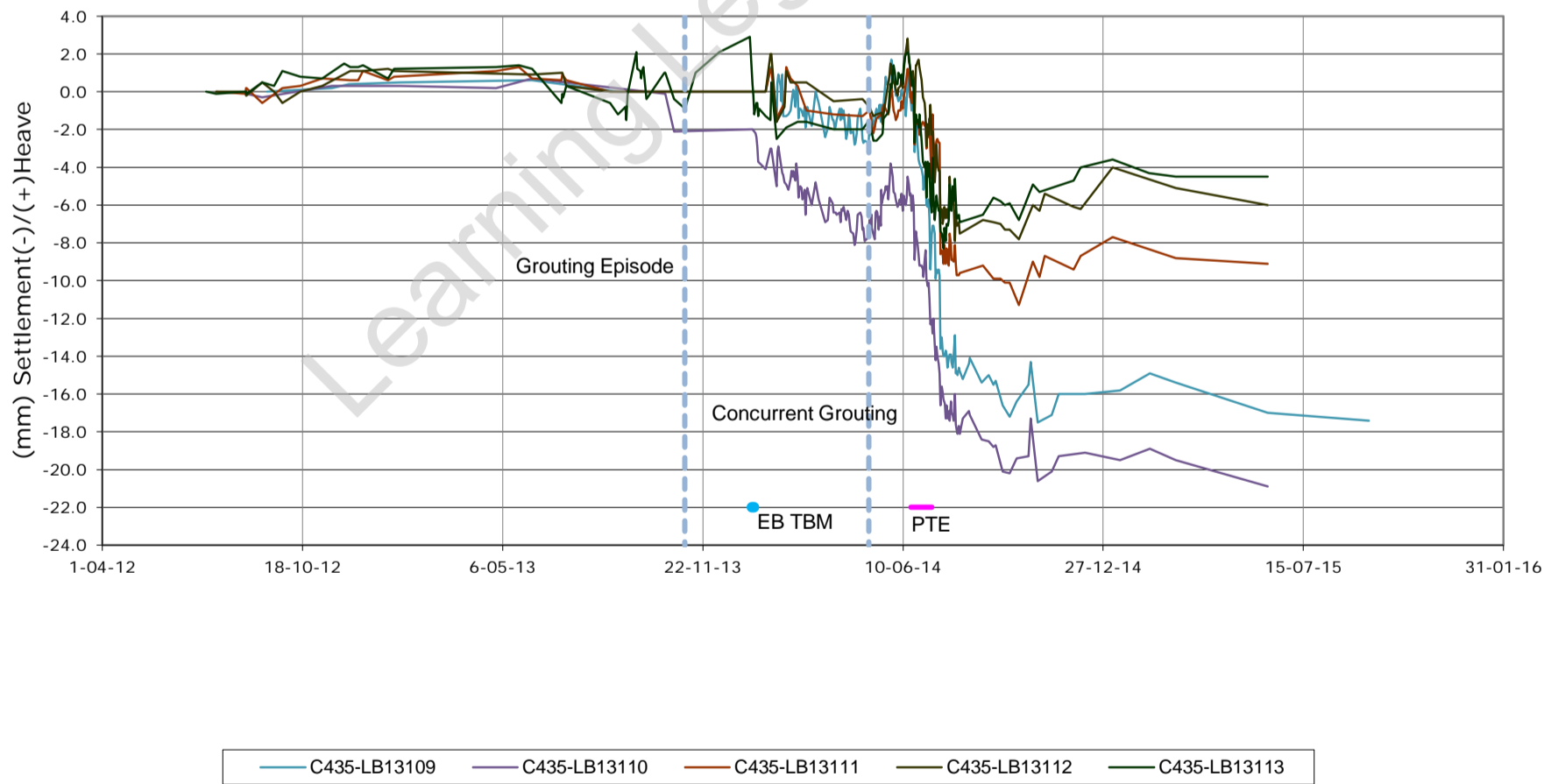


REPORT                    LEVelling  
 AREA                      70-77 COWCROSS ST (Cowcross St facade)  
 DEVICE                    Precise Levelling Points

COWCROSS STREET

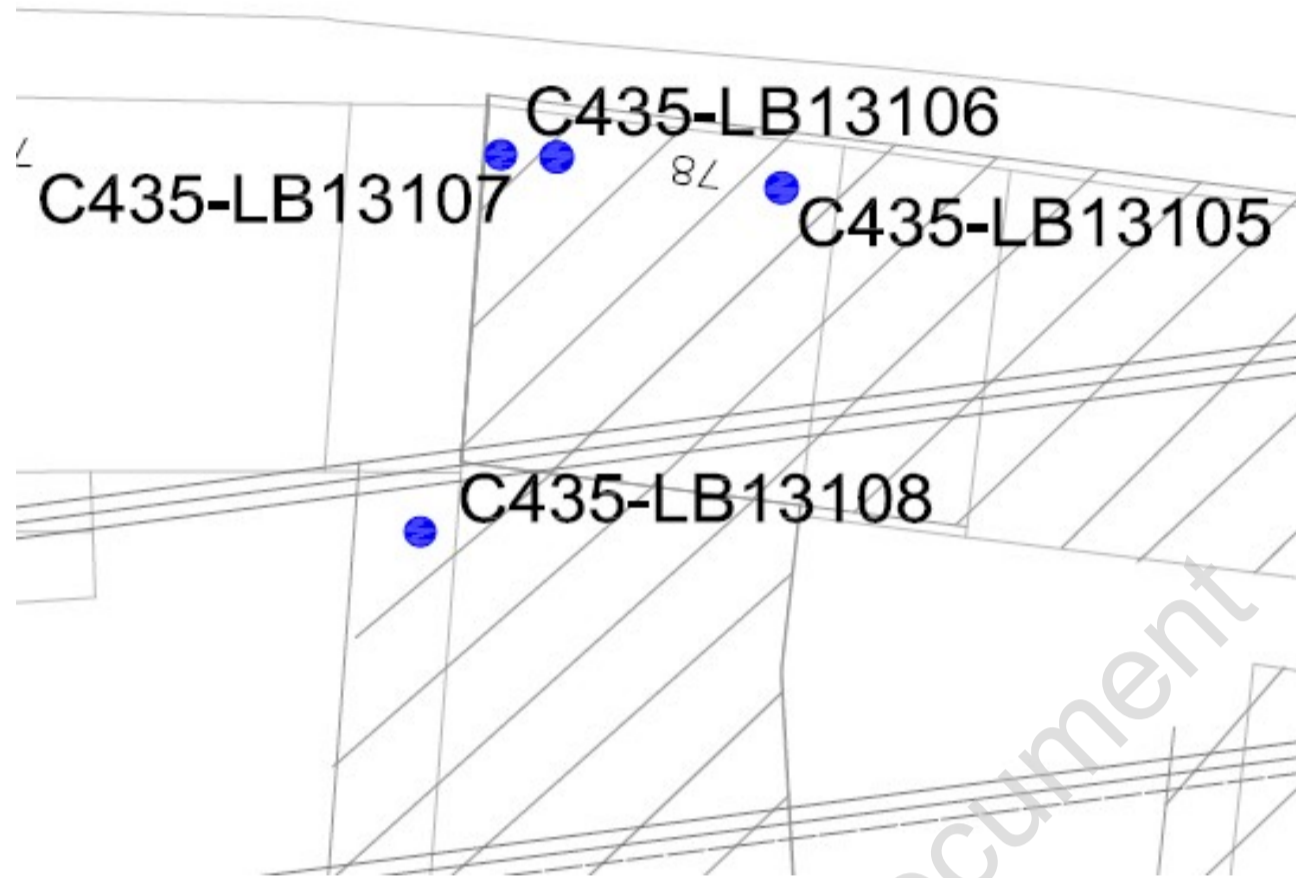


Building: 70-77 COWCROSS ST (Cowcross St facade)

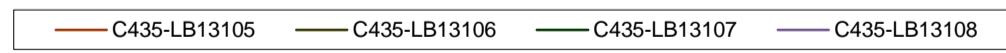
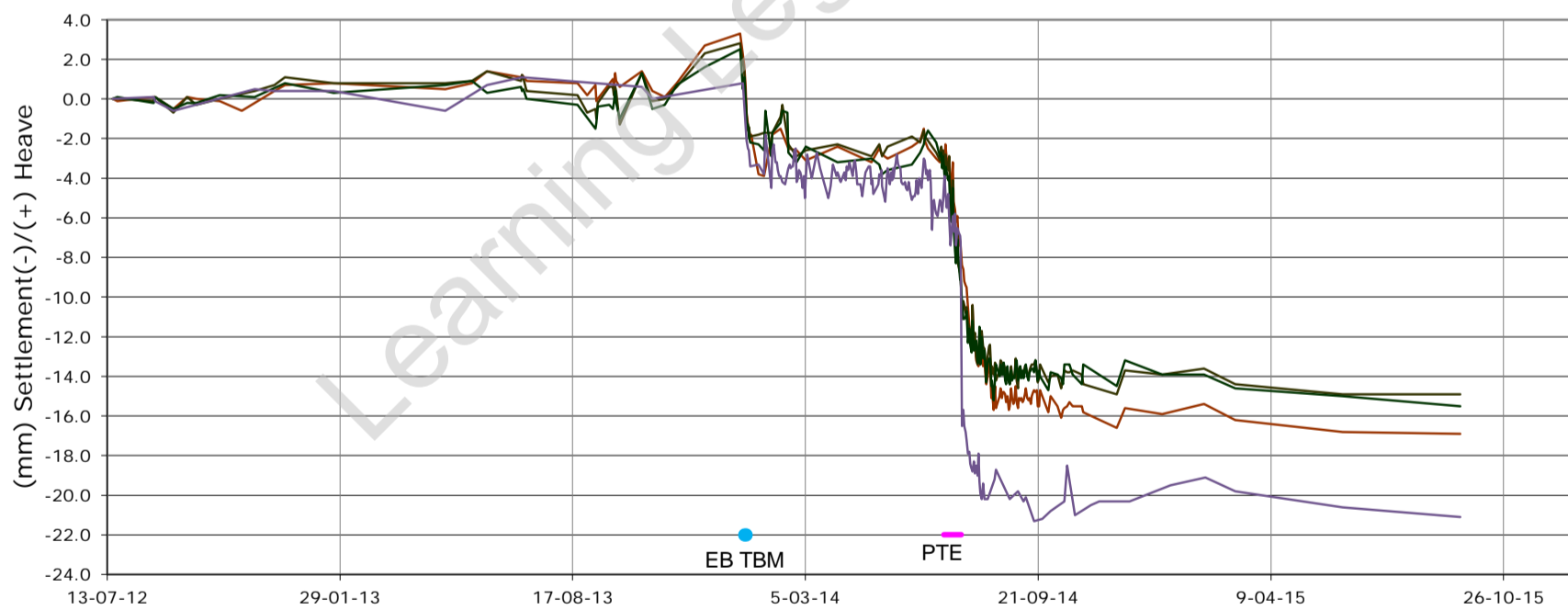


REMARKS:  
 Sockets inside Compensation Grouting Area. No triggers breached.

REPORT                      LEVELLING  
AREA                         78 COWCROSS ST  
DEVICE                      Precise Levelling Points



Building: 78 COWCROSS ST

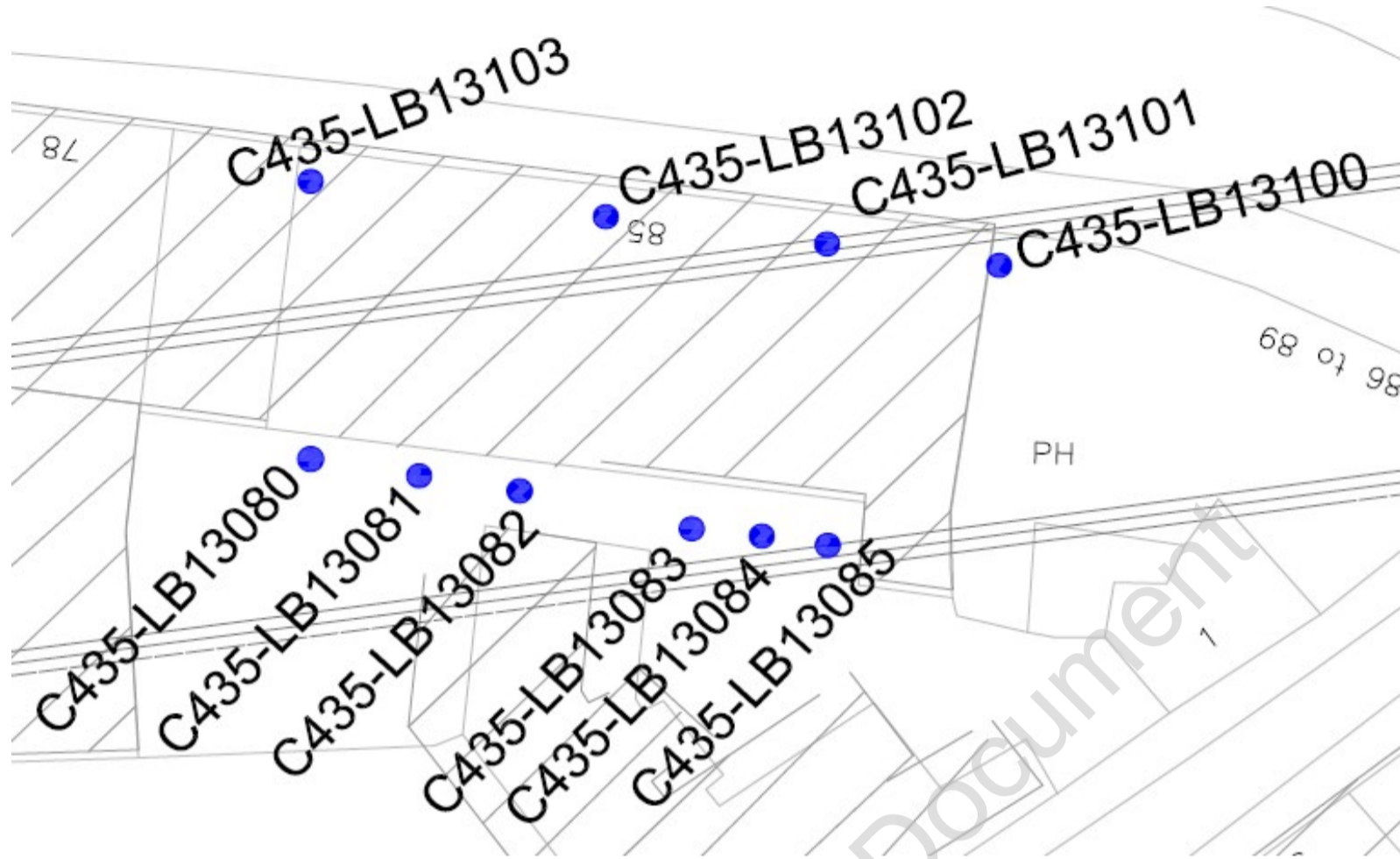


**REMARKS:**  
Sockets outside Compensation Grouting Area. No triggers breached.

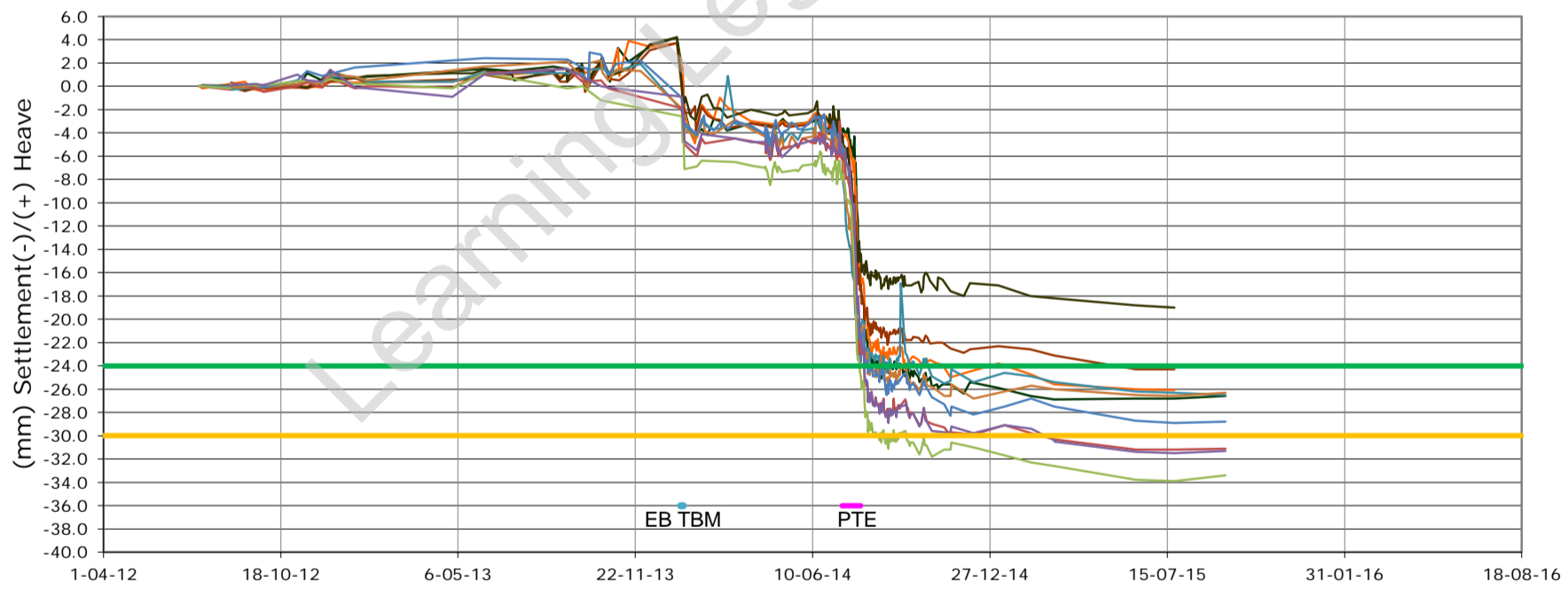


**GEOCISA UK**

REPORT                      LEVELLING  
 AREA                        79-85 COWCROSS ST (Cowcross St façade)  
 DEVICE                      Precise Levelling Points



Building: 79-85 COWCROSS ST (Cowcross St façade)



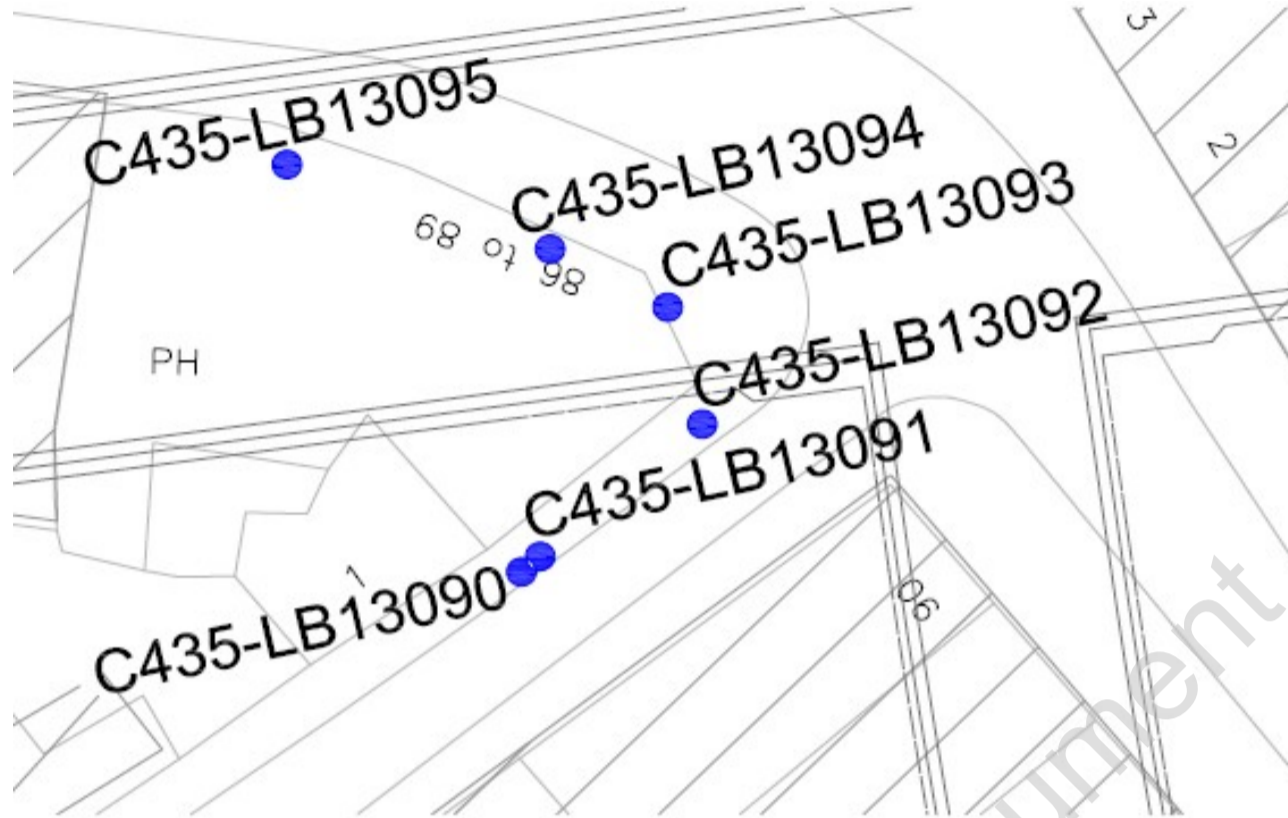
— C435-LB13100	— C435-LB13101	— C435-LB13102	— C435-LB13103	— C435-LB13080	— C435-LB13081
— C435-LB13082	— C435-LB13083	— C435-LB13084	— C435-LB13085	— Green Trigger	— Amber Trigger

REMARKS:  
 Sockets outside Compensation Grouting Area.  
 Green trigger breached by C435-LB13080 on 01-09-2014.  
 Green trigger breached by C435-LB13081 on 11-08-2014.  
 Green trigger breached by C435-LB13082 on 11-08-2014.  
 Green trigger breached by C435-LB13083 on 07-08-2014.  
 Green trigger breached by C435-LB13084 on 02-08-2014.  
 Green trigger breached by C435-LB13085 on 07-08-2014.  
 Green trigger breached by C435-LB13086 on 11-08-2014.  
 Green trigger breached by C435-LB13100 on 15-08-2014.  
 Green trigger breached by C435-LB13101 on 22-09-2014.  
 Green trigger breached by C435-LB13102 on 09-06-2015.  
 Amber trigger breached by C435-LB13083 on 09-03-2015.  
 Amber trigger breached by C435-LB13084 on 24-09-2014.  
 Amber trigger breached by C435-LB13085 on 09-03-2015.

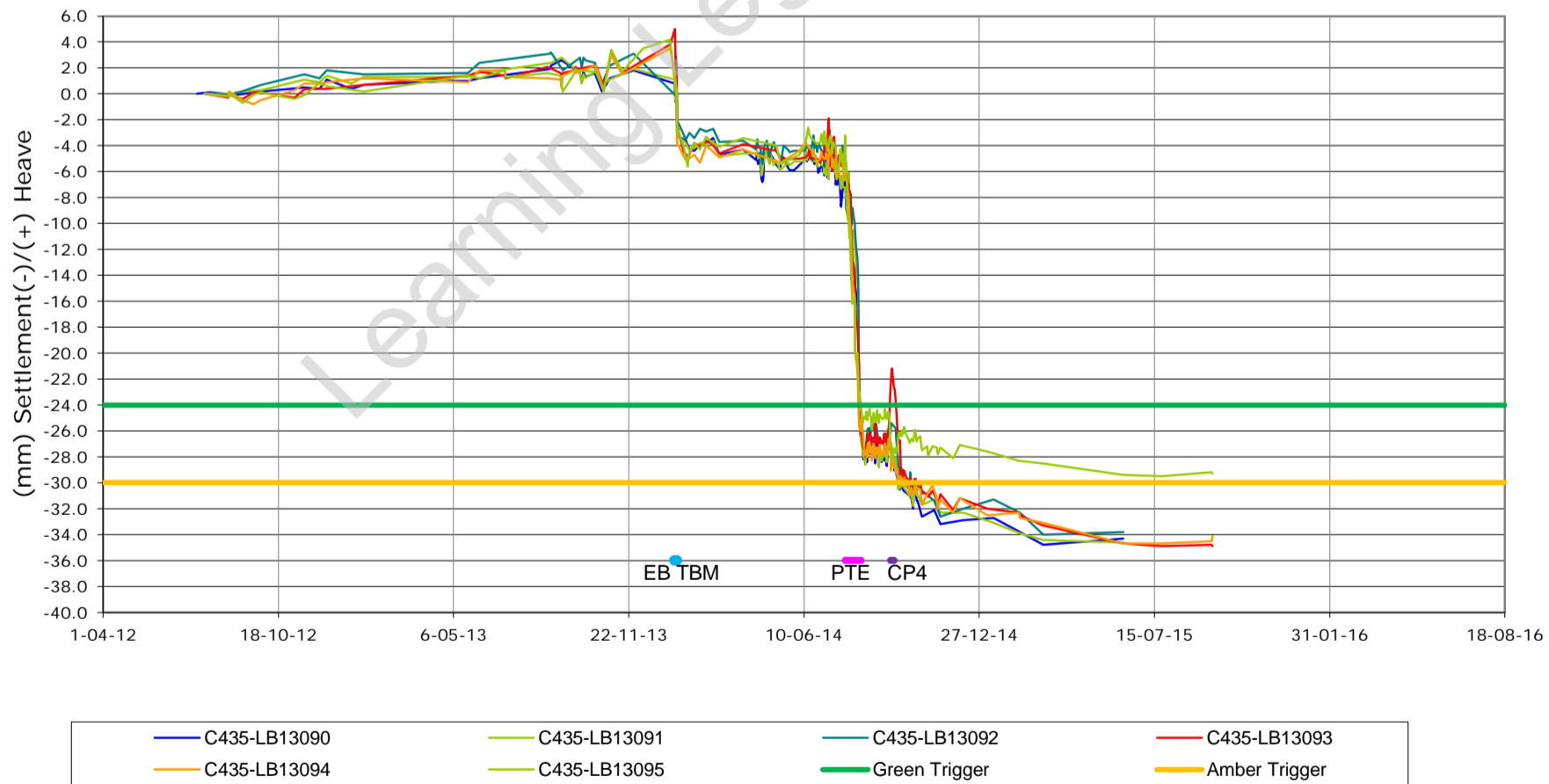


**GEOCISA UK**

REPORT	LEVELLING
AREA	86-89 COWCROSS ST
DEVICE	Precise Levelling Points



Building: 86-89 COWCROSS ST



**REMARKS:**

Sockets outside Compensation Grouting Area.

C435-LB13090 Green trigger breached on 11-08-2014.  
 C435-LB13091 Green trigger breached on 11-08-2014  
 C435-LB13092 Green trigger breached on 11-08-2014.  
 C435-LB13093 Green trigger breached on 12-08-2014.  
 C435-LB13094 Green trigger breached on 11-08-2014.  
 C435-LB13095 Green trigger breached on 13-08-2014.  
 C435-LB13090 Amber trigger breached on 25-09-2014.  
 C435-LB13091 Amber trigger breached on 25-09-2014.  
 C435-LB13092 Amber trigger breached on 08-10-2014.  
 C435-LB13093 Amber trigger breached on 08-10-2014.

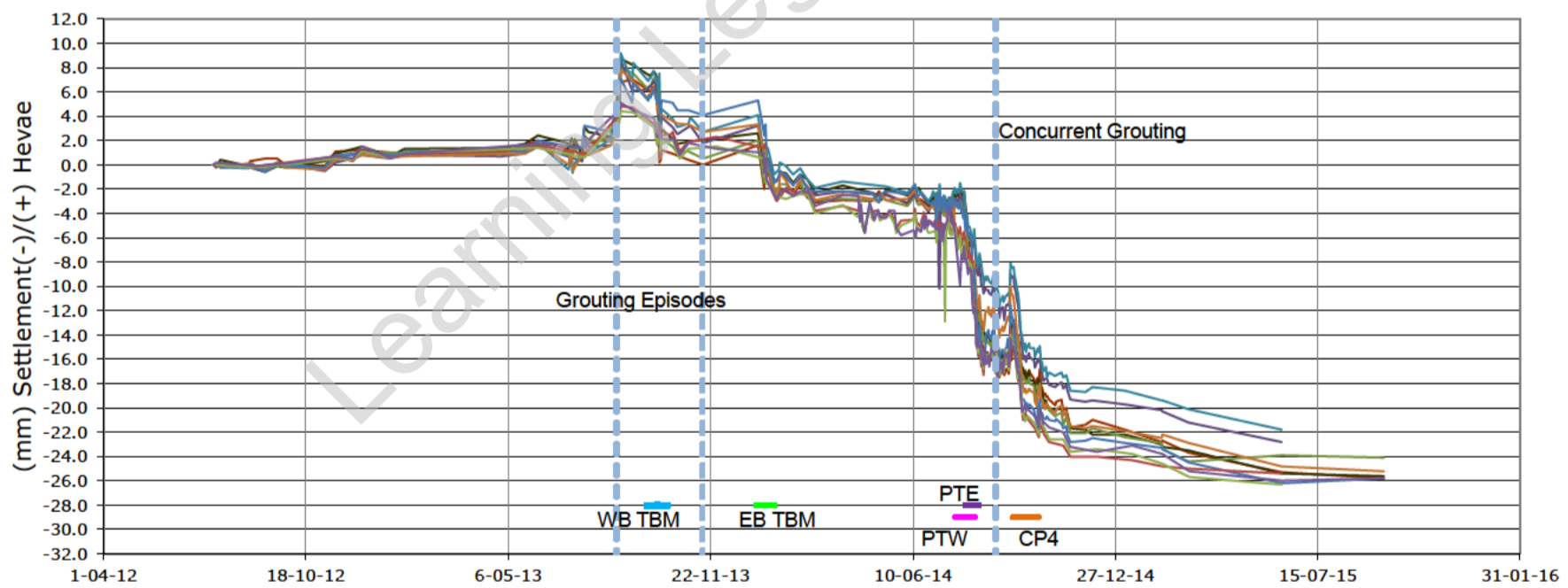


**GEOCISA UK**

REPORT                   LEVELLING  
 AREA                     90-94 COWCROSS St  
 DEVICE                  Precise Levelling Points



Building: 87 CHARTERHOUSE STREET

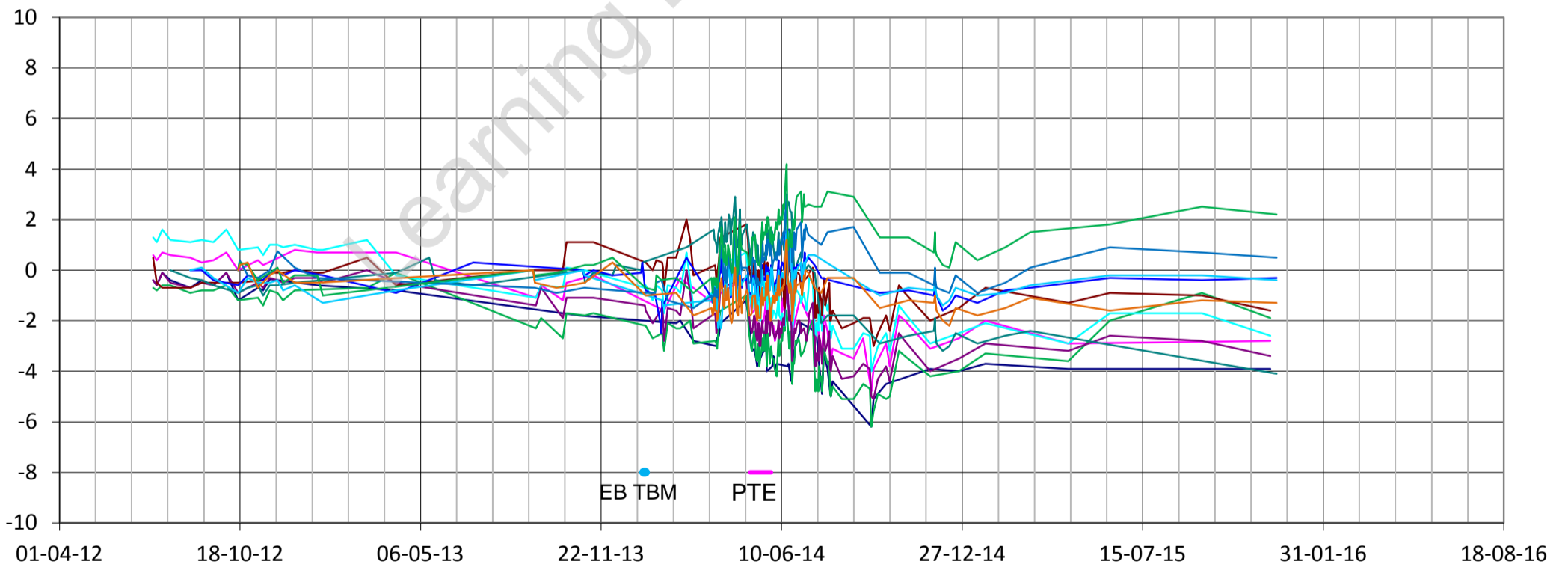
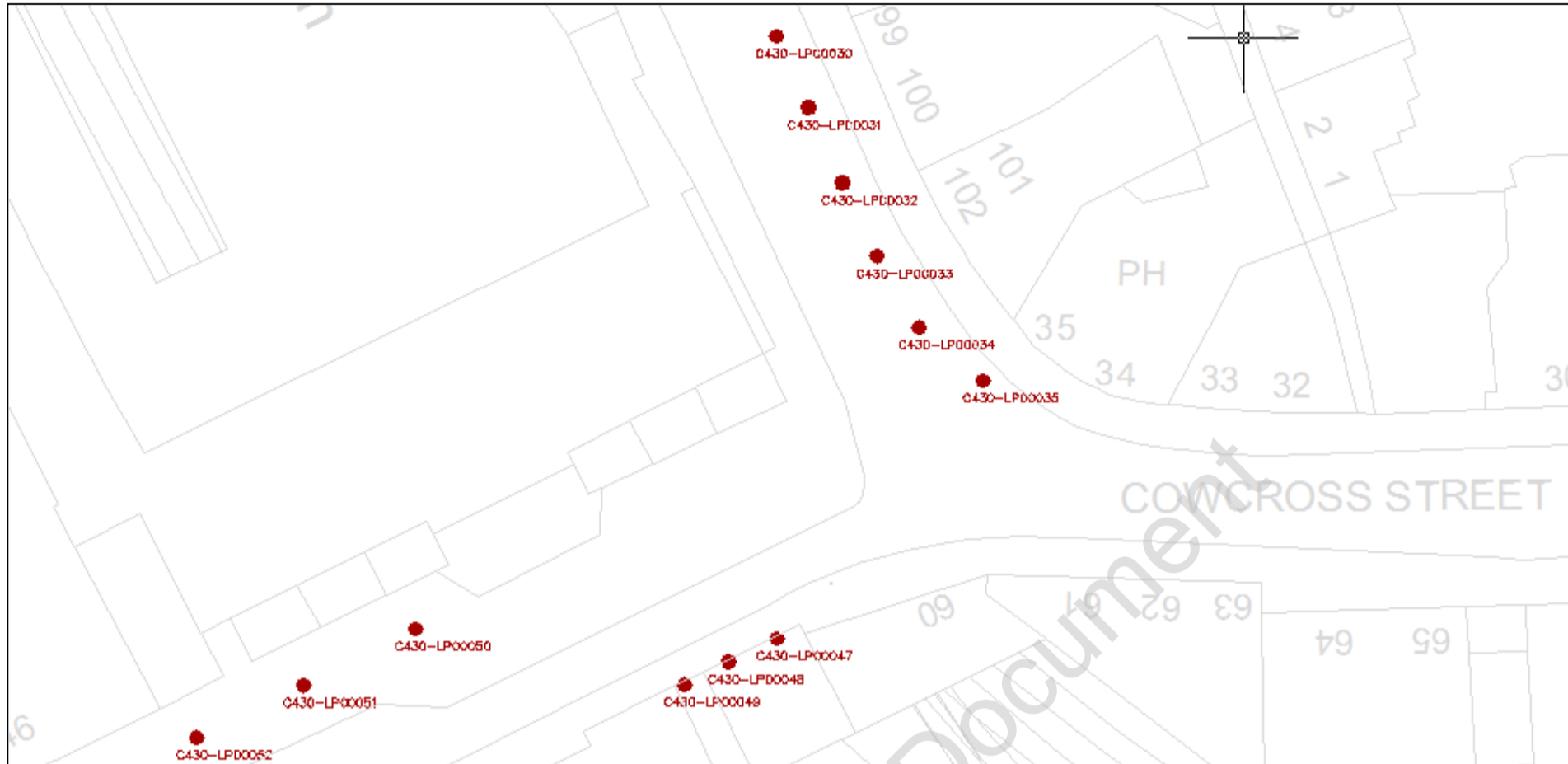


C435-LB13049	C435-LB13050	C435-LB13051	C435-LB13052	C435-LB13053
C435-LB13054	C435-LB13055	C435-LB13056	C435-LB13057	C435-LB13058

**REMARKS:**  
 Sockets inside Compensation Grouting Area. No triggers breached in slopes.



REPORT: LEVELLING  
AREA: COWCROSS ST AND TURNMILL ST  
DEVICE: PLP'S

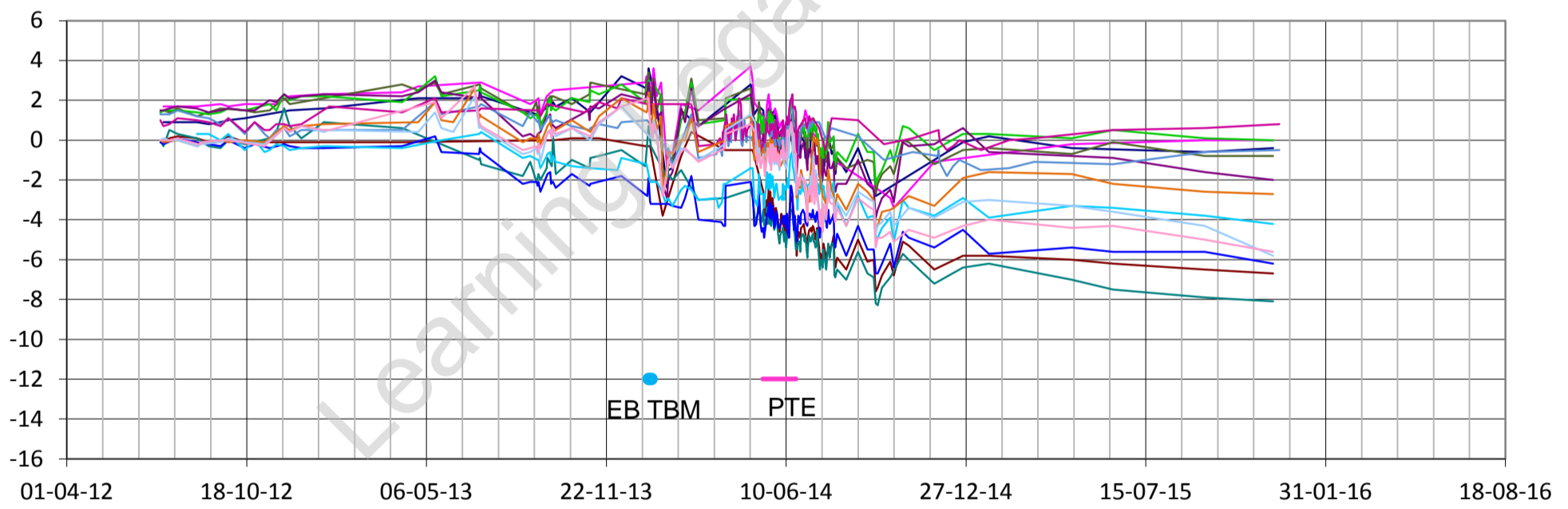
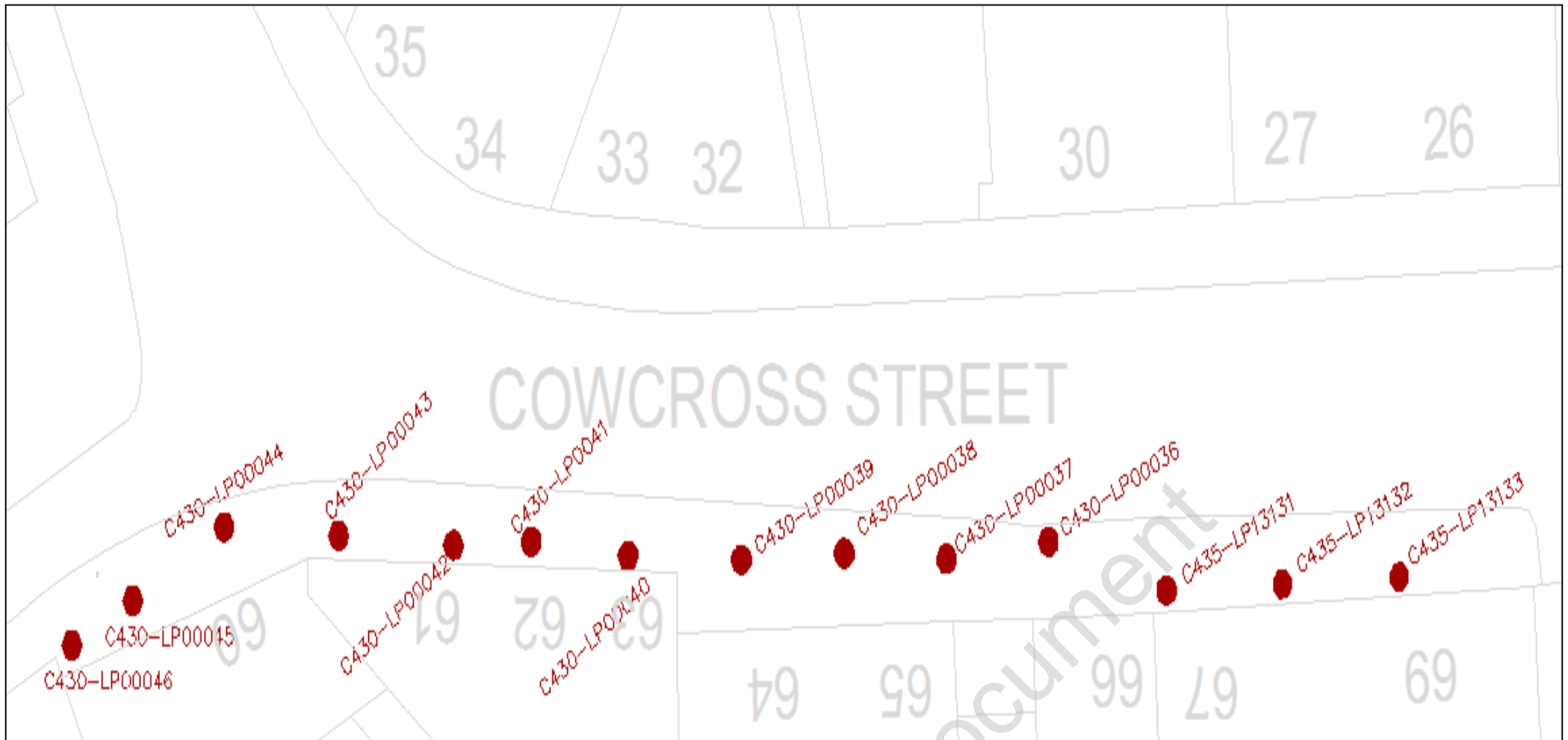


C430-LP00030(mm)	C430-LP00031(mm)	C430-LP00032(mm)	C430-LP00033(mm)
C430-LP00034(mm)	C430-LP00035(mm)	C430-LP00047(mm)	C430-LP00048(mm)
C430-LP00049(mm)	C430-LP00050(mm)	C430-LP00051(mm)	C430-LP00052(mm)

**REMARKS:**

Studs outside for the compensation grouting area. No triggers breached.

REPORT: LEVELLING  
 AREA: COWCROSS ST  
 DEVICE: PLP'S

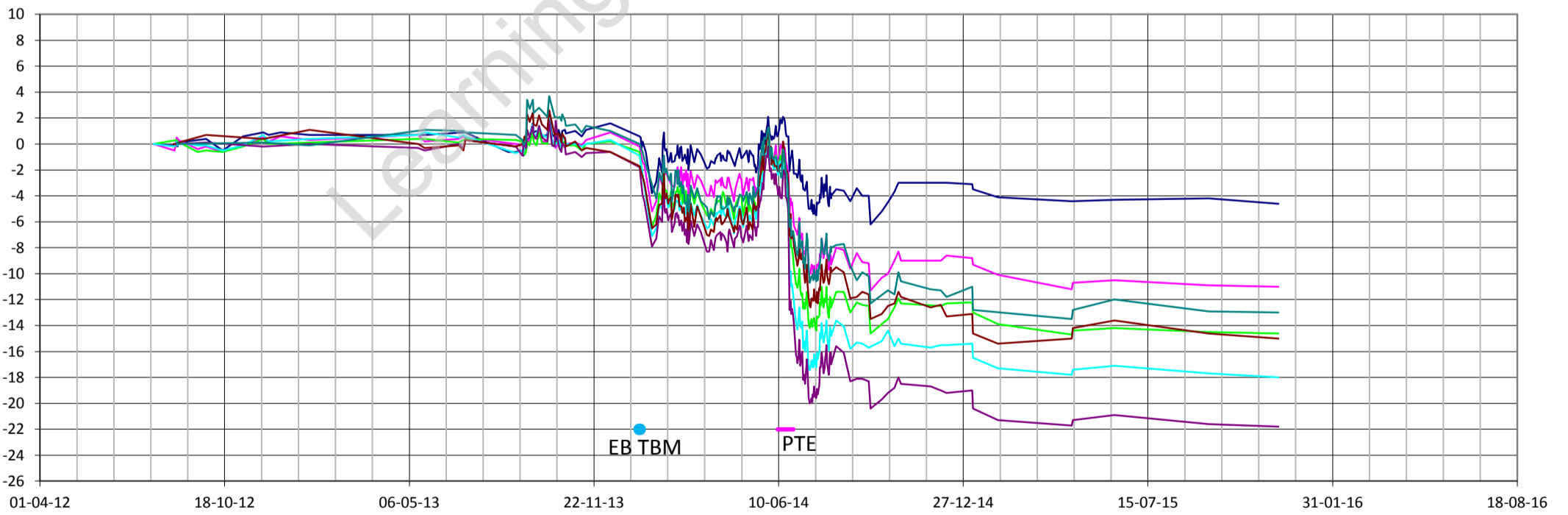
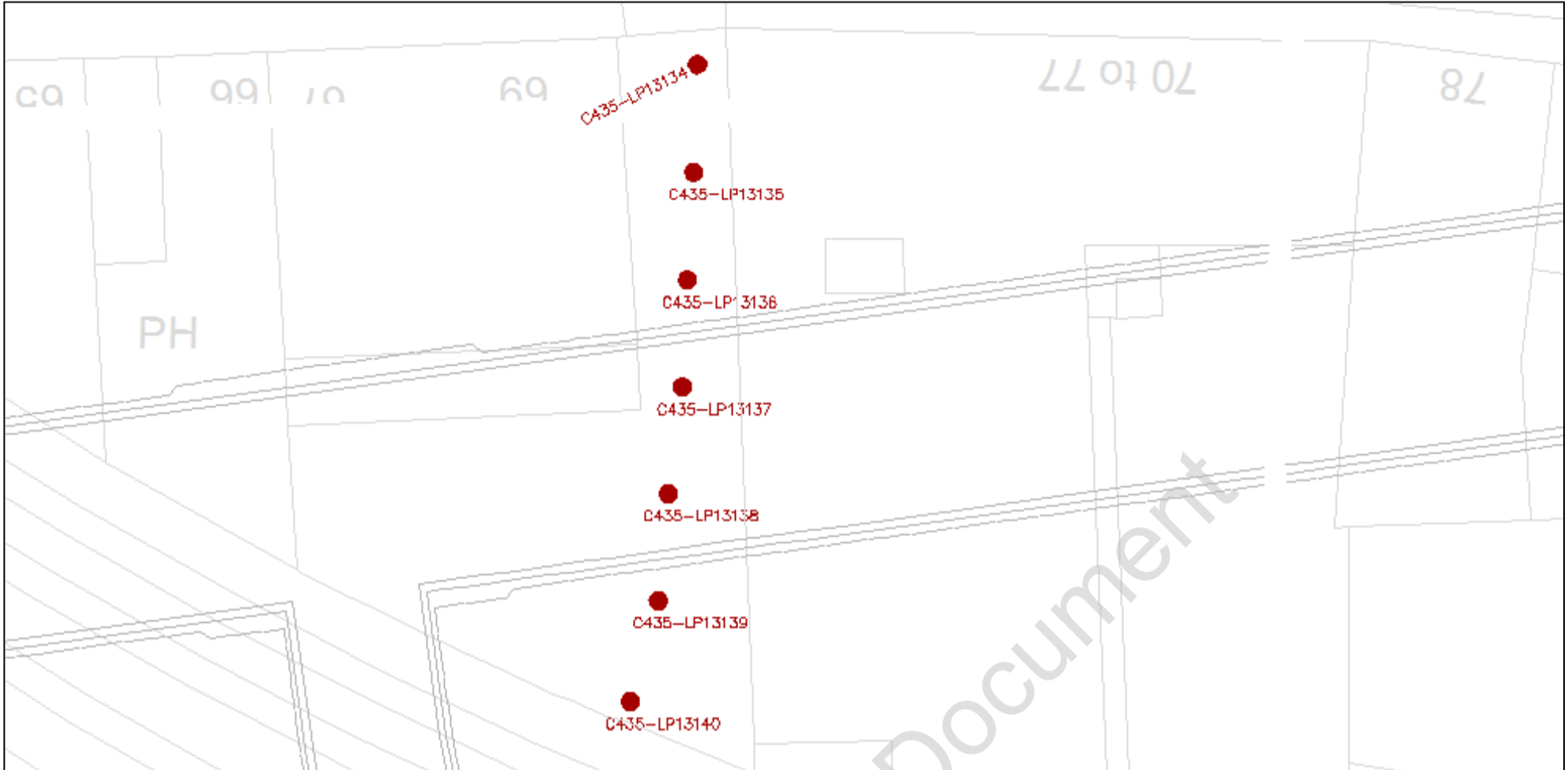


C430-LP00036(mm)	C430-LP00037(mm)	C430-LP00038(mm)	C430-LP00039(mm)
C430-LP00040(mm)	C430-LP00041(mm)	C430-LP00042(mm)	C430-LP00043(mm)
C430-LP00044(mm)	C430-LP00045(mm)	C430-LP00046(mm)	C435-LP13131(mm)
C435-LP13132(mm)	C435-LP13133(mm)		

**REMARKS:**  
 Studs outside for the Compensation Grouting Area. No triggers breached.



REPORT: LEVELLING  
AREA: COWCROSS ST AND TURNMILL ST  
DEVICE: PLP'S



— C435-LP13134(mm)	— C435-LP13135(mm)	— C435-LP13136(mm)	— C435-LP13137(mm)
— C435-LP13138(mm)	— C435-LP13139(mm)	— C435-LP13140(mm)	

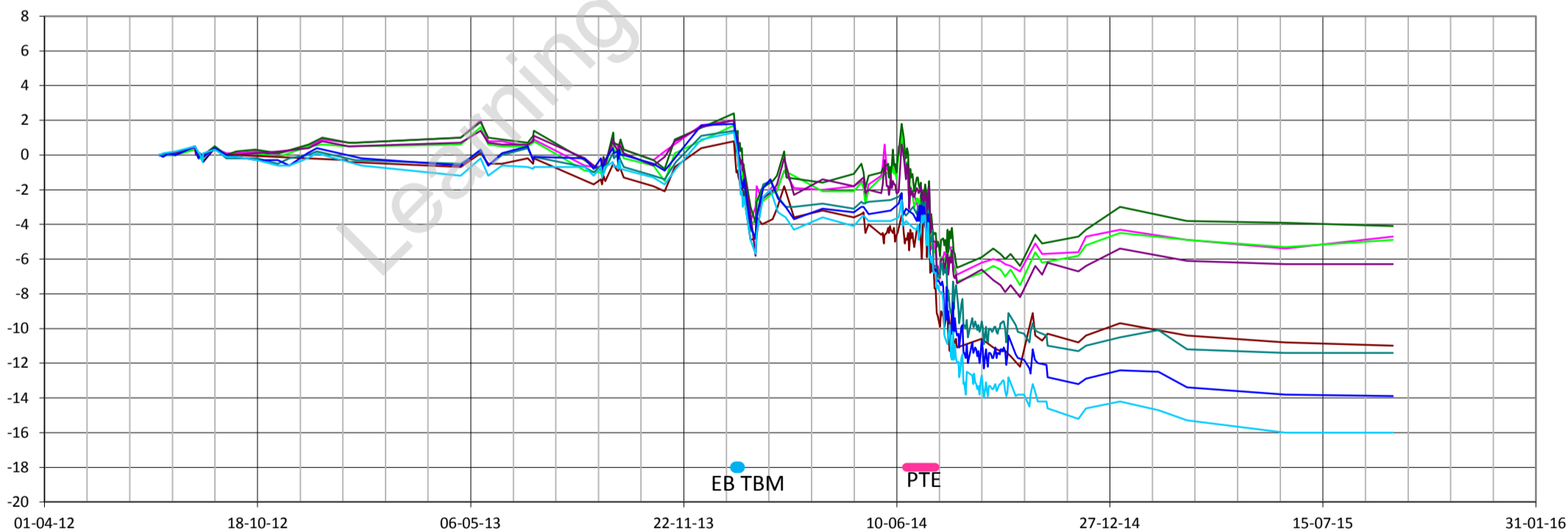
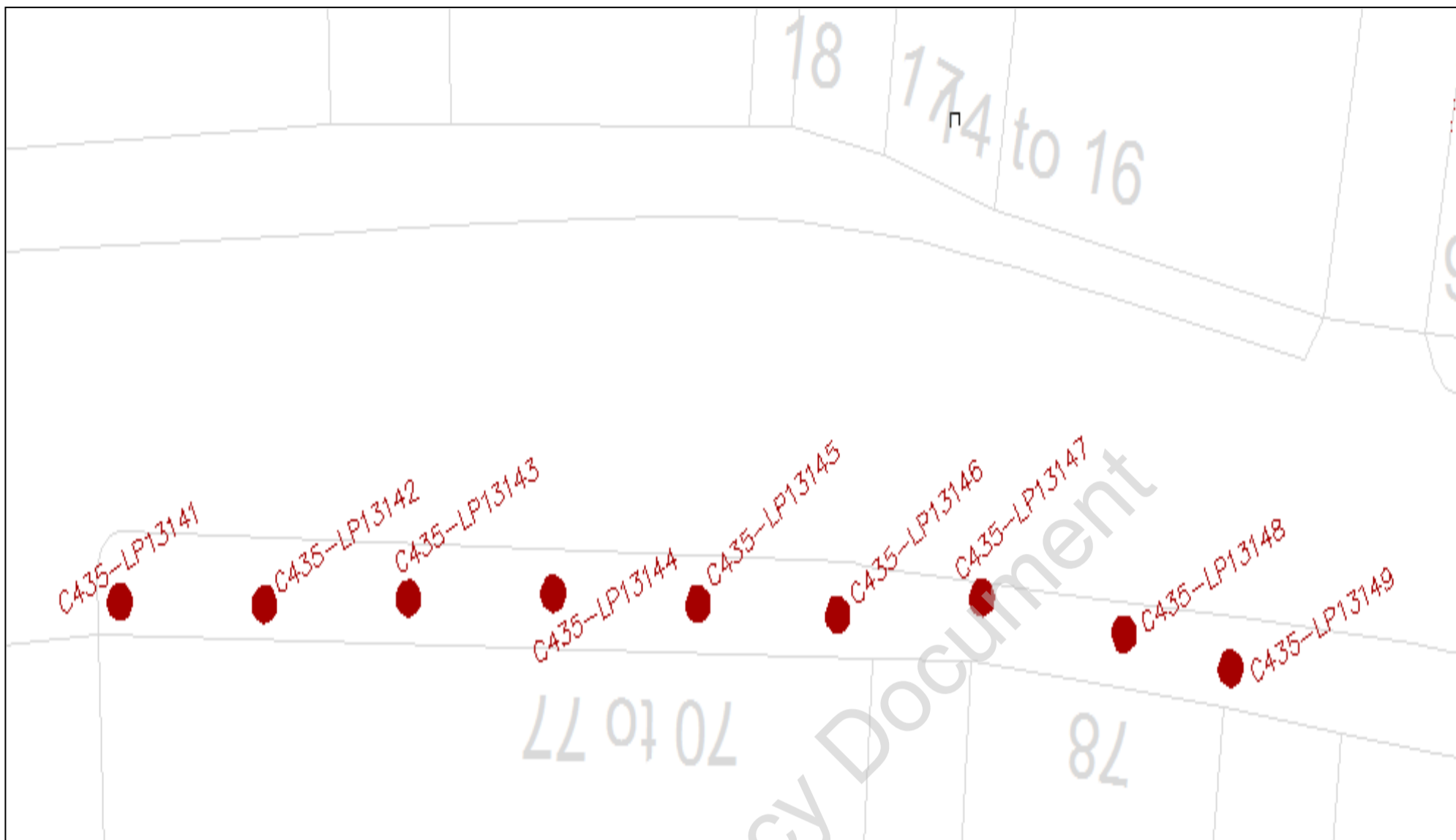
**REMARKS:**

Studs inside Compensation Grouting Area. Green trigger was breached in slope between C435-LP13138 and C435-LP13140 on 17-06-2014.





REPORT: LEVELLING  
AREA: COWCROSS ST AND TURNMILL ST  
DEVICE: PLP'S

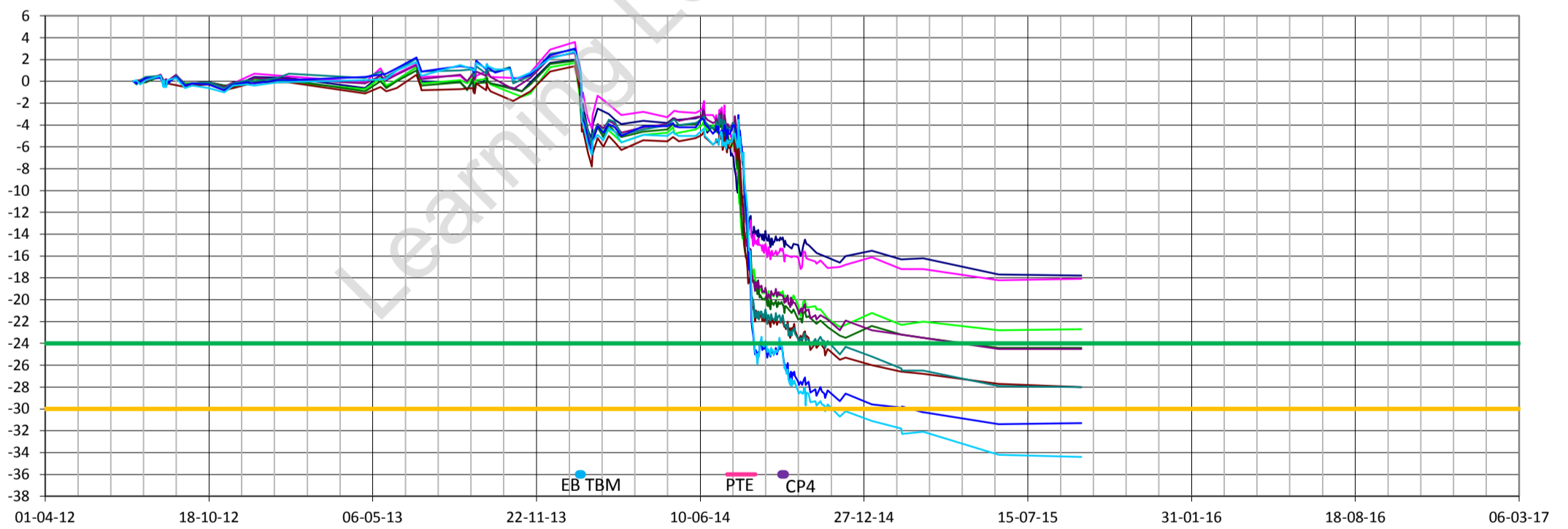
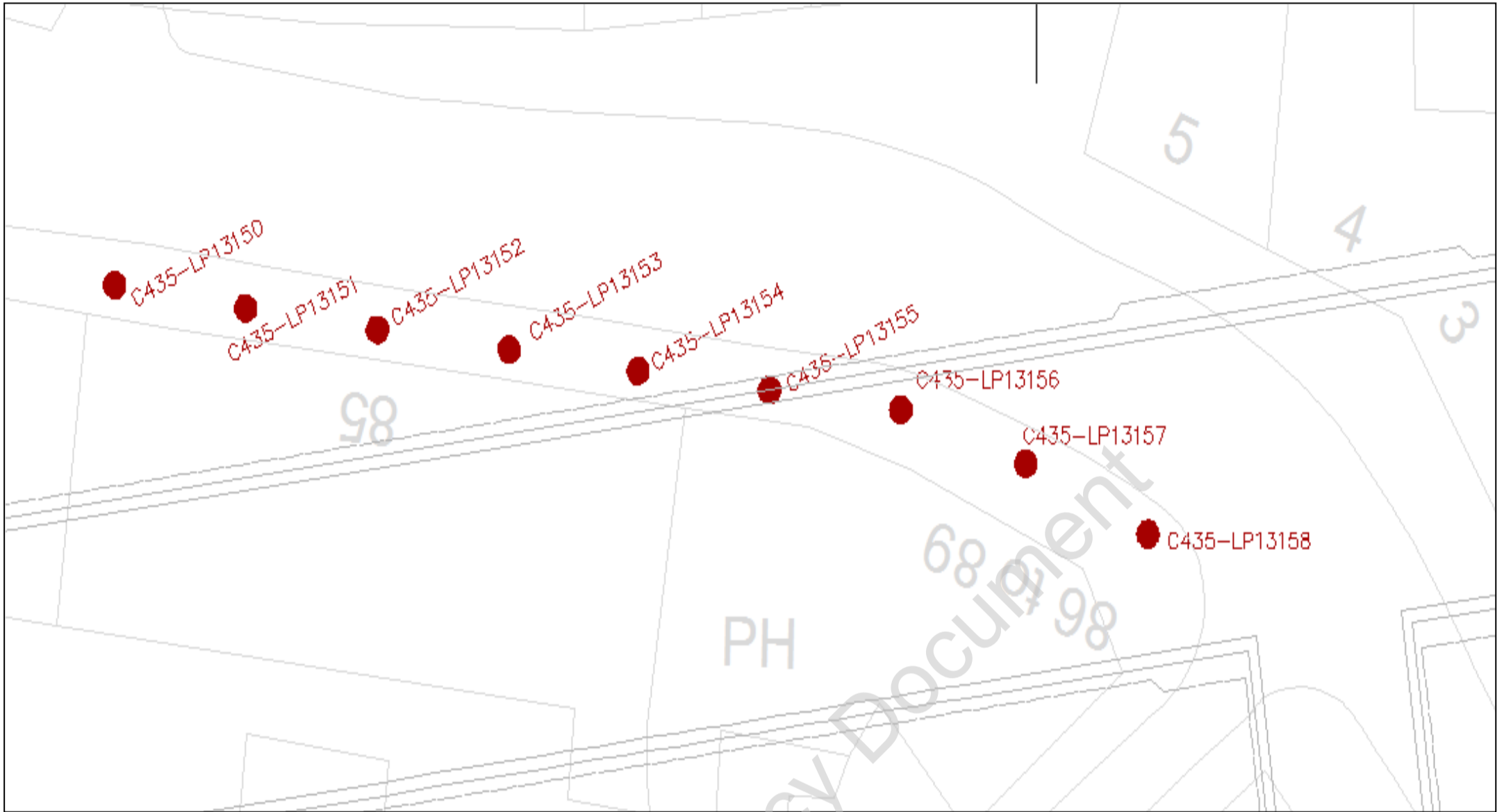


C435-LP13141(mm)	C435-LP13142(mm)	C435-LP13143(mm)	C435-LP13144(mm)	C435-LP13145(mm)
C435-LP13146(mm)	C435-LP13147(mm)	C435-LP13148(mm)	C435-LP13149(mm)	

**REMARKS:**  
Studs inside the Compensation Grouting Area. No triggers breached.



REPORT: LEVELLING  
AREA: COWCROSS ST AND TURNMILL ST  
DEVICE: PLP'S

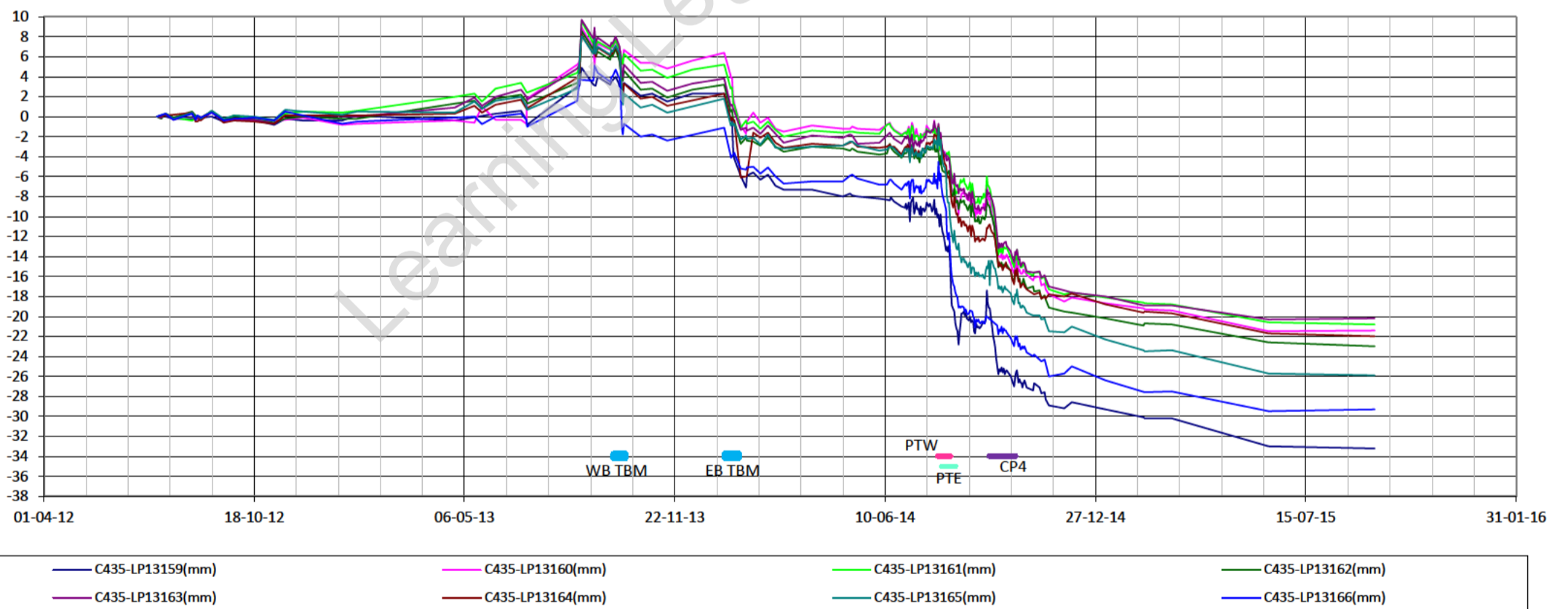
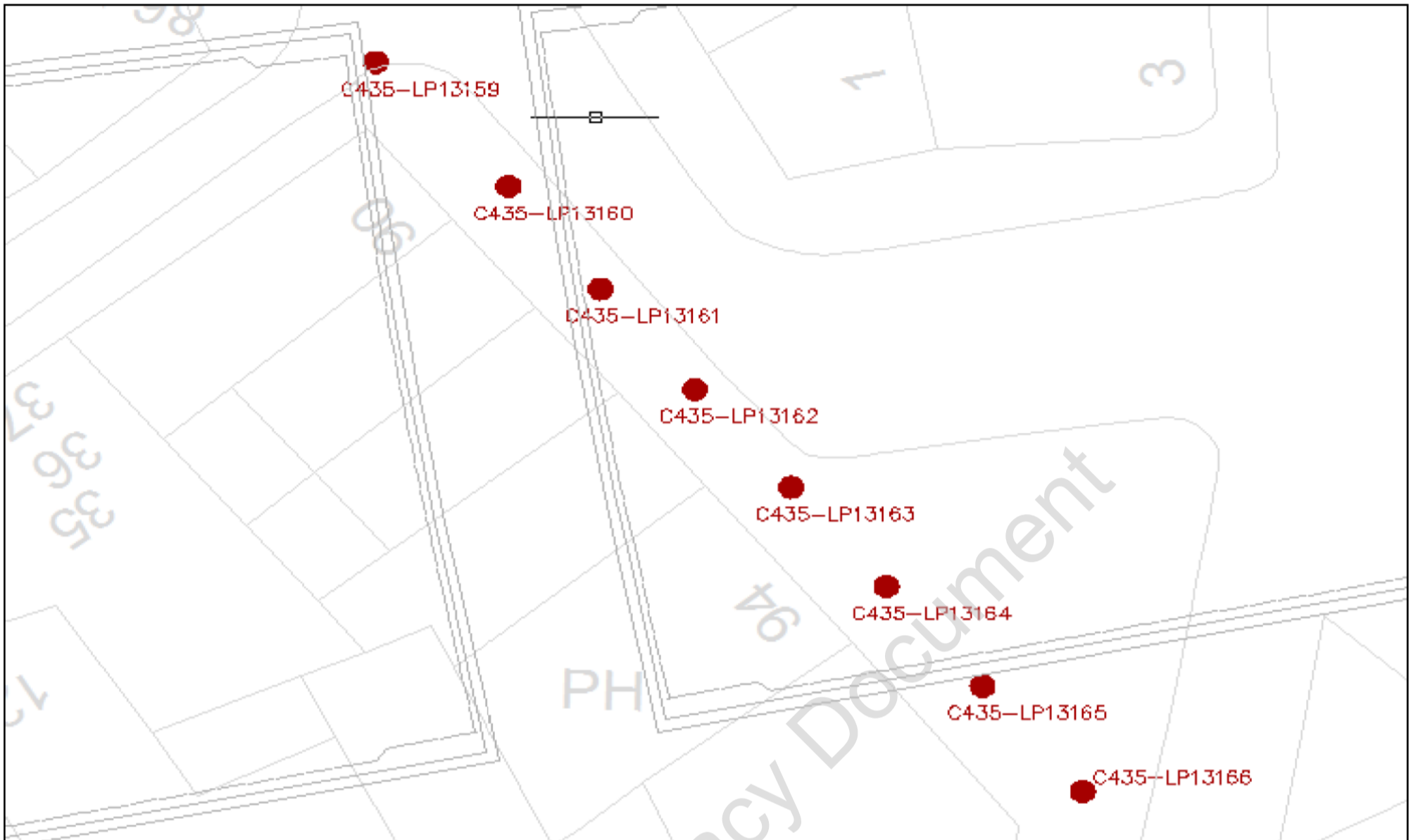


C435-LP13150(mm)	C435-LP13151(mm)	C435-LP13152(mm)	C435-LP13153(mm)	C435-LP13154(mm)	C435-LP13155(mm)
C435-LP13156(mm)	C435-LP13157(mm)	C435-LP13158(mm)	Green	Amber	

**REMARKS:**

Studs outside influence Compensation Grouting Area. Green trigger was breached by C435-LP13157 on 14-08-2014, C435-LP13158 on 15-08-2014, C435-LP13155 on 22-10-2014 and C435-LP13156 on 22-10-2014.  
Amber trigger was breached by C435-LP13158 on 27-11-2014 and C435-LP13157 on 09-03-2015.

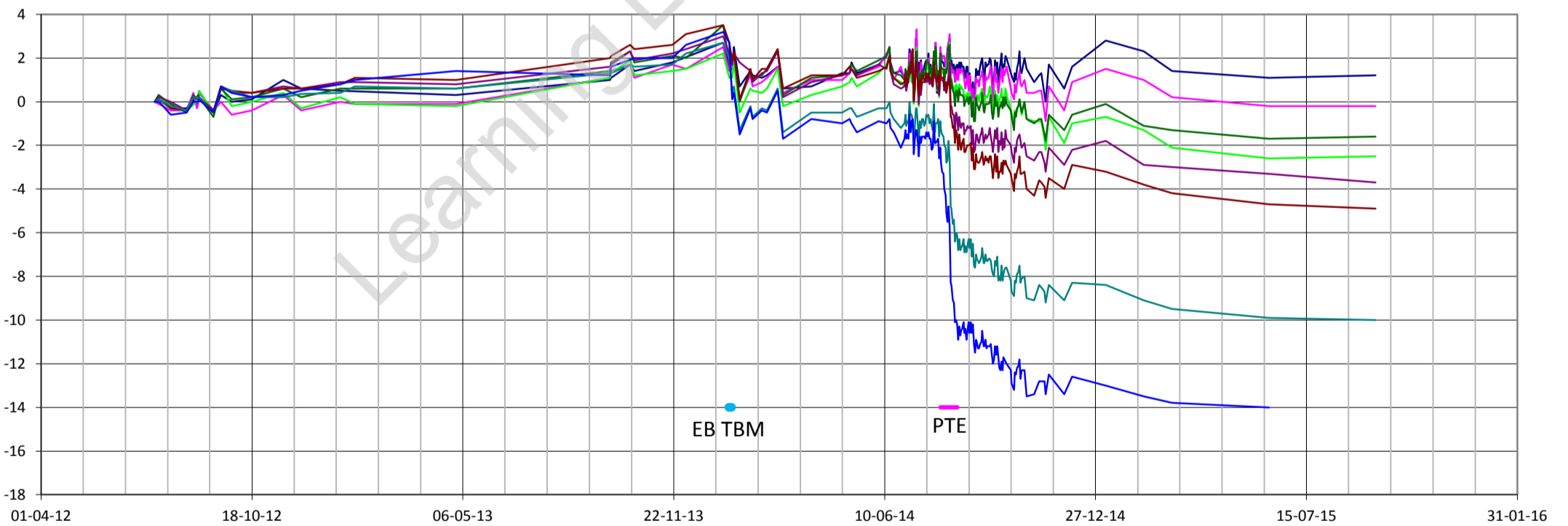
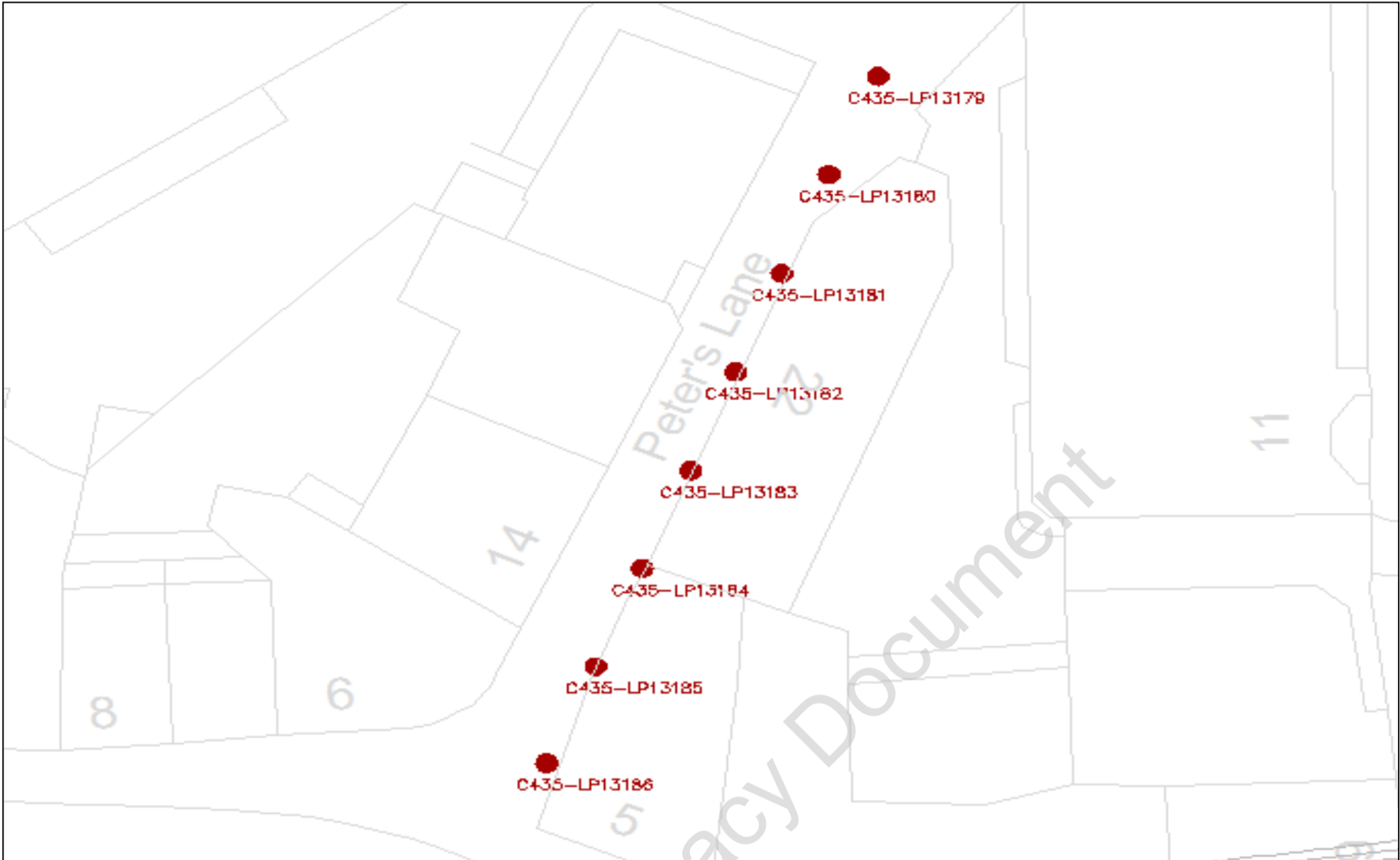
REPORT: LEVELLING  
 AREA: COWCROSS ST AND TURNMILL ST  
 DEVICE: PLP'S



**REMARKS:**

Studs inside Compensation Grouting Area. Green trigger was breached on slope between C435-LP13164 and C435-LP13166 on 15-05-2014.

REPORT: LEVELLING  
 AREA: PETER'S LANE  
 DEVICE: PLP'S

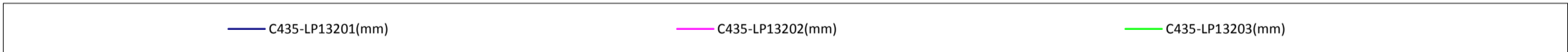
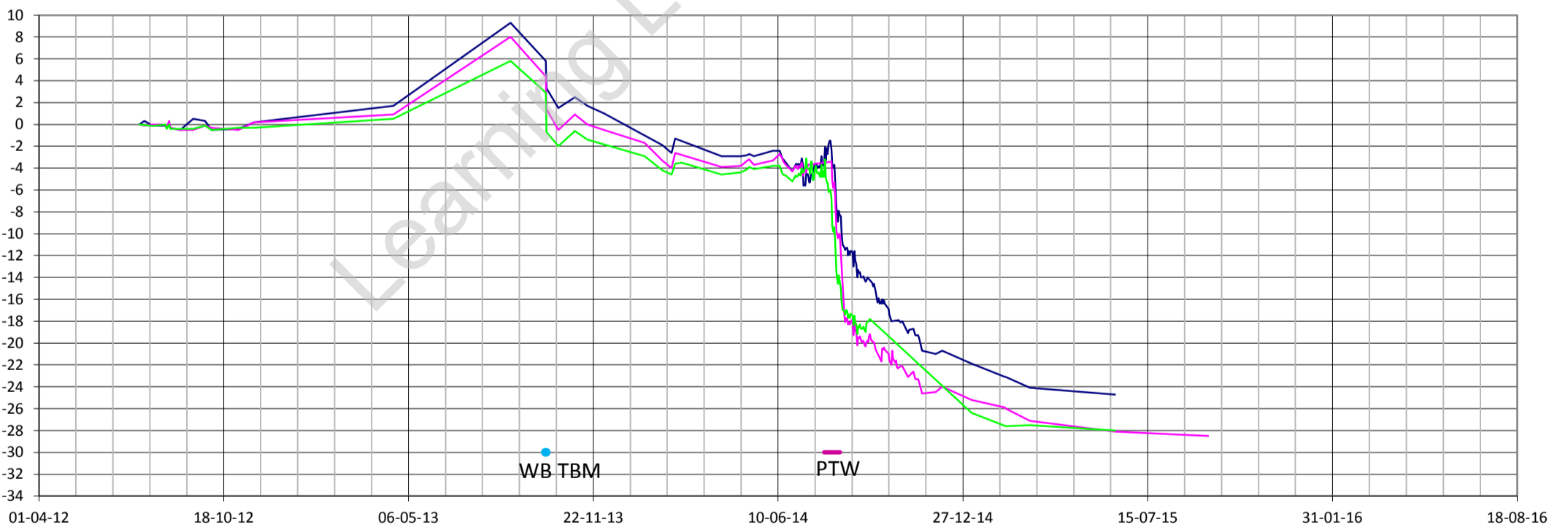
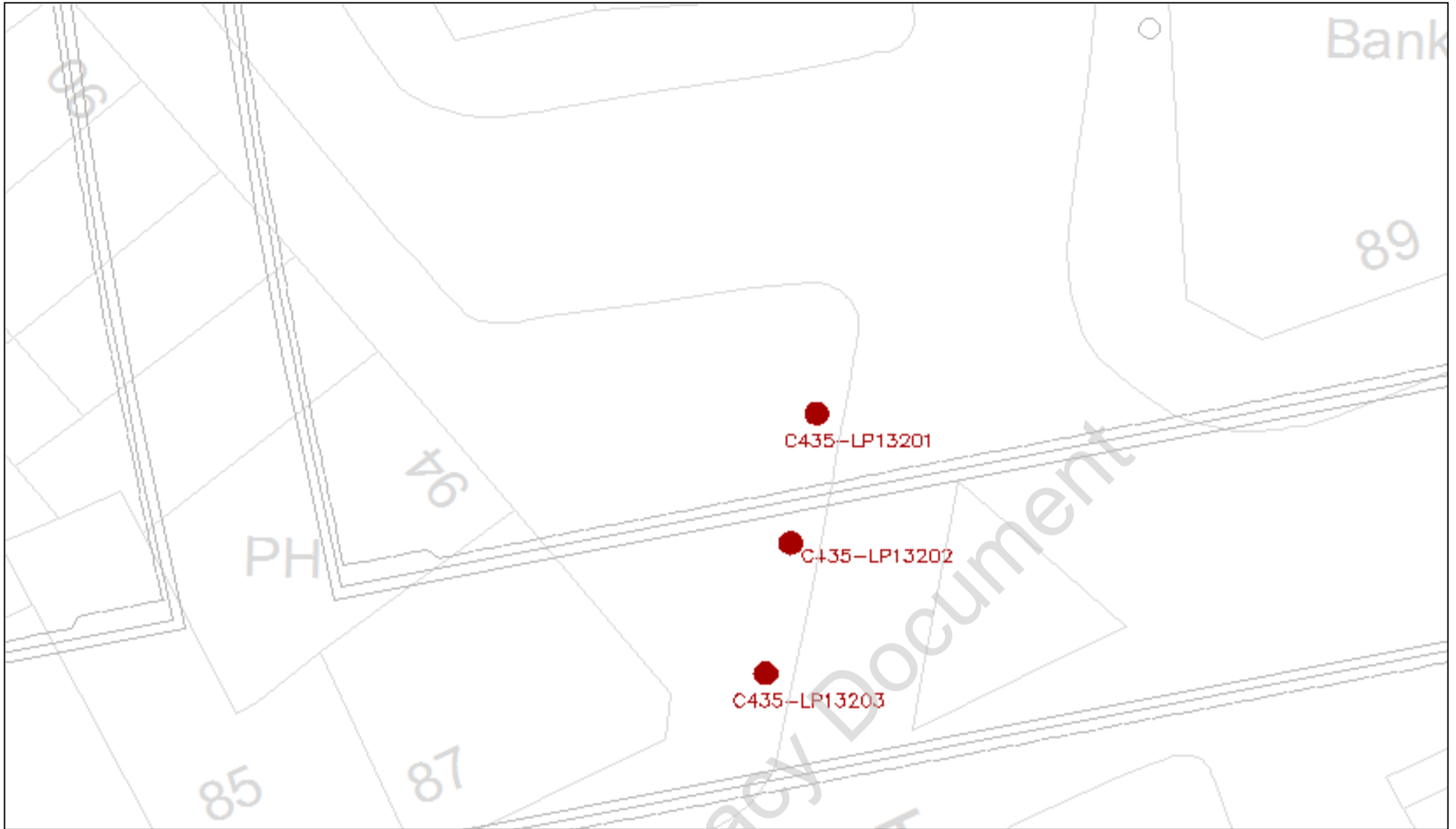


C435-LP13179(mm)	C435-LP13180(mm)	C435-LP13181(mm)	C435-LP13182(mm)
C435-LP13183(mm)	C435-LP13184(mm)	C435-LP13185(mm)	C435-LP13186(mm)

**REMARKS:**  
 Studs outside Compensation Grouting Area. No triggers breached.



REPORT: LEVELLING  
AREA: COWCROSS ST AND TURNMILL ST  
DEVICE: PLP'S



**REMARKS:**

Studs inside Compensation Grouting Area. No triggers breached.

## 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.
- TaM Tube a Manchette.

Learning Legacy Document