



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

## C435 Farringdon Main Station

CRL Lead reviewer: [REDACTED]
CRL Reviewer: [REDACTED]

### Monitoring Close-Out Report:

Internal Monitoring in buildings between  
Charterhouse Street, Cowcross Street and  
Greenhill's Rents

**CRL Document Number: C435-BFK-C2-RGN-M123-51618**

Supplier Document Number: N/A

Contract MDL reference C13.012

#### 1. Contractor Document Submittal History:

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1.0	07-10-2015	[REDACTED]	[REDACTED]	[REDACTED]	For acceptance
2.0	08-12-2015	[REDACTED]	[REDACTED]	[REDACTED]	For acceptance

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

Stakeholder submission required: LU  NR  DLR  RfI  LO  Other: \_\_\_\_\_ Purpose of submission: For no objection  For information

This document has been reviewed by the following individual for coordination, compliance, integration and acceptance and is acceptable for transmission to the above stakeholder for the above stated purpose.

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

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

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

#### 3. Acceptance by Crossrail:

02/02/2016

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**APPENDIX A: DRAWINGS / PHOTOMONTAGES**

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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 reports will provide justification for the decommissioning of the instruments.

## B. INSTRUMENTS

### B.1 Description of the Instruments

This Close-Out Report relates the Cowcross Street, Albion Courtyard and Greenhill’s Rents Area, consisting of Tiltmeters and Electrolevel beams located internally in these basements. See table 1 below with details.

LOCATION	SENSOR TYPE	SENSOR CODE
85 Cowcross Street	Tiltmeter	C435-TB00901 A/B
	Electrolevel	C435-EL000311
	Electrolevel	C435-EL000321
	Electrolevel	C435-EL000331
	Electrolevel	C435-EL000332
90 Cowcross Street	Tiltmeter	C435-TB00201 A/B
93 Cowcross Street	Tiltmeter	C435-TB00301 A/B
94 Cowcross Street	Tiltmeter	C435-TB00401 A/B
	Tiltmeter	C435-TB00402 A/B

Table 1: Details Internal Monitoring instrumentation

At the moment, this area monitored by these devices is in a Long Term basis from 16/04/2015.

These devices are shown in the following documents:

#### Drawings:

- C122-OVE-C2-DDA-CR001\_Z-31532.pdf
- C122-OVE-C2-DDA-CR001\_Z-31405.pdf
- C122-OVE-C2-DDA-CR001\_Z-31408.pdf

#### Installation Reports:

- C435-BFK-C2-RGN-M123-50037

FCDs:

- C435-FCD-0343
- C435-FCD-0697
- C435-FCD-0793

Also, further information about other relevant installations within these buildings can be found in the next document:

- C435-BFK-C2-RGN-M123-50999: Installation Report - Internal Monitoring. BRE-Sockets, Invar Scales and Crackmeters.

## B.2 Location of the Instruments

As you can see from the Figure 1 below, the instruments described in Section B.1 are located in Cowcross Street and Greenhill's Rents area. A drawing showing the location of these devices can be found in the Appendix A.



Figure 1 – Map showing the location of monitored buildings.

## C. MOVEMENTS

### 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 tunnelling works. In all cases, these comprise of the passage of a TBMs (C300) and a platform tunnel enlargement.

ACTIVITY	START DATE	END DATE
Moorgate Spur Shaft No. 1 TAM Installation	08/07/2013	20/08/2013
Moorgate Spur Shaft No. 1 Pre-Treatment works	19/08/2013	15/09/2013
WB TBM passage	01/10/2013	04/10/2013
EB TBM passage	13/01/2014	16/01/2014
SCL-PTW enlargement	21/06/2014	20/08/2014
SCL-PTE enlargement	29/06/2014	01/09/2014
SCL-CP4	17/09/2014	16/10/2014

#### C.1.2 Resulting Movements

- 85 Cowcross Street:  
data for Tiltmeters and Electrolevel beams installed internally in this building is shown in Appendix B. No unusual movement recorded by Tiltmeters during WB-TBM and EB-TBM passages. Some fluctuation in readings recorded during PTE and PTW enlargement works, but being insignificant the movement caused by these activities and by CP4 cross passage excavation.  
By Electrolevels, no significant movement recorded during WB and EB TBM passages, being the maximum movement recorded of 1.7mm during SCL-PTE Enlargement works
- 90 Cowcross Street:  
data for Tiltmeters installed internally in this building is shown in Appendix B. No unexpected movement recorded during WB-TBM and EB-TBM passages. Some fluctuation in readings recorded during PTE and PTW enlargement works, but being insignificant the movement caused by these activities and by CP4 cross passage excavation.
- 93 Cowcross Street:  
data for Tiltmeters installed internally in this building is shown in Appendix B. No unusual movement recorded during WB-TBM and EB-TBM passages. Some fluctuation in readings recorded during PTE and PTW enlargement works, but being insignificant the movement caused by these activities and by CP4 cross passage excavation.
- 94 Cowcross Street:  
data for Tiltmeters installed internally in this building is shown in Appendix B. No unexpected movement recorded during WB-TBM and EB-TBM passages. Some fluctuation in readings recorded during PTE and PTW enlargement works, but being insignificant the movement caused by these activities and by CP4 cross passage excavation. Around 1mm/m of movement recorded during Pre-Treatment works carried out from Moorgate Spur No.1 shaft.

## 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.

In this case, the right trigger values depend on the building location where the devices are installed.

90, 93 and 94 Cowcross Street are located Inside the compensation grouting area, so the trigger values are as follow:

- DEFAULT ALERT (in any direction): 10mm

In case of 85 Cowcross Street, the trigger values are shown below taking into account these buildings are located outside the compensation grouting area:

- DEFAULT ALERT (in any direction): 10mm
- GREEN: 24mm settlement
- AMBER: 30mm settlement
- RED: 38mm settlement

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MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
85 COWCROSS STREET	C435-EL000311	Electrolevel	Settlement	05/10/2015 16:26	-1.91	Clear	Clear
	C435-EL000321	Electrolevel	Settlement	05/10/2015 16:26	-0.82	Clear	Clear
	C435-EL000331	Electrolevel	Settlement	05/10/2015 16:26	-0.25	Clear	Clear
	C435-EL000332	Electrolevel	Settlement	05/10/2015 16:26	-2.18	Clear	Clear
	C435-TB00901A	Tiltmeter	A	05/10/2015 16:26	-1.43	Clear	Clear
	C435-TB00901B	Tiltmeter	B	05/10/2015 16:26	-0.60	Clear	Clear
90 COWCROSS STREET	C435-TB00201A	Tiltmeter	A	05/10/2015 16:19	-0.71	Clear	Clear
	C435-TB00201B	Tiltmeter	B	05/10/2015 16:19	-0.64	Clear	Clear
93 COWCROSS STREET	C435-TB00301A	Tiltmeter	A	05/10/2015 16:08	-0.66	Clear	Clear
	C435-TB00301B	Tiltmeter	B	05/10/2015 16:08	-1.86	Clear	Clear
94 COWCROSS STREET	C435-TB00401A	Tiltmeter	A	05/10/2015 16:54	-1.07	Clear	Clear
	C435-TB00401B	Tiltmeter	B	05/10/2015 16:54	-1.09	Clear	Clear
	C435-TB00402A	Tiltmeter	A	05/10/2015 16:54	-0.44	Clear	Clear
	C435-TB00402B	Tiltmeter	B	05/10/2015 16:54	1.19	Clear	Clear
DIFFERENTIAL MOVEMENT 35-37 GREENHILL'S RENTS AND 90-93 COWCROSS STREET	C435-LB13057 and C435-LB13058	BRE Sockets	Settlement	09/11/2015	0.6	Clear	Clear

### C.3 Significant Issues with the Instrumentation

- Tiltmeters C435-TB00901A/B installed internally in 85 Cowcross Street building were damaged on 16/06/2013, being fixed properly on 21/08/2013 coming the readings back to normal after the maintenance works and applying an offset taking into account the movement recorded during this time by surrounding devices in this period of time.
- Electrolevels C435-EL000311, C435-EL000321, C435-EL000331 and C435-EL000332 were damaged on 16/06/2013, being fixed properly on 21/08/2013 coming the readings back to normal after the maintenance works an applying an offset taking into account the movement recorded during this time by surrounding devices in this period of time.

### C.4 Residual Risks

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

## D. CONCLUSIONS

Following the WB and EB TBMs passage, as well as the SCL enlargement of PTW and PTE and the cross passage CP4 and Compensation Grouting works carried out from the Moorgate Spur No.1 and No.3 shafts, a maximum measured settlement of 2.18mm has been recorded in the 85 Cowcross Street building by these Electrolevels.

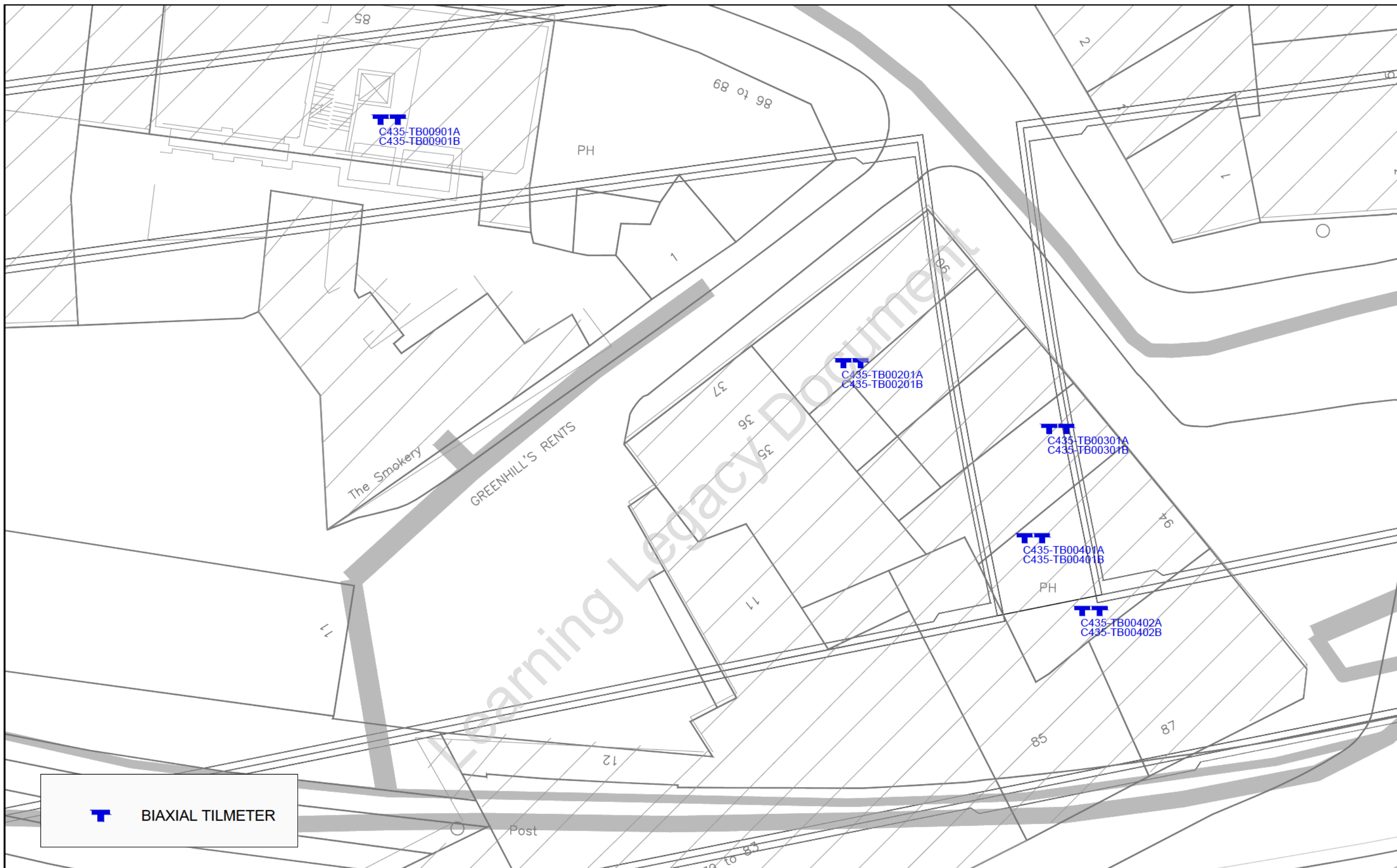
On the other hand, the maximum tilt movement recorded in A and B directions has been -1.43mm/m and -1.86mm/m in the 85 Cowcross Street and 93 Cowcross Street buildings by these Tiltmeters.

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



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## **Appendix A: Drawings / Photomontages**




**T** BIAXIAL TILMETER

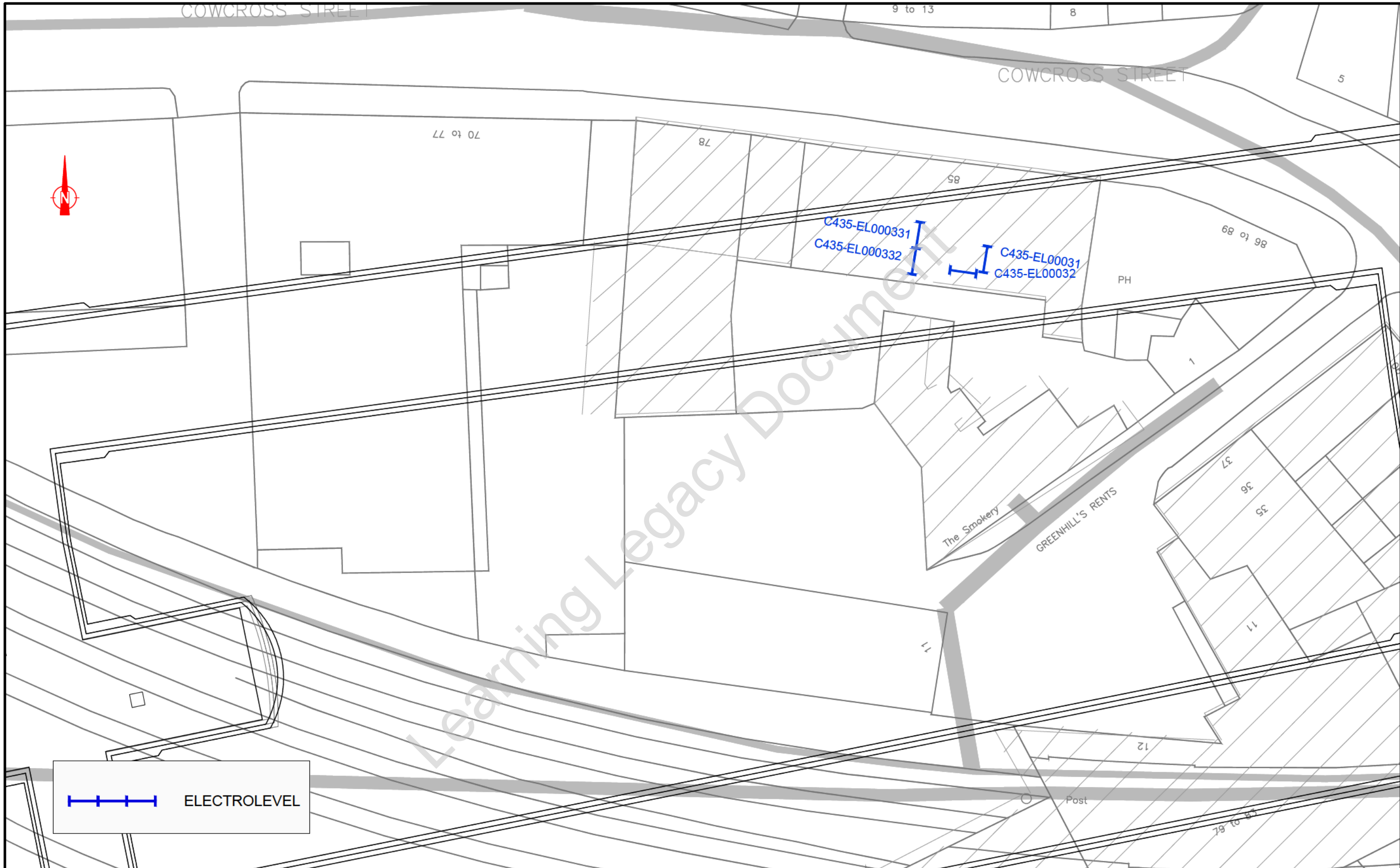
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01	23-08-2013					

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**BKF**  
 Barri Ferrovial Kier

Contract :	C435 I&M FARRINGDON STATION
Originator :	GEOCISA
Location :	CROSSRAIL GENERAL
Title :	Biaxial Tiltmeters - 90-94 Cowcross St
Scale :	@ A3
Drg No :	C435-BFK-C2-RGN-M-123-50037-IR-TB-85/90/94CCR
Rev :	
Suit :	
By :	
Chk :	
App :	
Auth :	



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ELECTROLEVEL

Rev.	Date	Description	By	Chkd	App	Auth
01	23-08-2013					

Notes:

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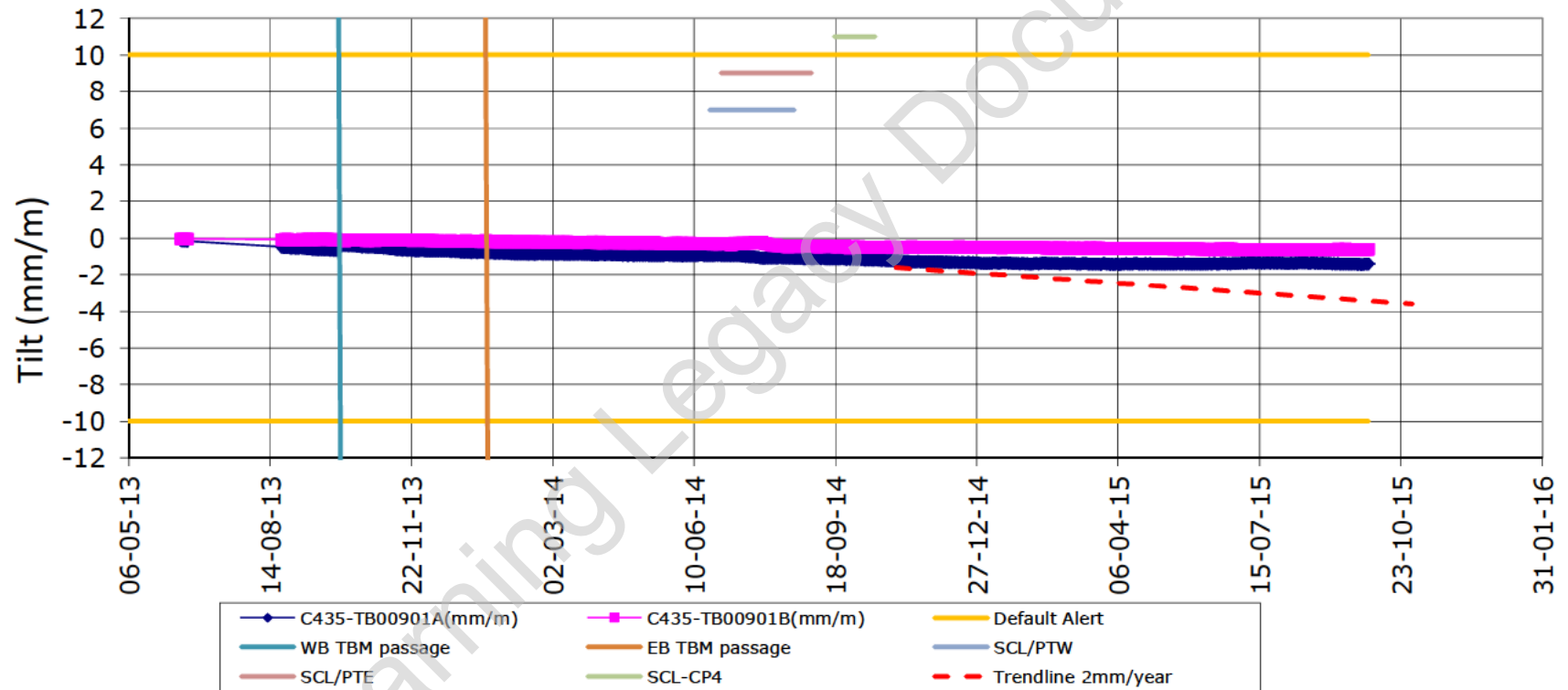
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Originator : GEOCISA		Chk : <span style="background-color: black; color: black;">[REDACTED]</span>	
Location : CROSSRAIL GENERAL		App : <span style="background-color: black; color: black;">[REDACTED]</span>	
Title : Electrolevel Beams-85 Cowcross St		Auth :	
Drg No : C435-BFK-C2-RGN-M-123-50037-IR-EL-85/90/94CCR	Rev :	Suit :	

\$Pby\$

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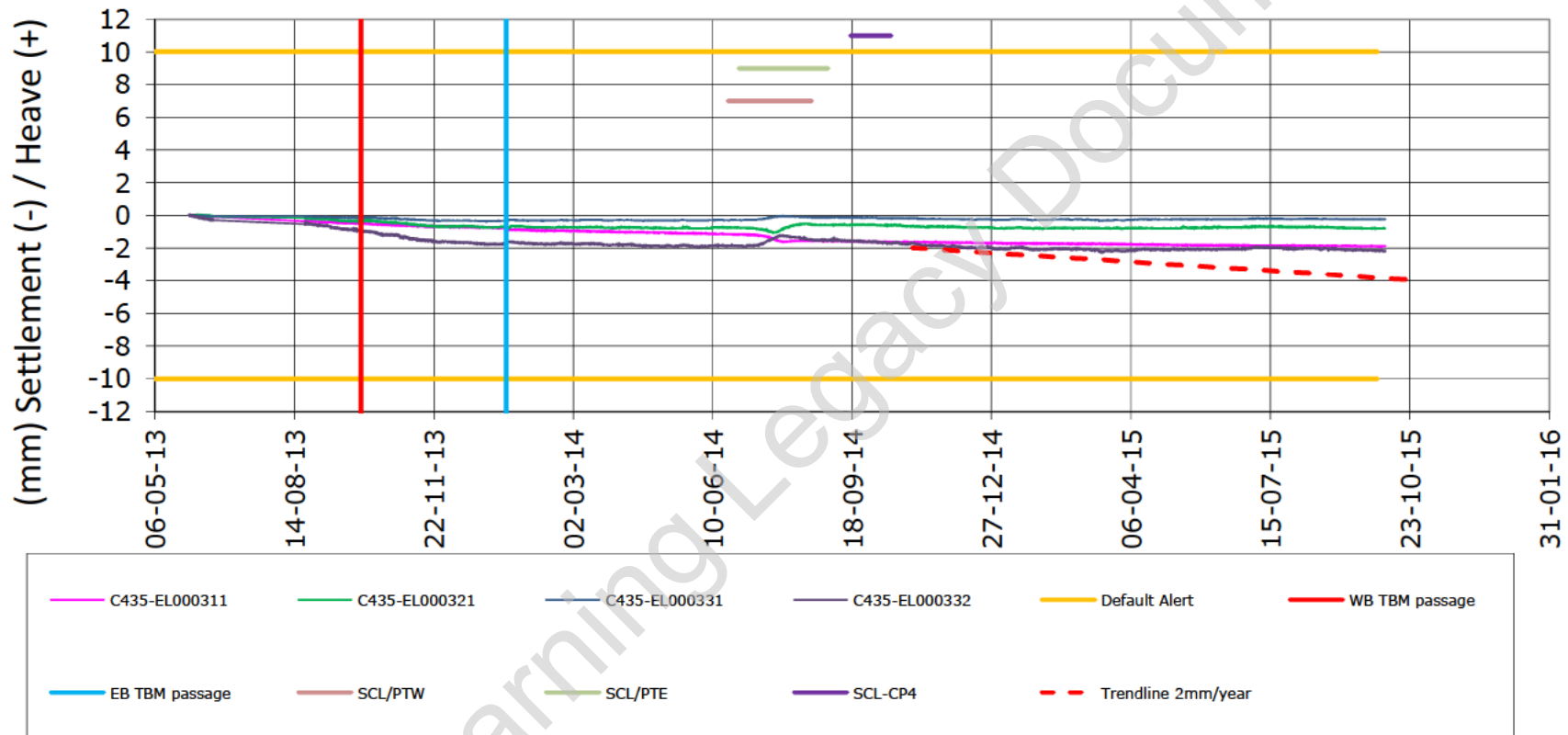
## **Appendix B: Graphs**

85 Cowcross Street



REMARKS:

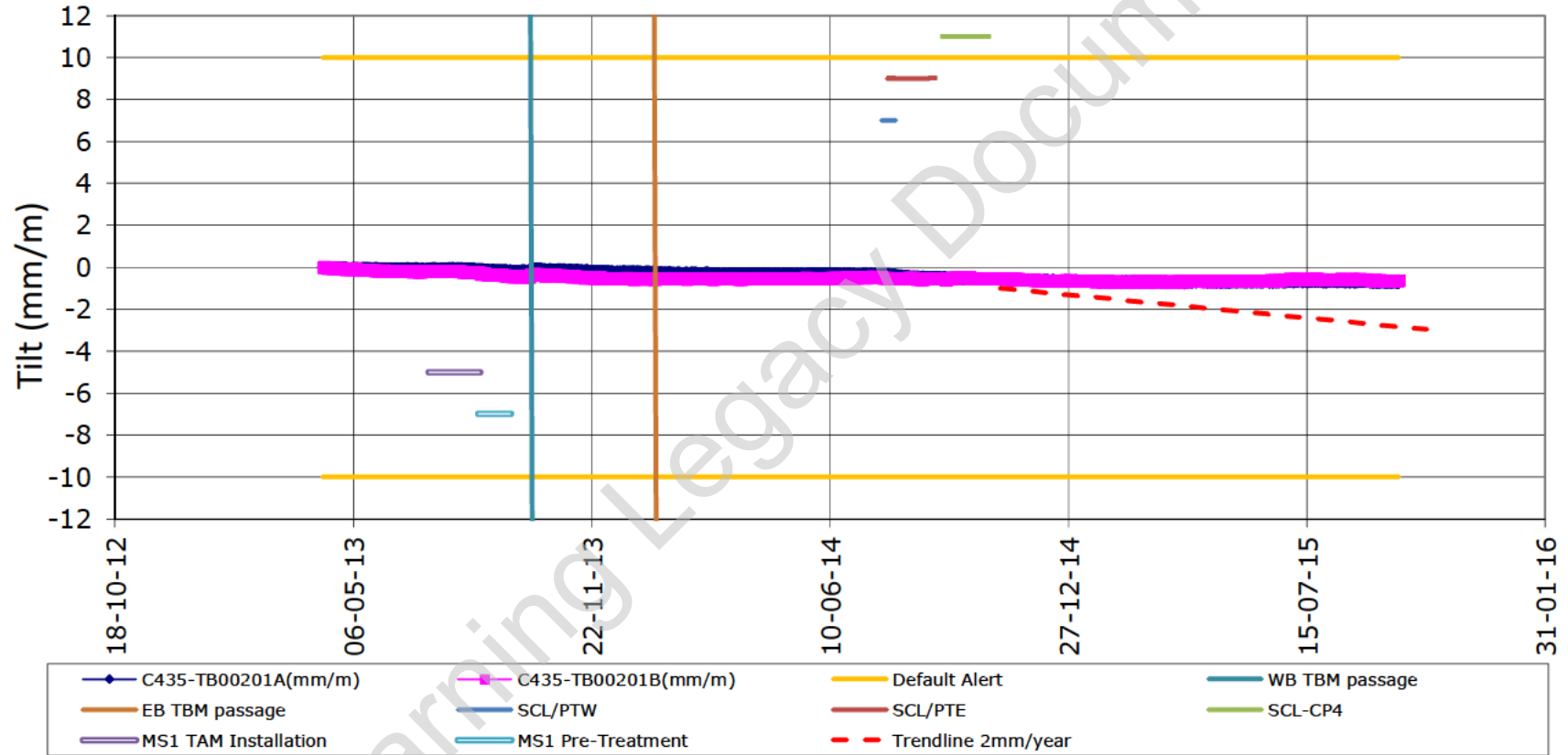
85 Cowcross Street



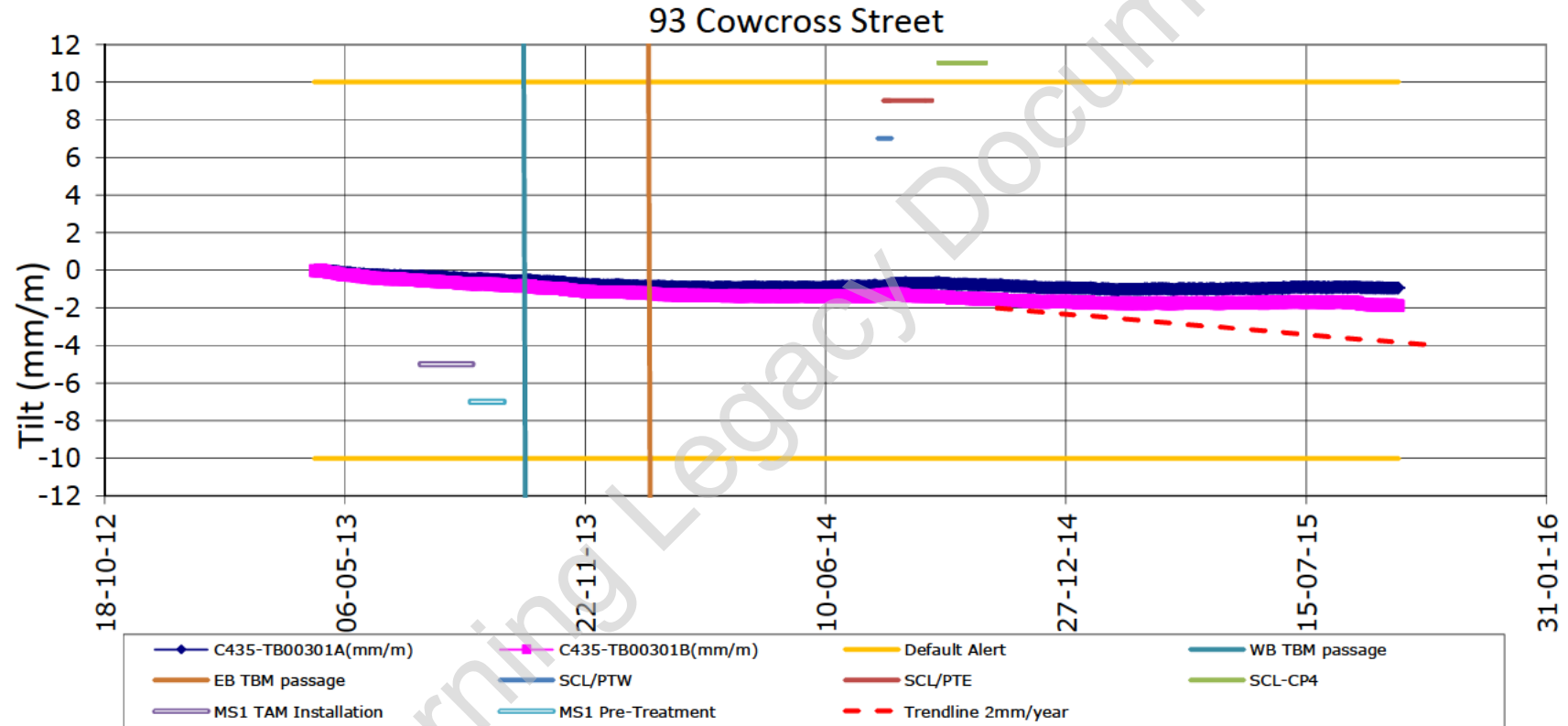
REMARKS:

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90 Cowcross Street



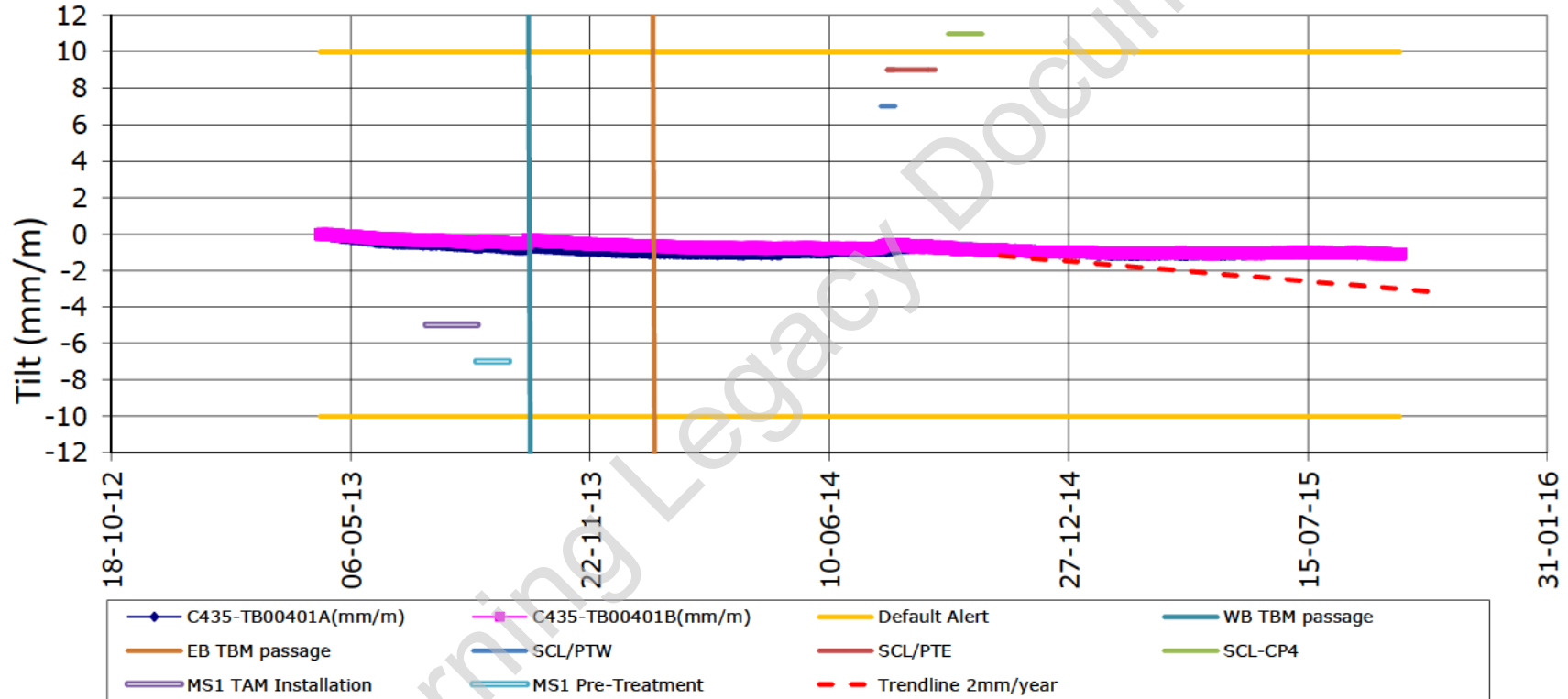
REMARKS:



REMARKS:

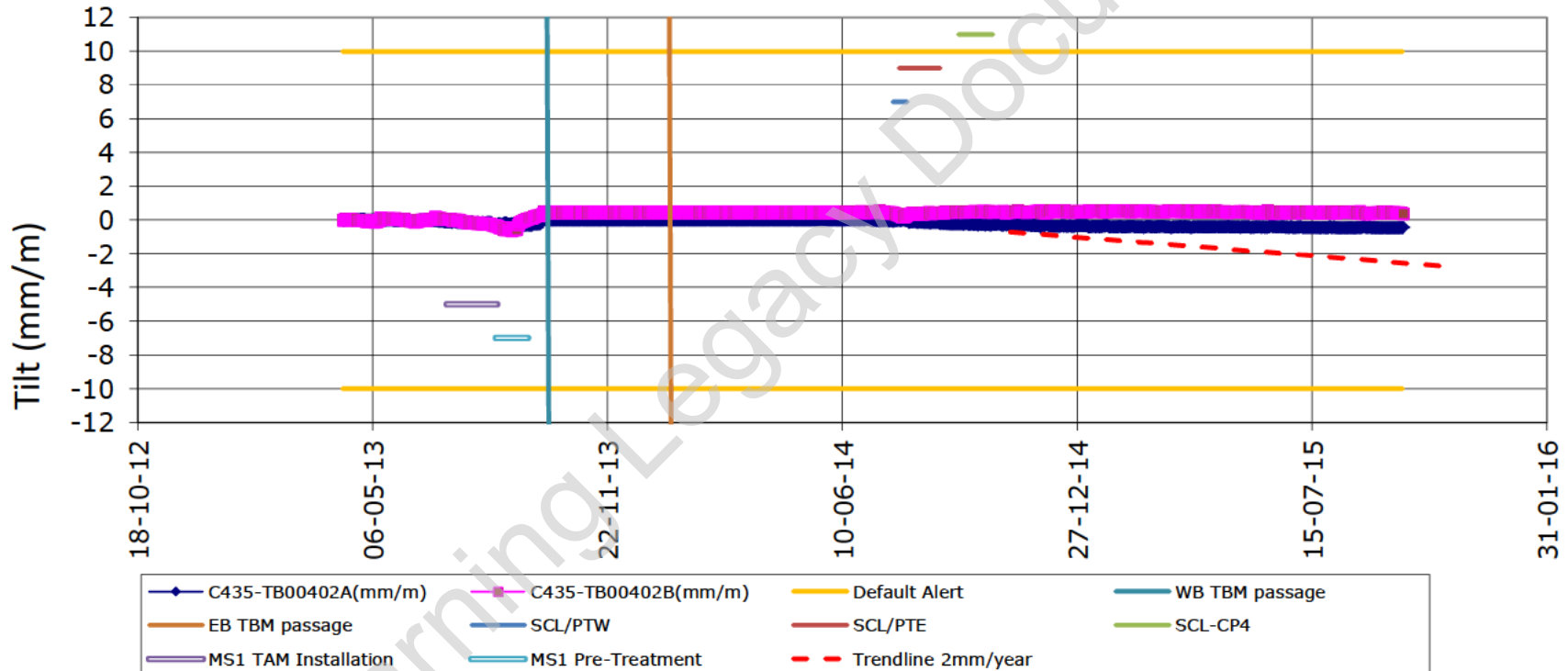


94 Cowcross Street



REMARKS:

94 Cowcross Street



REMARKS: