



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

## C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer:

### Monitoring Close-Out Report: Inclinometers C435-IM00001, C435-IM00002 and C435-IM00014

**CRL Document Number: C435-BFK-C2-RGN-M123-51672**

**Supplier Document Number: N/A**

**Contract MDL reference C13.012**

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

Stakeholder submission required: LU  NR  DLR  RL  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"/>
				27/10/2016	<input type="checkbox"/>

#### 3. Acceptance by Crossrail:

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## A. INTRODUCTION

In line with the C122 Instrumentation & Monitoring C122-OVE-Z4-RSP-CR001-00007 Sections KX10.2113 and KX10.2114 (final and close-out reports), 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 report will provide justification for the decommissioning of the instruments.

## B. INSTRUMENTS

### B.1 Description of the Instruments

This Close-Out Report relates the In-ground Monitoring Inclinerometers. See Table 1 below with details:

Device	Location	Depth (m)	Easting (m)	Northing (m)	Elevation (mATD)	Description
C435-IM00001	WTH	38.50	81944.746	36468.849	105.769	Manual inclinometer
C435-IM00002	Butcher's Ramp	35.00	82030.399	36486.1016	110.4725	Manual inclinometer
C435-IM00014	Moorgate Spur	37.00	82197.9818	36516.6124	109.1089	Manual inclinometer

Table 1: Details of the devices included in this report.

The devices included in this reports are shown in the following documents:

#### Drawings:

- C122-OVE-C2-DDA-CR001\_Z-31531. Asset Protection I&M Ground surface and In-ground Farringdon Station C435.
- C435-BFK-C2-DWG-M123-50042. In ground devices installed for Farringdon Station.

#### Installation Reports:

- C435-BFK-C2-RGN-M123-50041: Installation Report-In ground monitoring-Inclinerometer C435-IM00001.
- C435-BFK-C2-RGN-M123-50986: Installation Report-In ground monitoring-Inclinerometer C435-IM00002.
- C435-BFK-C2-RGN-M123-50979: Installation Report-In ground monitoring-Inclinerometer C435-IM00014.



## B.2 Location of the Instruments

In ground inclinometers included in this report are located on the plan below highlighted in yellow.

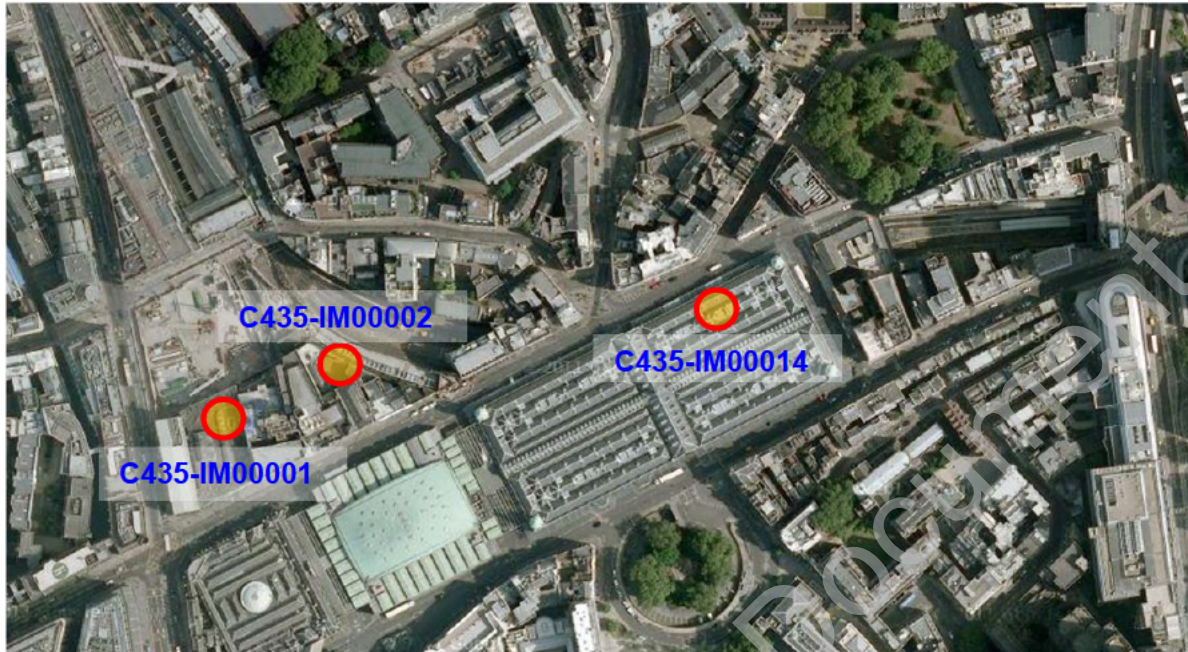


Figure 1 – Plan showing the Location for the devices included in this report.

## C. MOVEMENTS

### C.1 Movements Resulting from Construction Activities

#### C.1.1 Relevant Crossrail (BKF) Works

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

Device	Activity	Start Date	End Date
C435-IM00001	WB TBM passage	11/09/2013	26/09/2013
	PL2 passage	27/04/2015	23/05/2015
C435-IM00002	WB TBM passage	23/09/2013	30/09/2013
	PTW passage	05/04/2014	15/06/2014
C435-IM00014	WB TBM passage	01/10/2013	04/10/2013
	PTW passage	05/08/2014	10/10/2014

Table 2 – Construction Activities associated to devices included in this report.

#### C.1.2 Resulting Movements

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

- Inclinometer C435-IM00001:
  - C300 WB TBM passage caused a maximum displacement of 5-6mm on direction A from 11-09-2013 to 26-09-2013.
  - PL2 passage caused a maximum displacement of 12mm on direction A from 27-04-2015 to 23-05-2015.
  - Maximum displacement captured by the inclinometer on direction A of 13mm.
  - Maximum displacement captured by the inclinometer on direction B of -12mm.

- Inclinerometer C435-IM00002:
  - C300 WB TBM passage caused a maximum displacement of 5-6mm on direction A from 23-09-2013 to 30-09-2013.
  - PTW passage caused a maximum displacement of 6mm on direction A from 05-04-2014 to 15-06-2014.
  - Maximum displacement captured by the inclinometer on direction A of 12mm
  - Maximum displacement captured by the inclinometer on direction B of -10mm.
- Inclinerometer C435-IM00014:
  - C300 WB TBM passage caused a maximum displacement of 2-3mm on direction A from 01-10-2013 to 04-10-2013.
  - PTW passage caused a maximum displacement of 4-5mm on direction A from 05-08-2014 to 10-10-2014.
  - Maximum displacement captured by the inclinometer on direction A of -3mm
  - Maximum displacement captured by the inclinometer on direction B of -3.5mm.

## 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 device. No triggers have been defined for the instruments included in this report.

## C.3 Significant Issues with the Instrumentation

Inclinerometer C435-IM00002 was damaged on 27/09/2013 during the TBM passage, showing the data a 5mm kink at level 92.473 mATD. The horizontal displacement caused by the kink was accumulated from the level 92.473 mATD to the top of the inclinometer.

Inclinerometer C435-IM00002 was available until 10-04-2014 when it was damaged by PTW passage works.

Inclinerometer C435-IM00001 was available until 09-06-2015 when it was covered by concrete by WTH works.

## C.4 Residual Risks

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

- For Inclinerometer C435-IM00001 was on 09-06-2015.
- For Inclinerometer C435-IM00002 was on 10-04-2014.
- For Inclinerometer C435-IM00014 was on 03-12-2015.

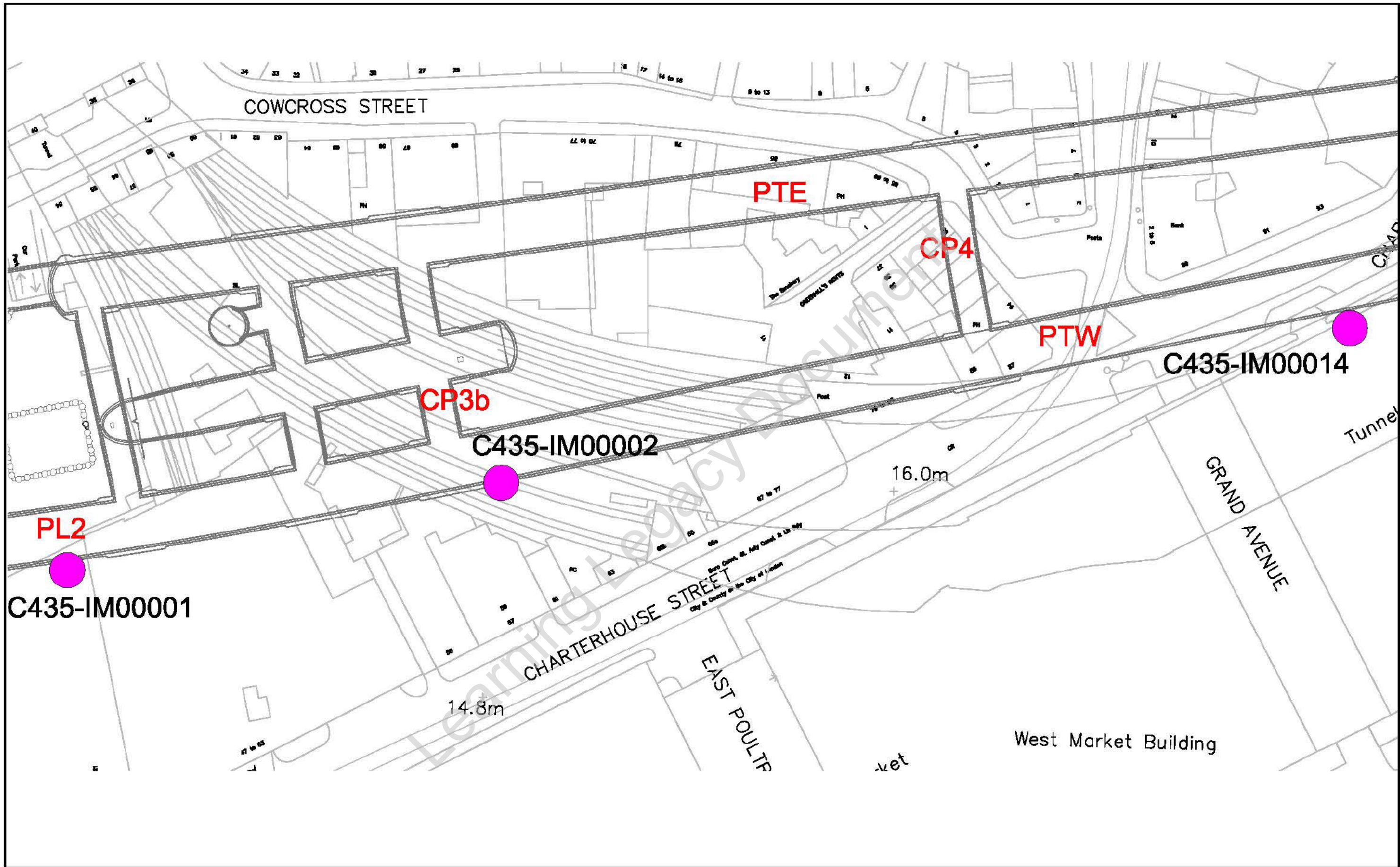
## D. CONCLUSIONS

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

APPENDIX A: DRAWINGS

Learning Legacy Document





Rev.	Date	Description	By	Chkd	App	Auth


Notes:



  
 C/ Los Llanos de Jerez 10-12  
 28023- MADRID  
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 Scale: @ A3

Contract: BORED TUNNELS (ALIGNMENT AND TRACK)  
 Originator: OVE ARUP & PARTNERS LIMITED  
 Location: CROSSRAIL GENERAL  
 Title: IN-GROUND DEVICES INSTALLED FOR FARRINGTON STATION.  
 Drg No: C435-BFK-C2-DWG-M123-50042

By:	
Chk:	
App:	
Auth:	

sPbys

APPENDIX B: GRAPHS

Learning Legacy Document





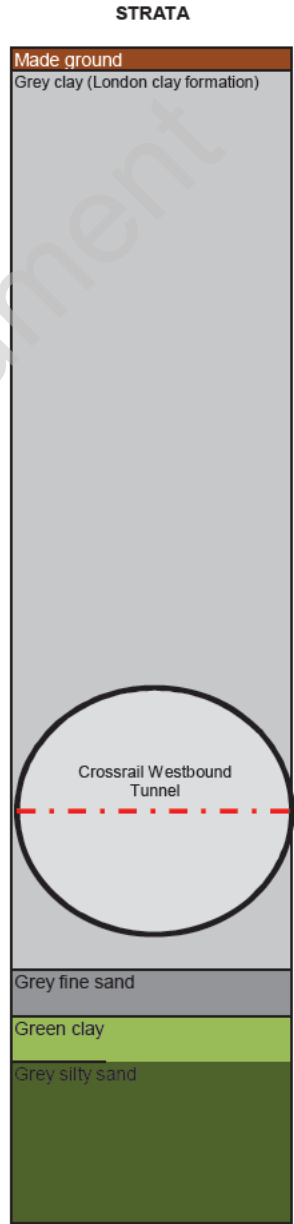
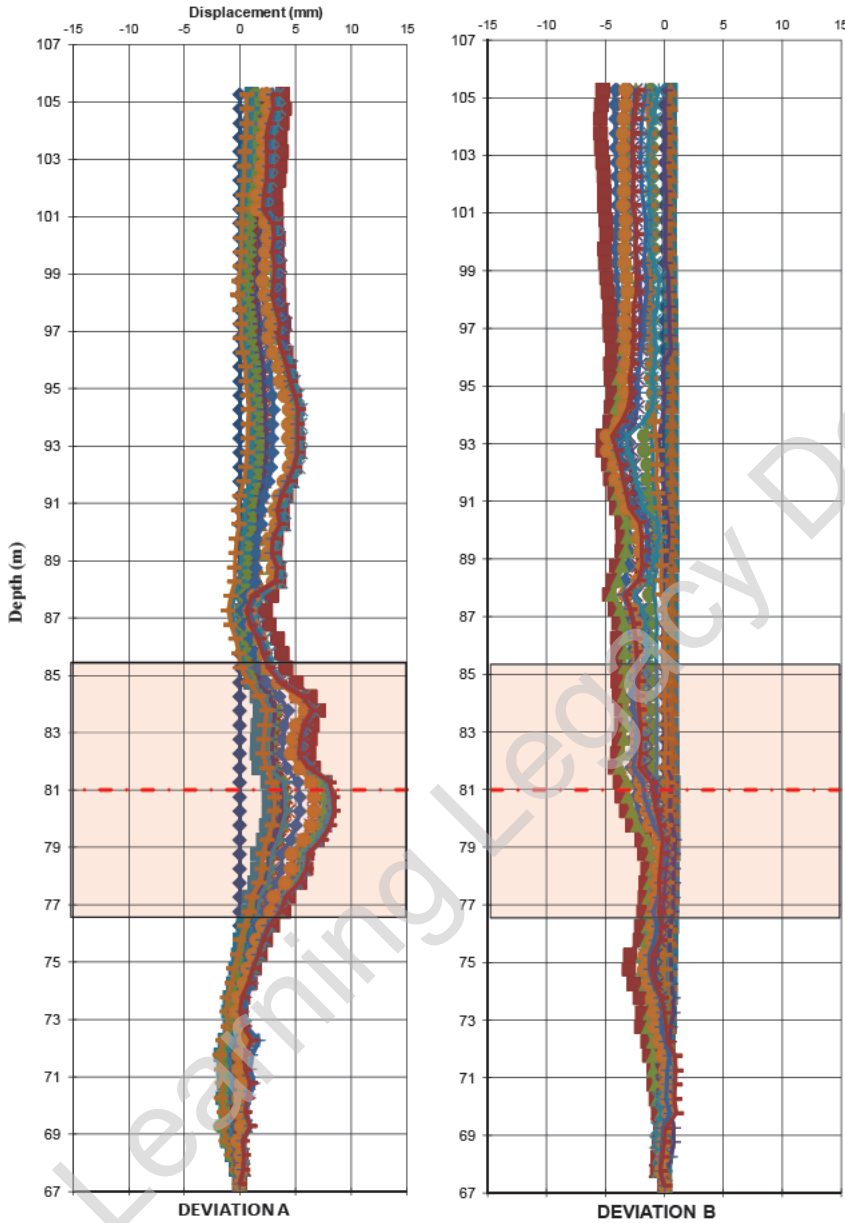
C435 FARRINGTON STATION



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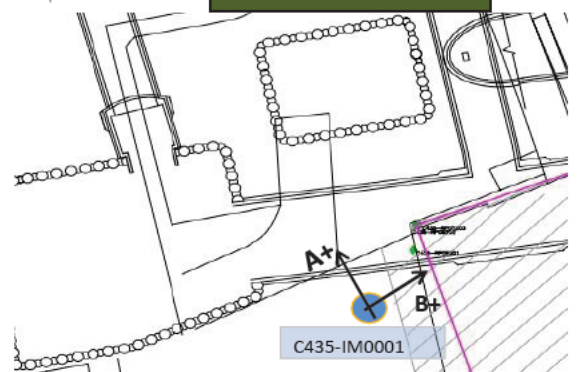
**REPORT:** MANUAL INCLINOMETER  
**LOCATION:** WTH  
**DEVICE:** Inclinometer C435-IM00001

Readings before/after C300 WT TBM passage



**MEASURING DATES**

13/03/2013 Baseline	11-9-13 15:00	12-9-13 10:00
13-9-13 10:00	14-9-13 10:00	15-9-13 12:00
16-9-13 9:00	17-9-13 12:00	18-9-13 8:30
19-9-13 8:30	20-9-13 10:30	21-9-13 12:30
22-9-13 12:30	23-9-13 16:30	24-9-13 9:30
25-9-13 11:30	26-9-13 11:30	-
		- - - TBM AXIS



**REMARKS:**



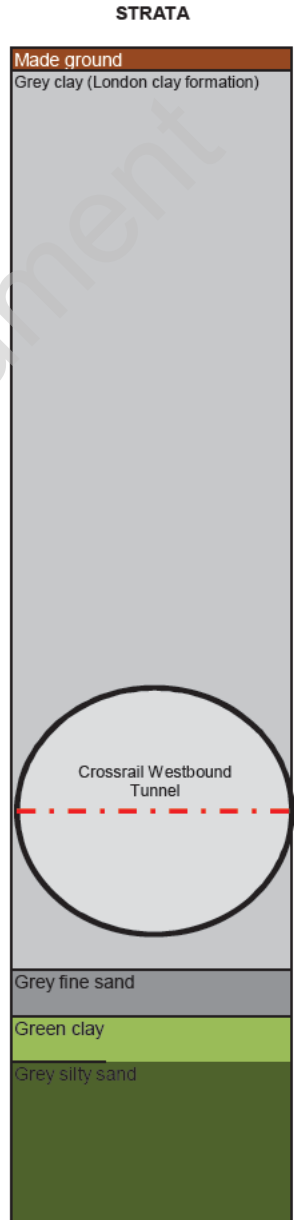
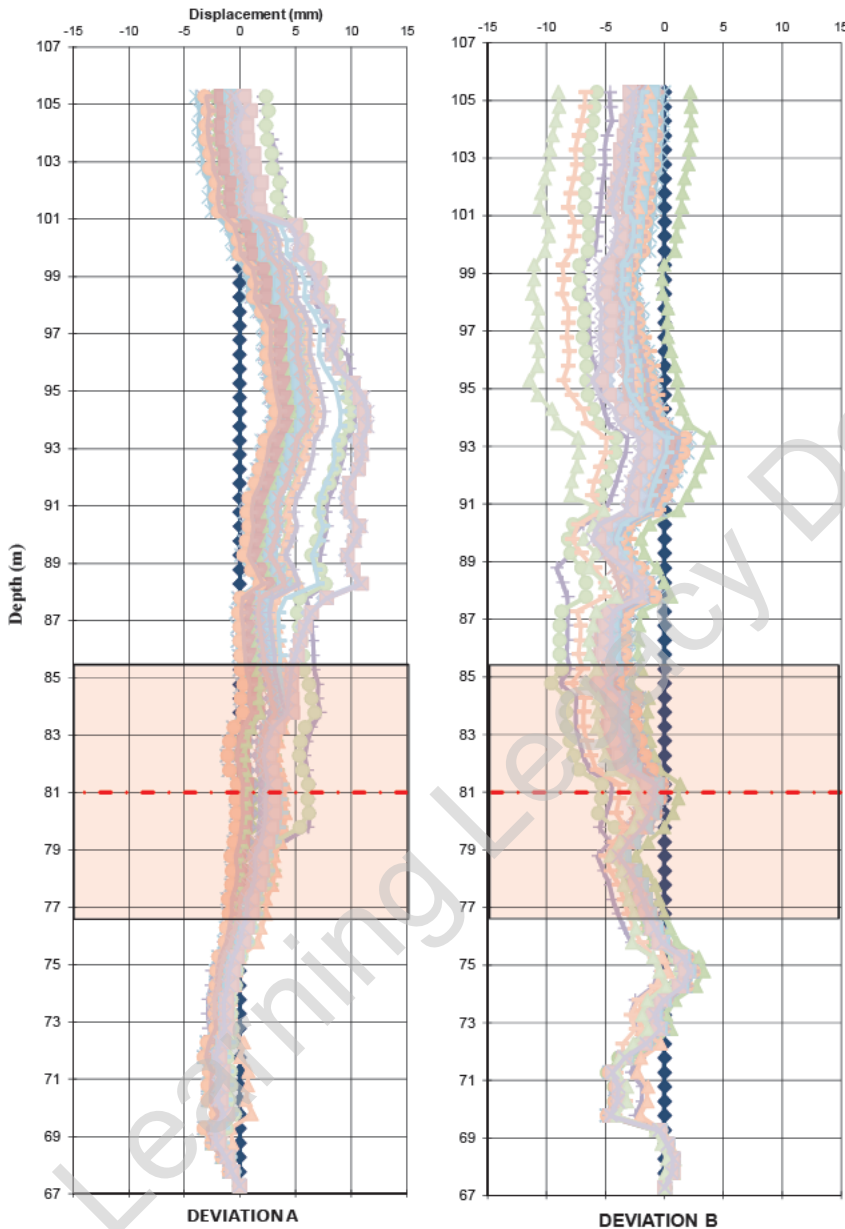
C435 FARRINGTON STATION



**GEOCISA UK**

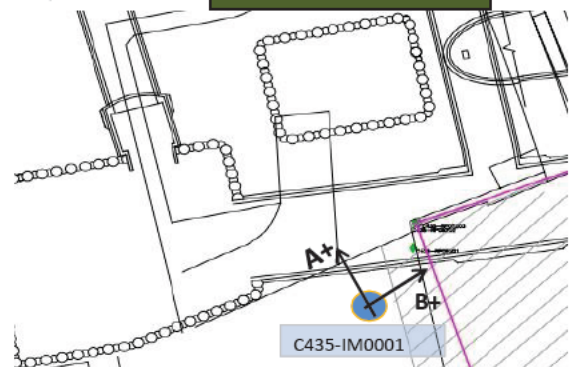
**REPORT:** MANUAL INCLINOMETER  
**LOCATION:** WTH  
**DEVICE:** Inclinometer C435-IM00001

Readings before/after PL2 passage



**MEASURING DATES**

13/03/2013 Baseline	27-4-15 13:15	28-4-15 13:15
29-4-15 13:15	1-5-15 13:15	2-5-15 13:15
3-5-15 13:15	4-5-15 13:15	5-5-15 13:15
6-5-15 13:15	7-5-15 13:15	8-5-15 13:15
9-5-15 13:15	10-5-15 13:15	11-5-15 13:15
12-5-15 13:15	13-5-15 13:15	14-5-15 13:15
15-5-15 13:15	16-5-15 13:15	17-5-15 13:15
19-5-15 13:15	20-5-15 13:15	23-5-15 13:15
- - - TBM AXIS		



**REMARKS:**



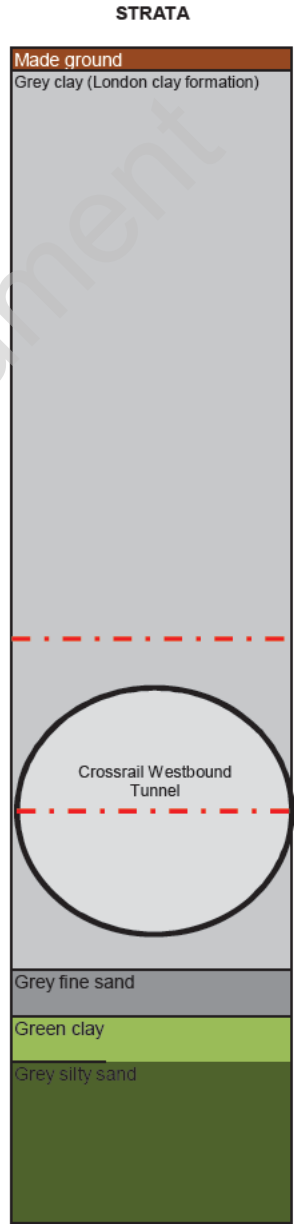
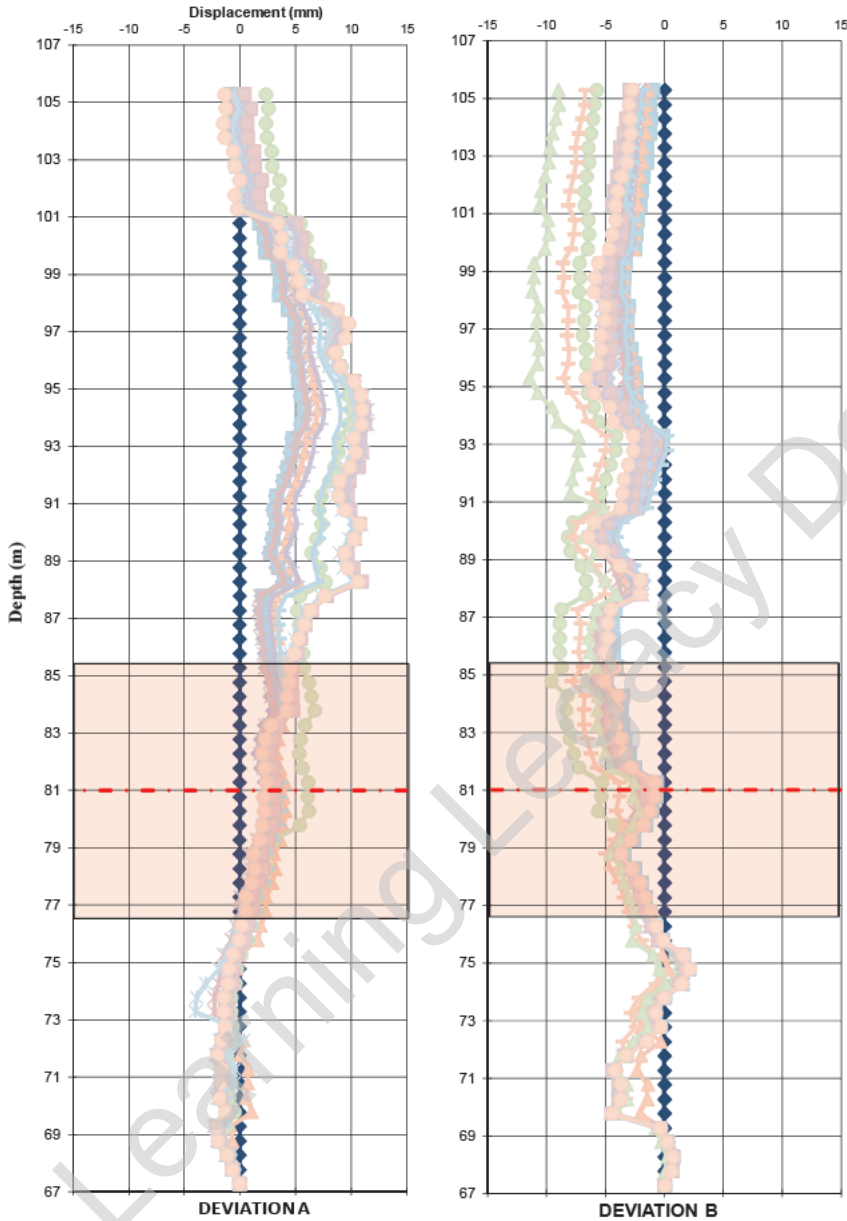
C435 FARRINGTON STATION



**GEOCISA UK**

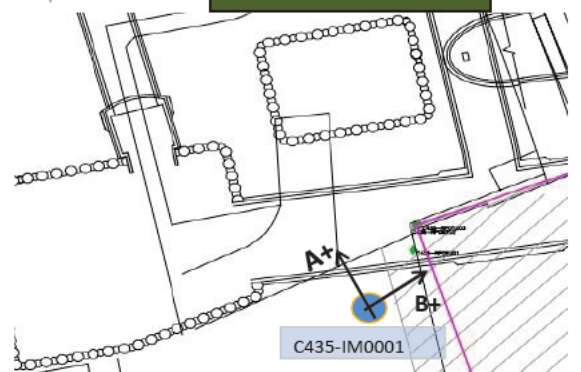
**REPORT:** MANUAL INCLINOMETER  
**LOCATION:** WTH  
**DEVICE:** Inclinometer C435-IM00001

Last readings



**MEASURING DATES**

13/03/2013 Baseline	10-5-15 13:15	11-5-15 13:15
12-5-15 13:15	13-5-15 13:15	14-5-15 13:15
15-5-15 13:15	16-5-15 13:15	17-5-15 13:15
19-5-15 13:15	20-5-15 13:15	23-5-15 13:15
2-6-15 13:15	9-6-15 13:15	-
- - - TBM AXIS		



**REMARKS:**



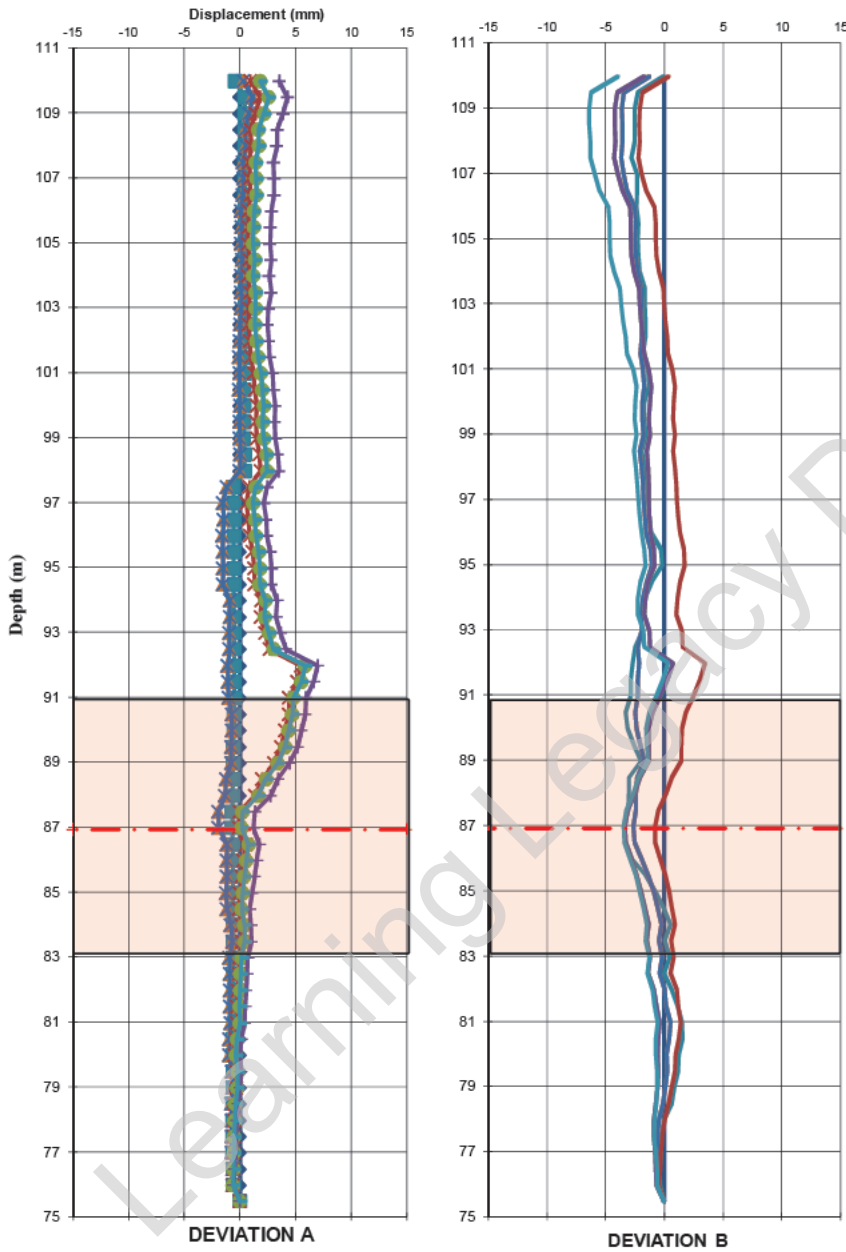
C435 FARRINGTON STATION



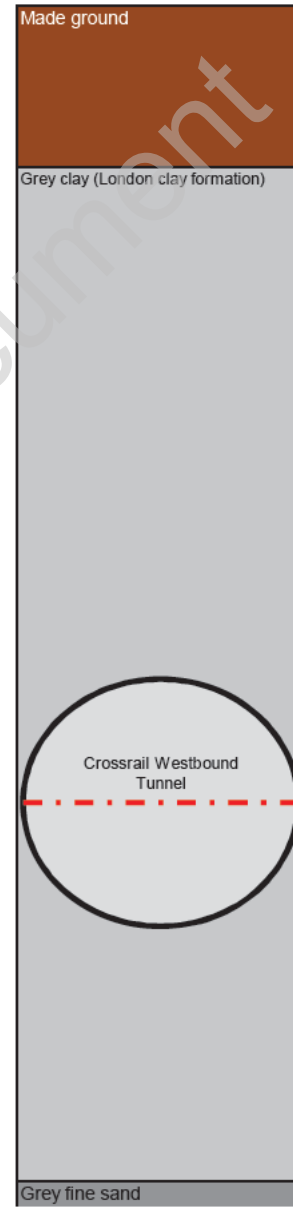
**GEOCISA UK**

**REPORT:** MANUAL INCLINOMETER  
**LOCATION:** Butcher's Ramp  
**DEVICE:** Inclinometer C435-IM00002

Readings before/after C300 WB TBM passage

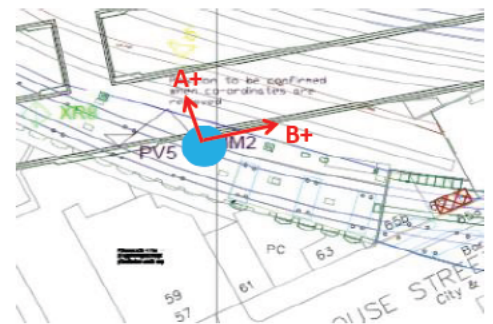


**STRATA**



**MEASURING DATES**

◆ 18/07/2013 Baseline	■ 23-9-13 16:20	▲ 25-9-13 16:20
✕ 26-9-13 15:30	✱ 27-9-13 16:30	● 28-9-13 17:30
◆ 29-9-13 11:30	■ 30-9-13 12:00	→ • TBM AXIS



**REMARKS:**





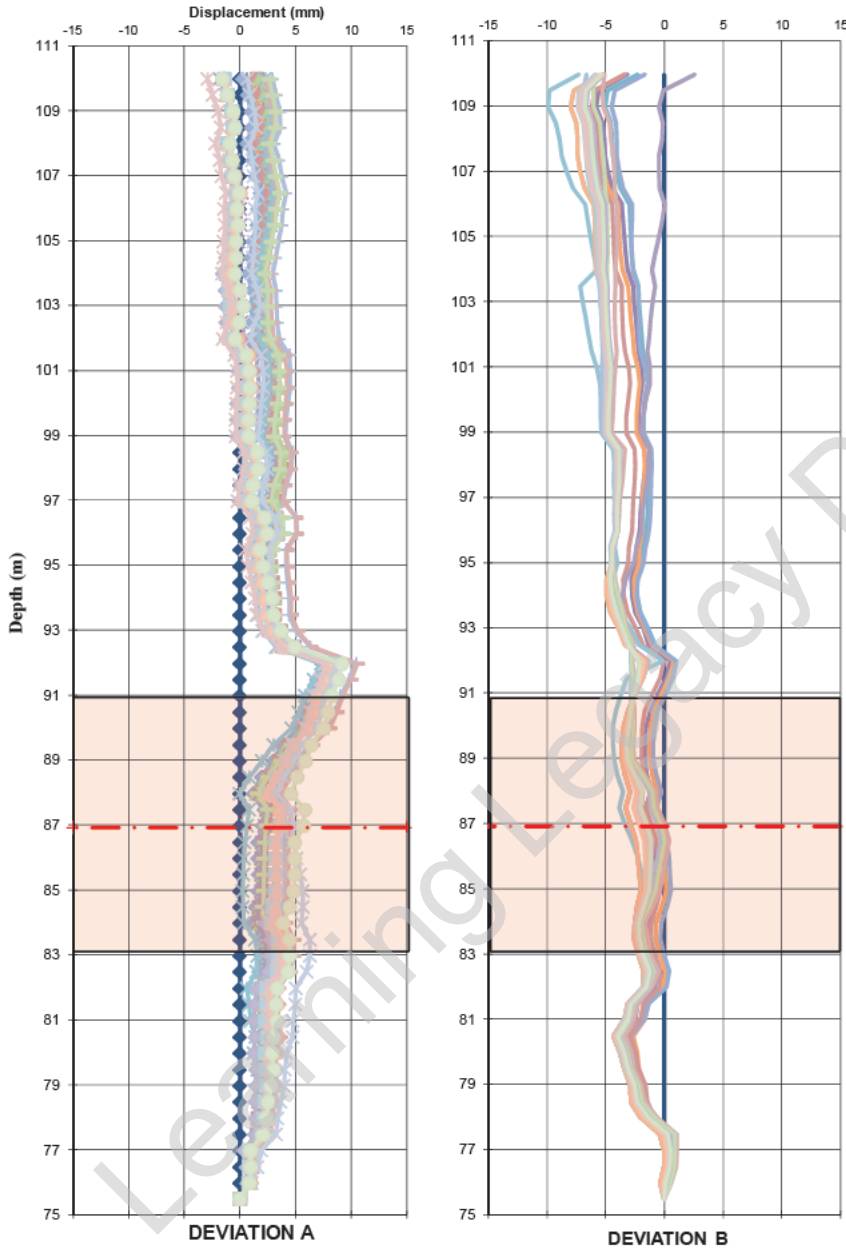
C435 FARRINGTON STATION



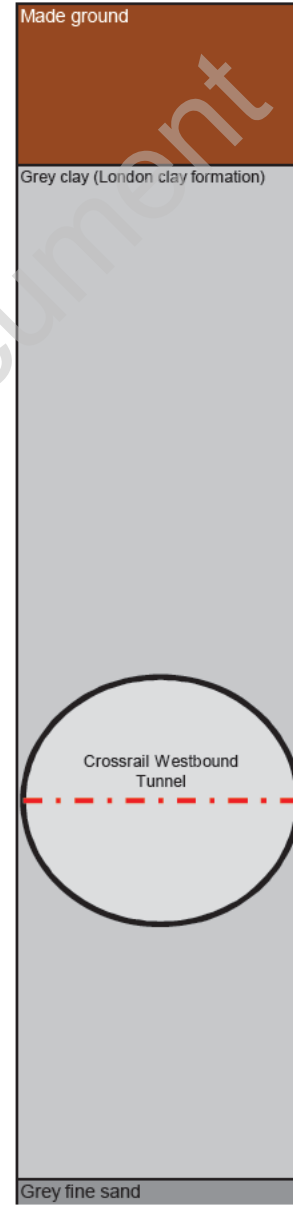
**GEOCISA UK**

**REPORT:** MANUAL INCLINOMETER  
**LOCATION:** Butcher's Ramp  
**DEVICE:** Inclinometer C435-IM00002

Readings before/during PTW passage until the device was operative.

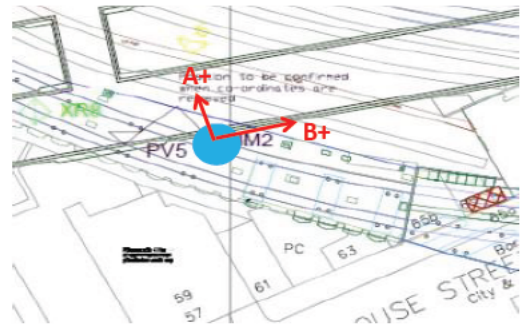


**STRATA**



**MEASURING DATES**

18/07/2013 Baseline	24-3-14 17:00	25-3-14 16:15
26-3-14 13:30	27-3-14 10:30	28-3-14 16:15
29-3-14 18:20	30-3-14 17:15	31-3-14 18:00
1-4-14 16:00	2-4-14 9:15	3-4-14 16:15
4-4-14 10:45	5-4-14 10:45	6-4-14 10:45
7-4-14 17:15	8-4-14 15:45	9-4-14 11:30
10-4-14 11:30	TBM AXIS	



**REMARKS:**



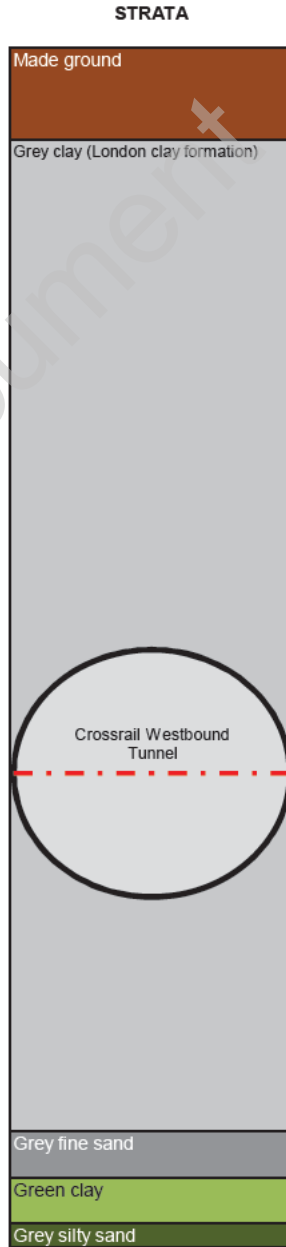
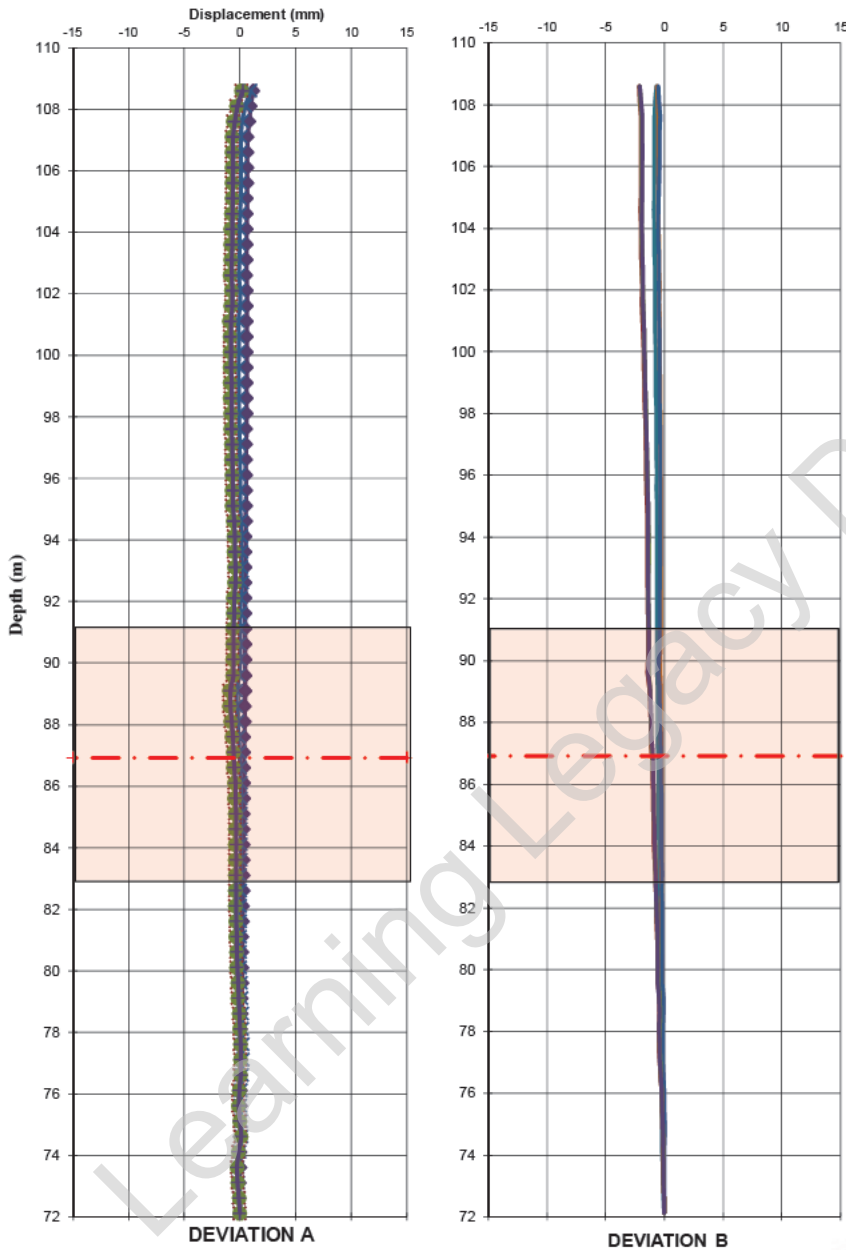
C435 FARRINGTON STATION



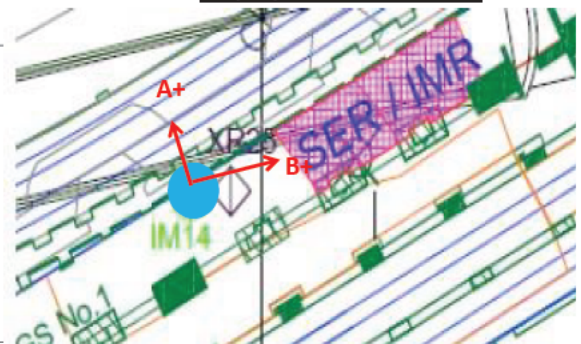
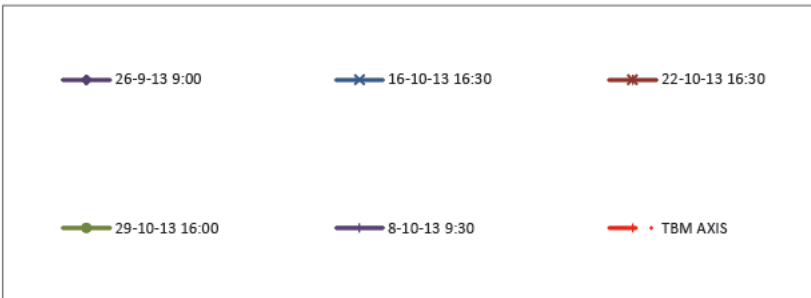
**GEOCISA UK**

**REPORT:** MANUAL INCLINOMETER  
**LOCATION:** Moorgate Spur  
**DEVICE:** Inclinometer C435-IM00014

Readings before/after C300 WB TBM passage



**MEASURING DATES**



**REMARKS:**



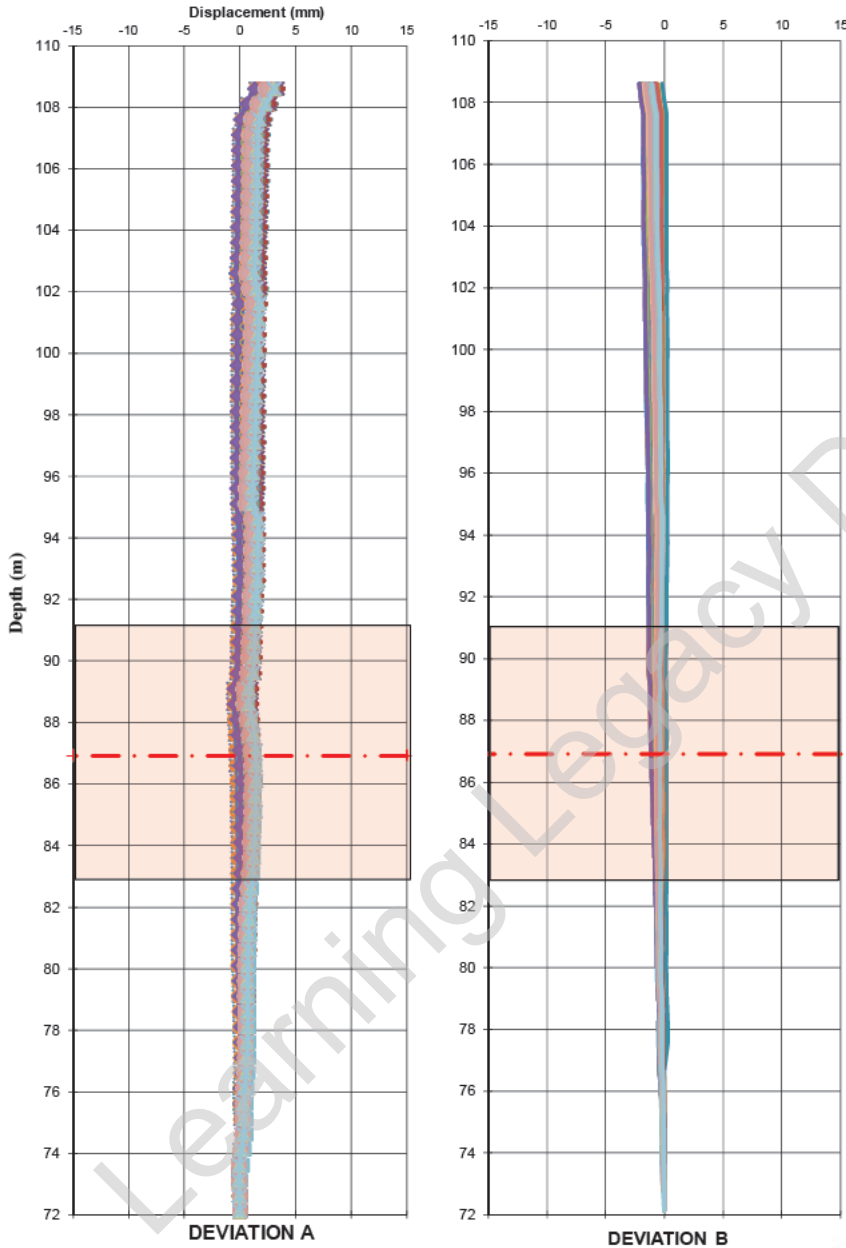
C435 FARRINGTON STATION



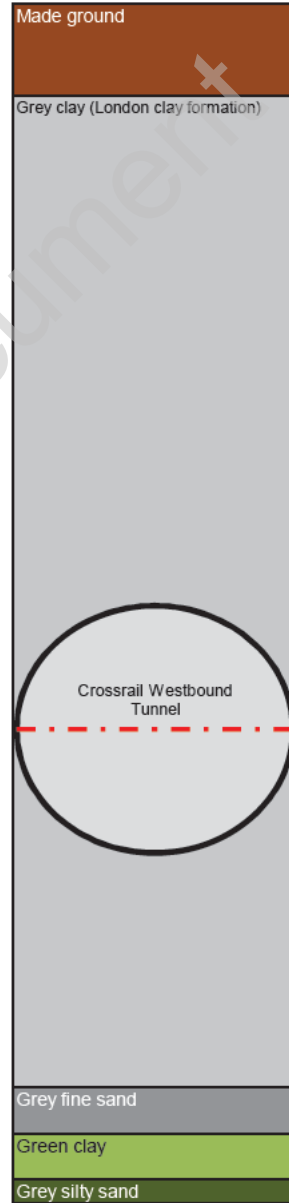
**GEOCISA UK**

**REPORT:** MANUAL INCLINOMETER  
**LOCATION:** Moorgate Spur  
**DEVICE:** Inclinometer C435-IM00014

Readings before/after PWT passage

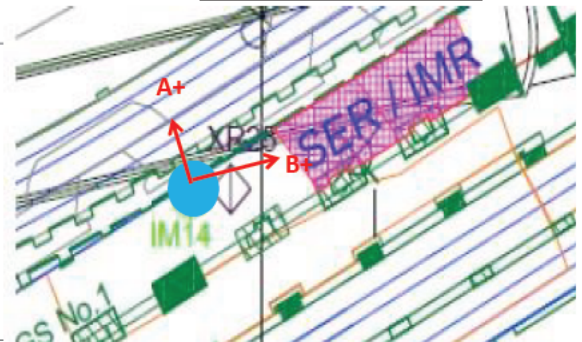


**STRATA**



**MEASURING DATES**

5-8-14 12:30	6-8-14 12:30	7-8-14 12:30	8-8-14 12:30
10-8-14 12:30	11-8-14 12:30	12-8-14 12:30	13-8-14 12:30
14-8-14 12:30	15-8-14 12:30	16-8-14 12:30	17-8-14 12:30
18-8-14 12:30	19-8-14 10:20	20-8-14 15:45	21-8-14 15:20
22-8-14 10:10	25-8-14 17:00	26-8-14 10:15	27-8-14 15:45
28-8-14 15:45	29-8-14 15:45	30-8-14 15:45	31-8-14 15:45
1-9-14 15:45	2-9-14 10:45	3-9-14 9:50	4-9-14 13:25
5-9-14 9:30	6-9-14 9:30	7-9-14 9:30	8-9-14 9:30
9-9-14 9:30	10-9-14 9:30	11-9-14 9:30	12-9-14 9:30
15-9-14 16:30	16-9-14 15:20	17-9-14 16:30	18-9-14 12:00
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23-9-14 15:30	24-9-14 13:45	25-9-14 9:20	26-9-14 17:30
27-9-14 17:30	28-9-14 11:45	29-9-14 9:15	30-9-14 9:15
1-10-14 9:15	2-10-14 12:30	3-10-14 12:20	4-10-14 17:25
5-10-14 15:00	6-10-14 13:00	7-10-14 16:00	8-10-14 11:50
9-10-14 16:00	10-10-14 16:20		



**REMARKS:**



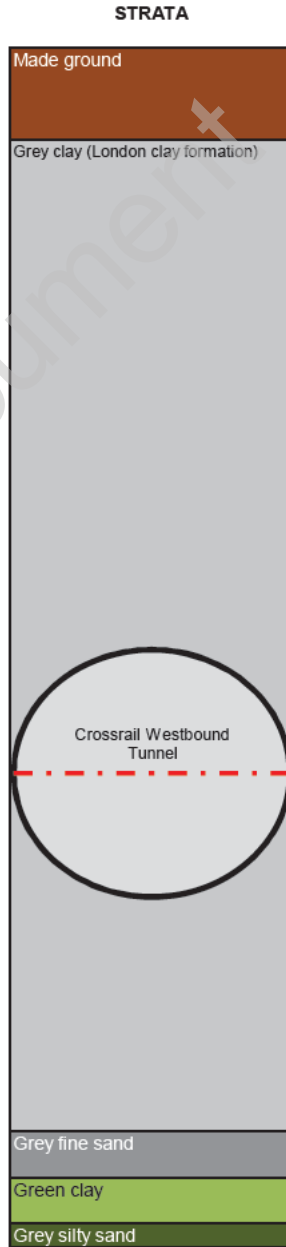
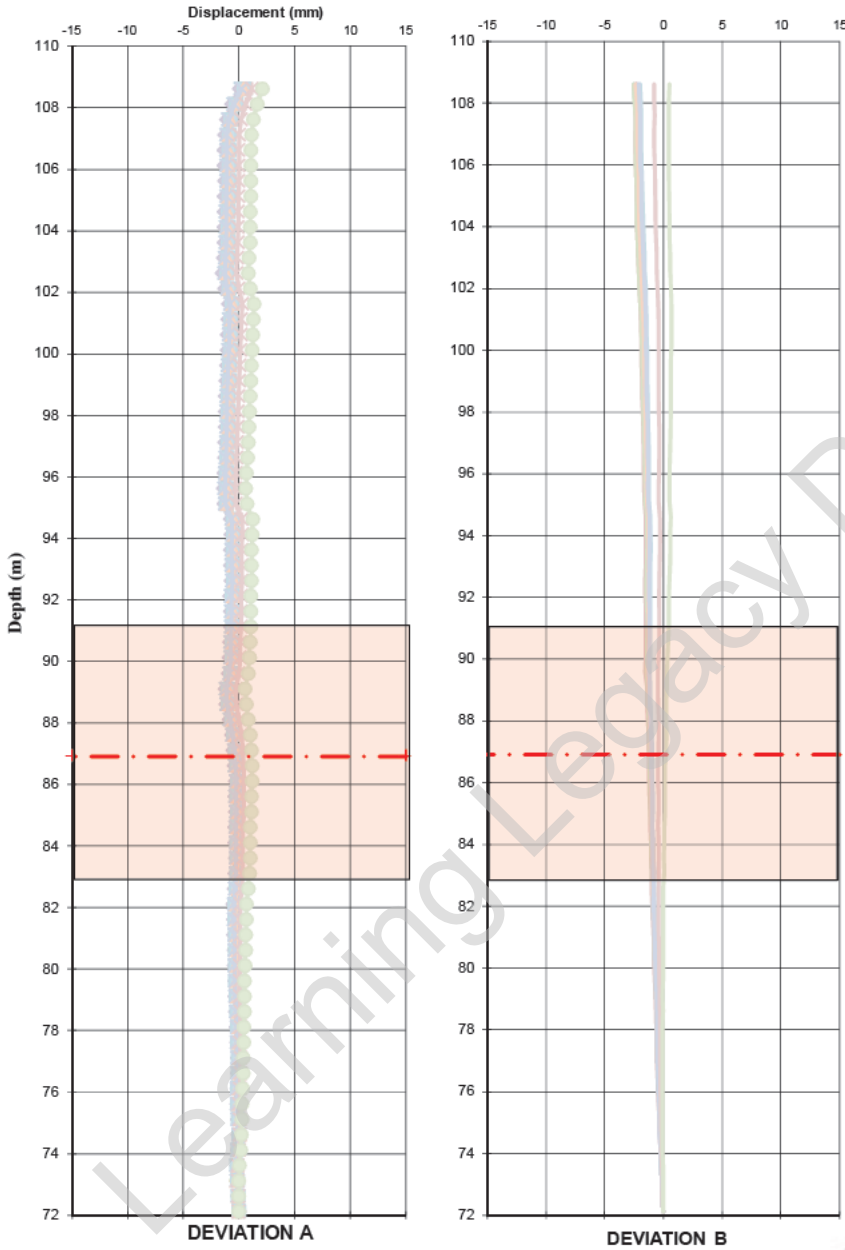
C435 FARRINGTON STATION



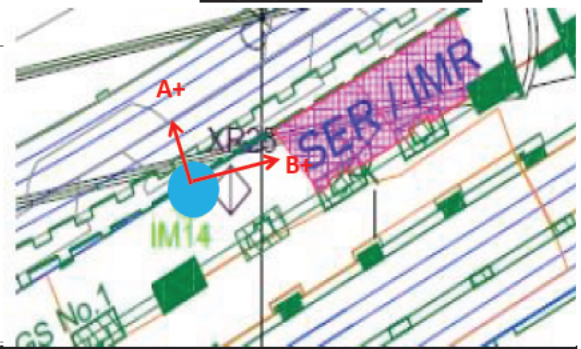
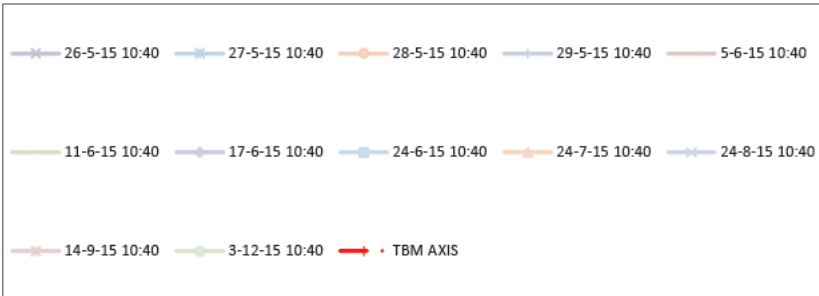
**GEOCISA UK**

**REPORT:** MANUAL INCLINOMETER  
**LOCATION:** Moorgate Spur  
**DEVICE:** Inclinometer C435-IM00014

Last readings



**MEASURING DATES**



**REMARKS:**



## APPENDIX C: GLOSSARY

- ATS Automatic Total Station.
- ETH Eastern Ticket Hall.
- WB Westbound.
- TBM Tunnel Boring Machine.
- EB Eastbound.
- PTW Platform Tunnel West.
- PTE Platform Tunnel East.
- CP Cross Passage.
- CH Concourse Hall.
- VA Ventilation Adit.
- STE Stub Tunnel East.
- STW Stub Tunnel West.
- RTE Running Tunnel East.
- ES Escalator Shaft.
- TaM Tube a Manchette.
- WTH West Ticket Hall.
- PL Platform Link.

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