C300/410

Western Tunnels & Caverns Project

Final Monitoring Report

TBM DRIVES ~ from Bond Street Station to Tottenham Court Road Station

CRL Document No. **C300-BFK-C4-RGN-CRT00_ST005-51016**

Contract MDL reference: C03.035

1. Contractor Document Submittal History

Revision	Date	Prepared by	Checked by	Approved by	Reason for Issue
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2a. Stakeholder Review Required? YES ☐ NO ☒

Stakeholder submission required: LU ☐ RfL ☐ NR ☐ LO ☐ DLR ☐ 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: _____ Name: _____ Role: _____ Date: _____

Sign: _____ Name: _____ Role: _____ Date: _____

2b. Review by Stakeholder (if required):

Stakeholder Organisation	Job Title	Name	Signature	Date	Acceptance
					☐
					☐

3. Acceptance by *Crossrail*:

	***Crossrail* Review and Acceptance Decal** This decal is to be used for submitted documents requiring acceptance by *Crossrail*.	
☑	Code 1.	Accepted. Work May Proceed
☐	Code 2.	Not Accepted. Revise and resubmit. Work may proceed subject to incorporation of changes indicated
☐	Code 3.	Not Accepted. Revise and resubmit. Work may not proceed
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Reviewed/Accepted by: (signature) [redacted] Print Name: [redacted] Position: [redacted] Date: 09/12/15

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1. Purpose and Scope

The purpose of this document is to provide a summary of the observed movements relative to the TBM works between Bond Street Station and Tottenham Court Road Station s in accordance with the requirements of the Instrumentation and Monitoring Specification KX10, Clauses KX10.2113 and KX10.2114.

KX10.2114 Close-Out Reports

Prior to the de-commissioning of any instrumentation, the *Contractor* shall produce a "close-out" report which summarises the data from the instrumentation the *Contractor* wishes to remove and relates it to the construction activities which produced any observed changes. The report shall demonstrate that the rate of change in the data has reached an acceptably small rate either in accordance with specified rates or, where no rate is specified, in relation to trigger values and an evaluation of any potential residual risks.

This report is one of a series of 5 which cover the TBM drives between Royal Oak Portal and Farringdon Station as listed in Table 1.

Report title: *Final and Close Out Monitoring*	**Report Number:** C300-BFK-C4-RGN-CRT00_S 005-	Eastbound Tunnel		Westbound Tunnel	
		Start Chainage	End Chainage	Start Chainage	End Chainage
Royal Oak Portal to Paddington Station (ROP to PAD)	51232	510	1312	510	1300
Paddington Station to Bond Street Station (PAD to BOS)	51015	1670	3561	1660	3568
Bond Street Station to Tottenham Court Road Station (BOS to TCR)	51016	4187	4672	4159	4679
Tottenham Court oad Station to Fisher Street Shaft & Crossover (TCR to FIS)	51129	5147	5792	5108	5856
Fisher Street Shaft & Crossover to Farr gdon Station (FIS to FAR)	51130	6097	6860	6162	6945

Table 1 List of Final / Close Out Reports for TBM drives Royal Oak Portal to Farringdon.

1.1. Executive summary

This document includes settlement data from instruments on assets (BRE) and from general ground transects (PLP) for the TBM drives between Bond Street Station and Tottenham Court Road Station.

A summary of the monitoring data is provided, with the influence of the two TBM drives identified. The rate of post-construction settlement is compared to the specified limit of 2mm/year and the absolute magnitude of settlement is compared to the trigger values given in the C122 I&M plan. Points where trigger levels have been exceeded are listed. Monitoring data from Cross Passage 4a is also presented.

Information about Thames Water assets is provided, both within the report and in Appendix 3 (summary table). In general, no deflection amber trigger (average of 3 values) has been breached on Thames Water assets.

The transects from which data is presented are listed in Table 2. The locations of the instruments are plotted in Appendix 7 and those from which data is presented are identified. A summary of the final settlements recorded on all BRE and PLP is also given in Appendix 7. The maximum recorded settlement between Bond Street and Tottenham Court Road Stations is -17mm.

The transects marked with "*" in Table 2 were de-scoped less than 1 year after the passage of the TBMs. This was agreed during dedicated meetings with CRL and C122 based on analy is of the monitoring data (trends and settlement values).

TBM progress information, supporting documents references, and a summary of claims for building damage (provided by CRL) are provided in Appendices 1, 2 and 4 respective y.

The data from LU assets is presented in Appendix 6. The slides reported in Appendix 6 have been presented to LU, CRL and C122 representatives during dedicated meetings at which further monitoring was de-scoped.

It should be noted that the data from all instruments is available on the UCIMS platform.

Table 2: Transects presented

Sections
Regent Street / Hanover Street
Hanover Street*
Regent Street
Regent Street / Great Marlborough Street
Argyll Street*
31-38 Great Marlborough Street
39-60 Great Marlborough Street*
Poland Street
Berwick Street*
Wardour Street*

LU assets
LU08 – Bakerloo Line South of Oxford Circus
LU09 – Victoria Line South of Oxford Circus

It should be noted that some transects include a large number of measuring points. In these cases, for the sake of clarity, only the points within the zone of influence of the TBMs were included in the charts.

2. Summary of the observed settlements

2.1. Regent Street/Hanover Street PLPs

2.1.1. Data

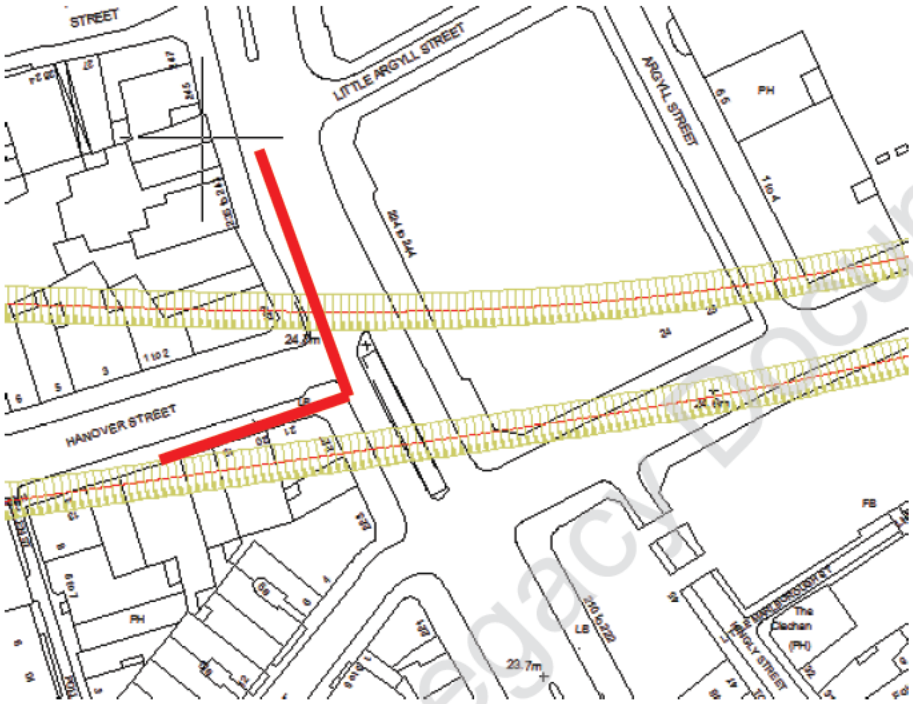


Figure 1: Location

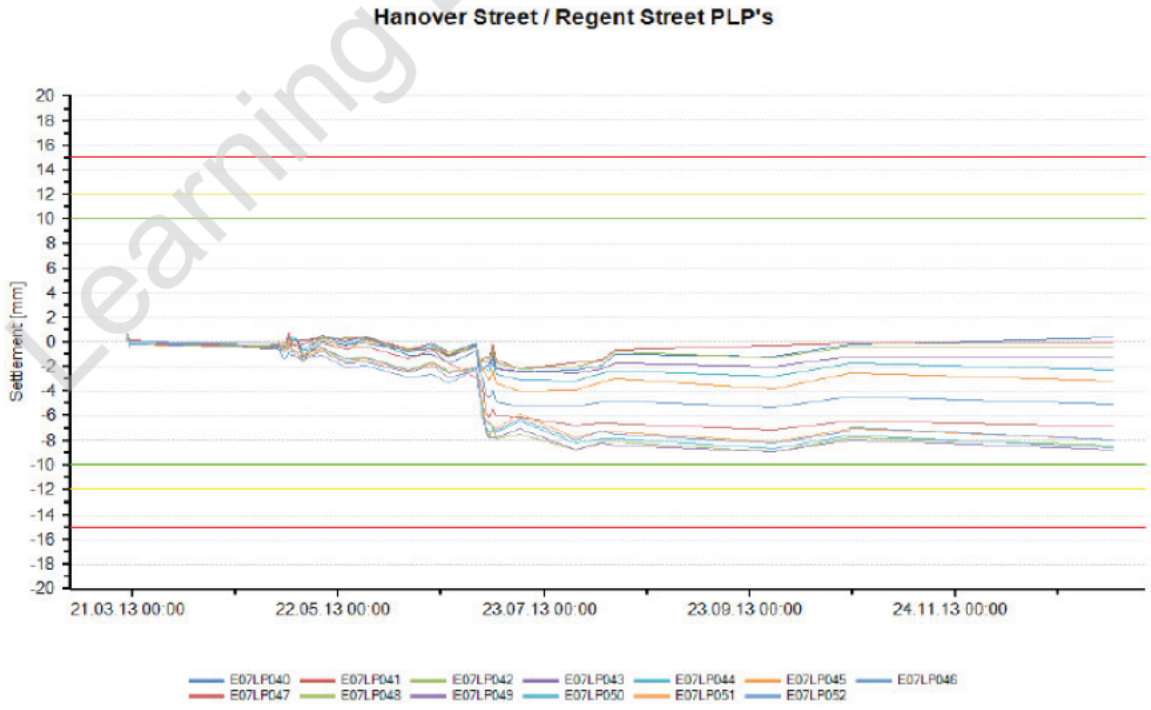


Figure 2: data time-plots: comparison against settlement triggers

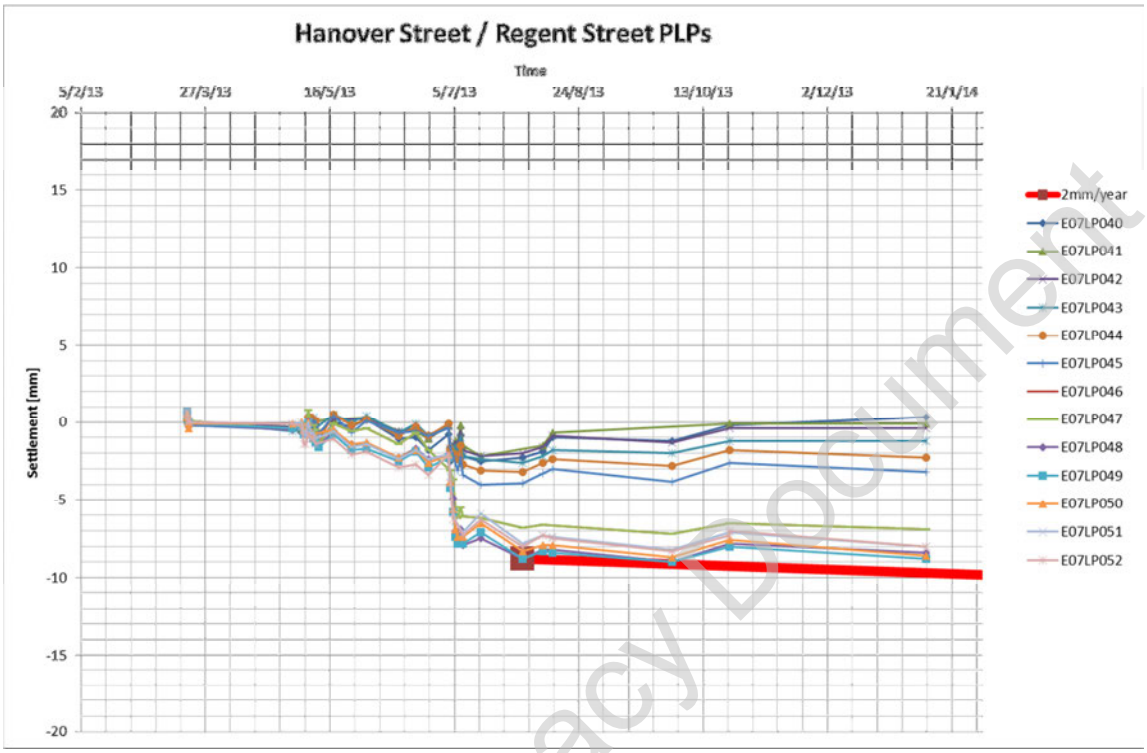


Figure 3: data time-plots - comparison against 2mm/year settlement rate (long-term)

2.1.2. Comments

The PLPs in Hanover Street / Regent Street settled up to approx. 10mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots, and the EB TBM effect is prevalent, as expected. No settlement trigger has been breached. The long-term trend is less than 2mm yea

The residual risk associated with long-term settlements is considered to be negligible.

2.2. Hanover Street BREs and PLPs

2.2.1. Data

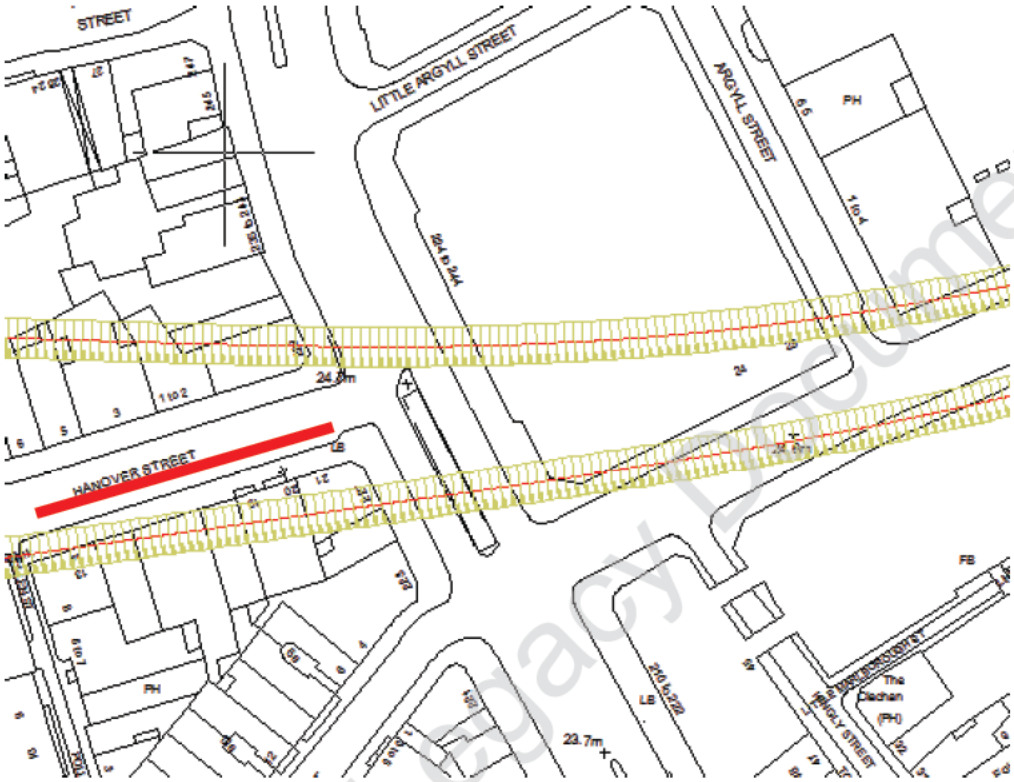


Figure 4: Location

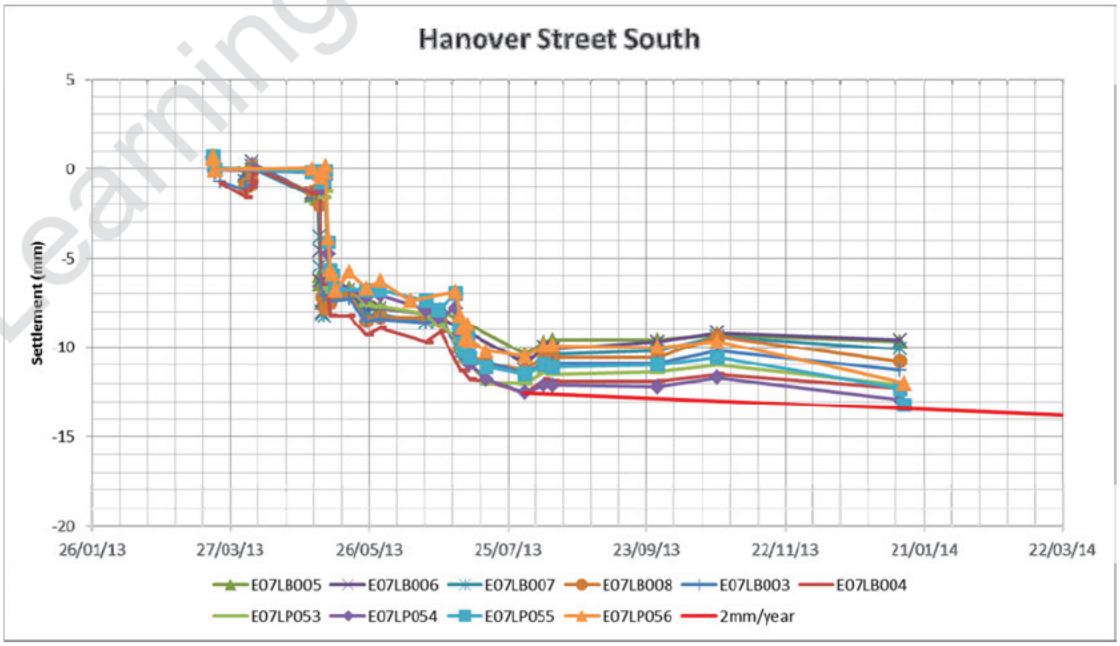


Figure 5: data time-plots - comparison against 2mm/year settlement rate (long-term)

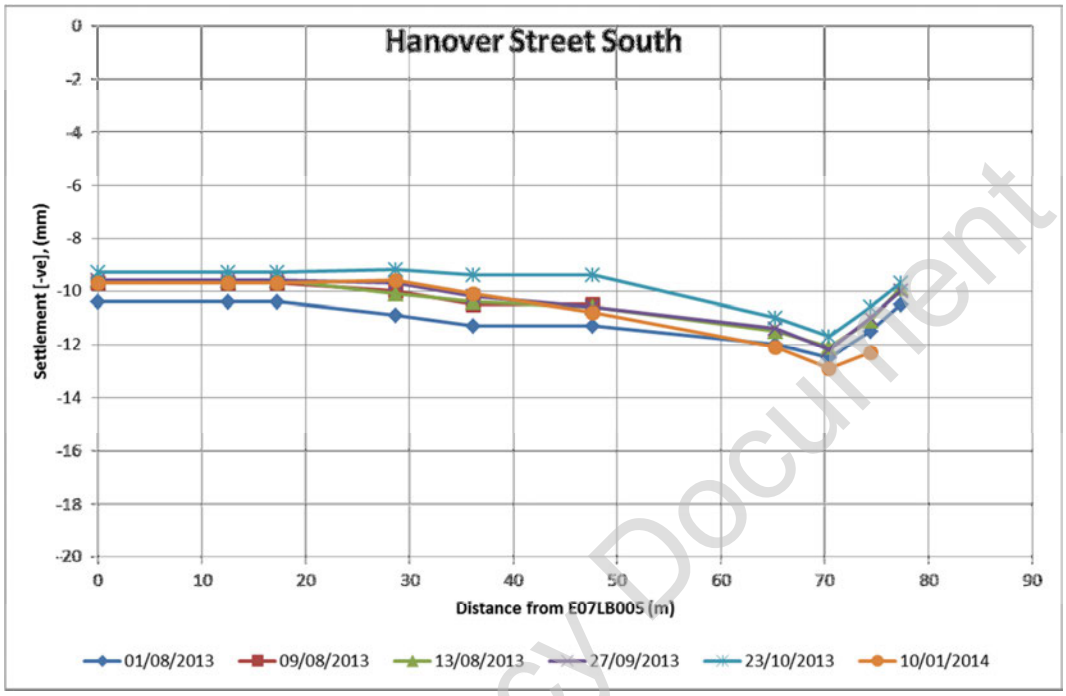


Figure 6: settlement-distance plot

Table 3a,b: Achieved Triggers – settlements and slopes

Point Code	Point type	Achieved Trigger
E07LB_07	BRE	Green
E07LB008	BRE	Green
E07LB003	BRE	Green
E07LB004	BRE	Amber
E07LP053	PLP	Amber
E07LP054	PLP	Amber
E07LP055	PLP	Amber
E07LP056	PLP	Green

Worst case slope [1/-]	Trigger
16,300	no

2.2.2. Comments

The PLPs in Hanover Street settled up to approx. 12mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots. Settlement triggers have been breached, as indicated in Table 3. The long-term trend is less than 2mm/year.

The residual risk associated with long-term settlements is considered to be negligible.

2.3. Regent Street PLPs

2.3.1. Data

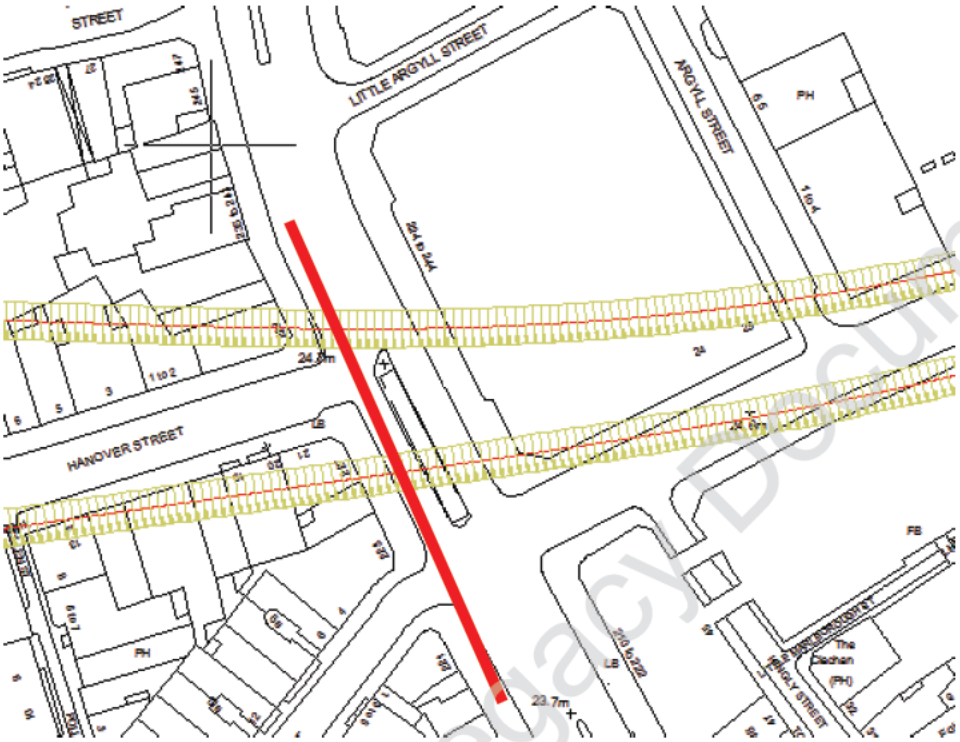


Figure 5: Location

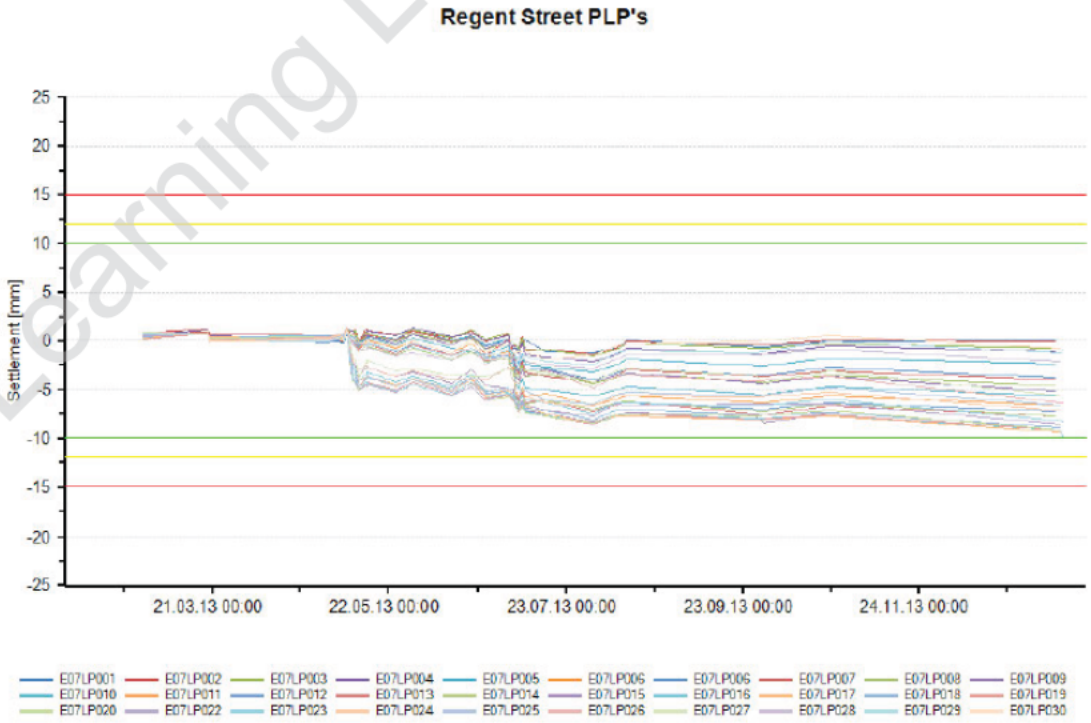


Figure 6: data time-plots - comparison against settlement triggers

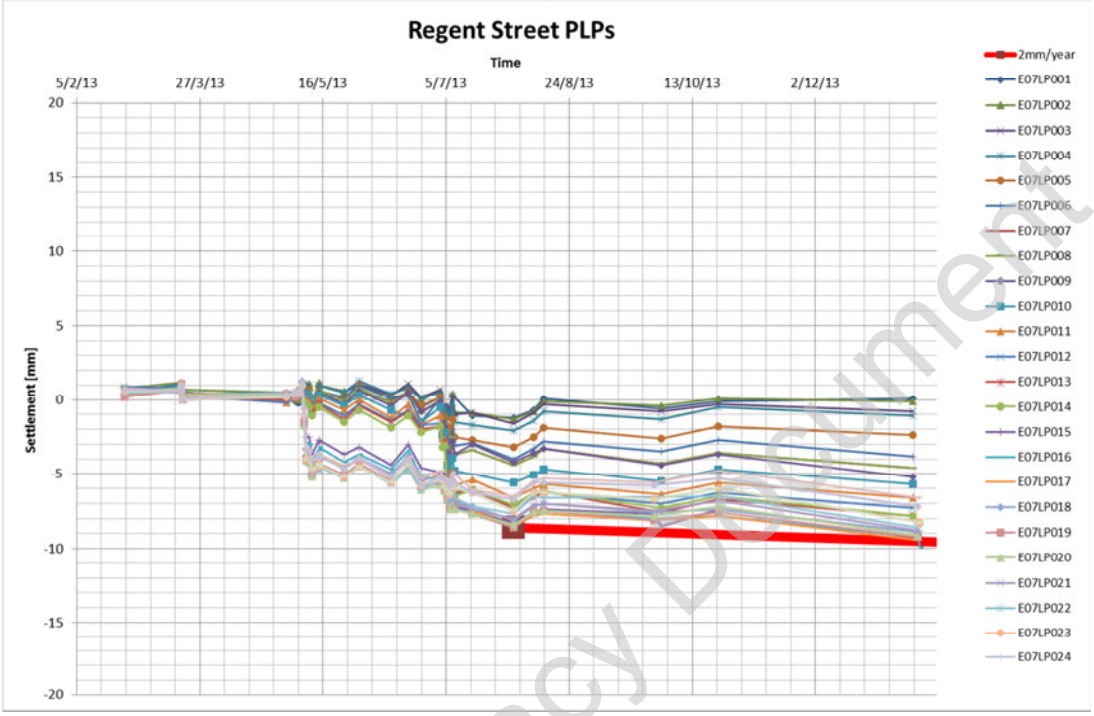


Figure 7: data time-plots - comparison against 2mm/year settlement rate (long-term)

2.3.2. Comments

The PLPs in Regent Street settled up to approx. 8mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots. No settlement trigger has been breached. The long term trend is less than 2mm/year.

The residual risk associated with long-term settlements is considered to be negligible.

2.4. Regent Street / Great Marlborough Street PLPs

2.4.1. Data

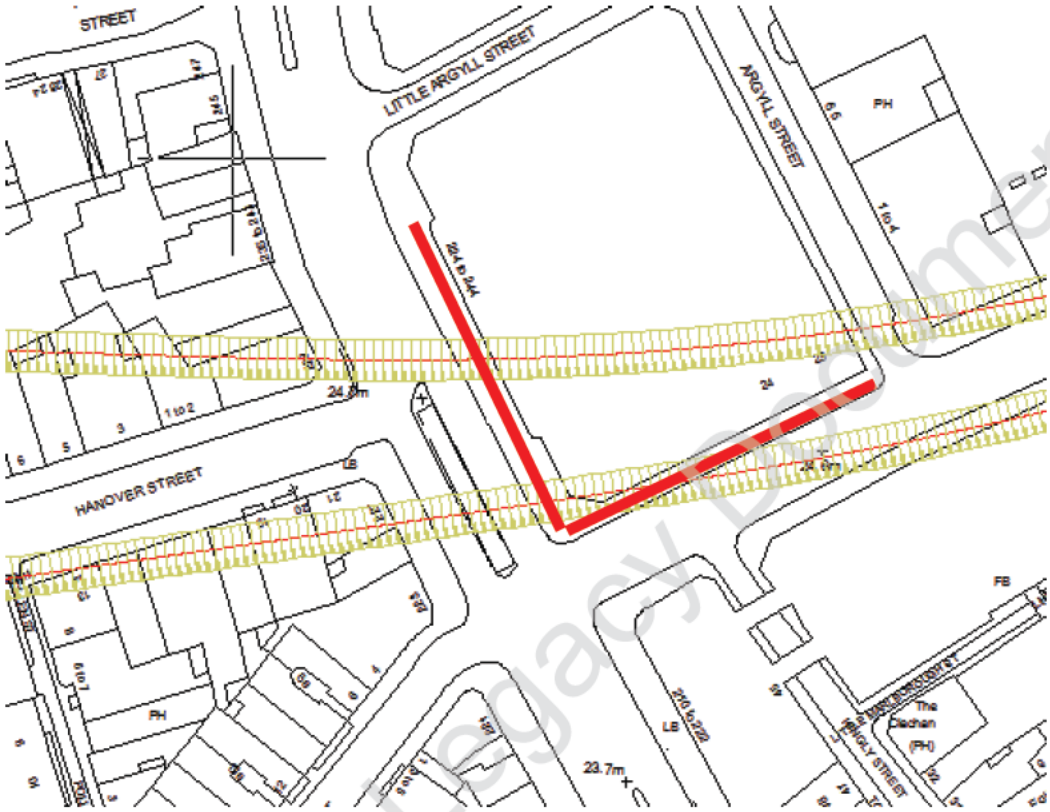


Figure 8: Location

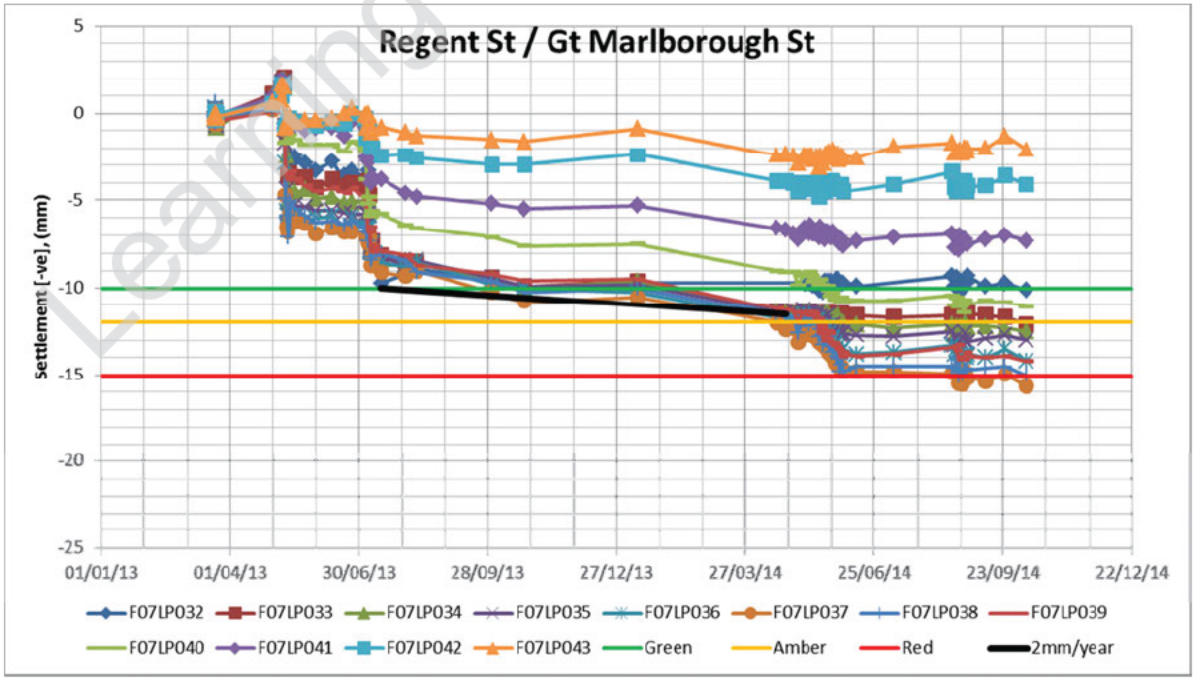


Figure 9: data time-plots - comparison against settlement triggers

Figure 10: not used

Table 4a,b: Achieved Triggers – settlements and deflection ratios (prior to CP4a)

Point Code	Point type	Achieved Trigger
F07LP039	PLP	Green
F07LP038	PLP	Green
F07LP037	PLP	Amber
F07LP036	PLP	Green
F07LP035	PLP	Green
F07LP034	PLP	Green
F07LP033	PLP	Green

Worst case deflection ratio (average of 3 values) [1/-]	Trigger
44,200	no

2.4.2. Comments

The PLPs in Regent Street / Grea Ma lborough Street settled up to approx. 11mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots. Any settlement developed after end of April 2014 is related with the excavation of Cross-Passage 4a (see Section 2.5). The rate of settlement following the running tunnels and prior to the excavation of CP4a was close t the specified value of 2mm / year.

2.5. Cross Passage 4a

The majority of Cross Passage 4a (CP4a) was excavated during May / June 2014. A small back excavation was carried out at the end of August 2014. The following data show the impact during both of these periods.

2.5.1. Data

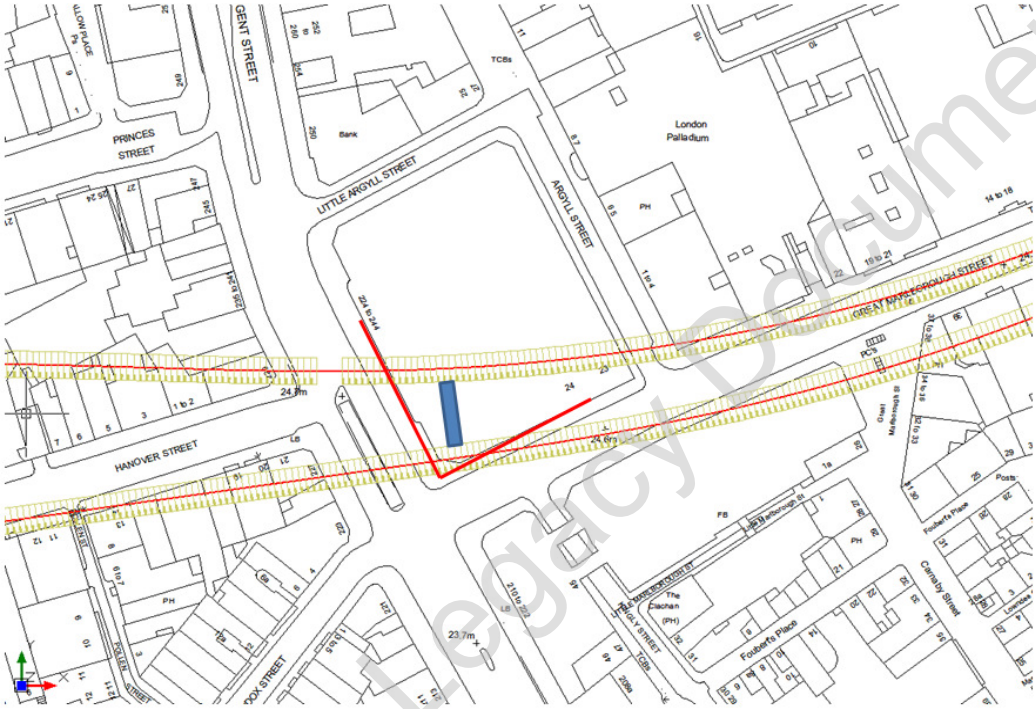


Figure 11: CP4a location

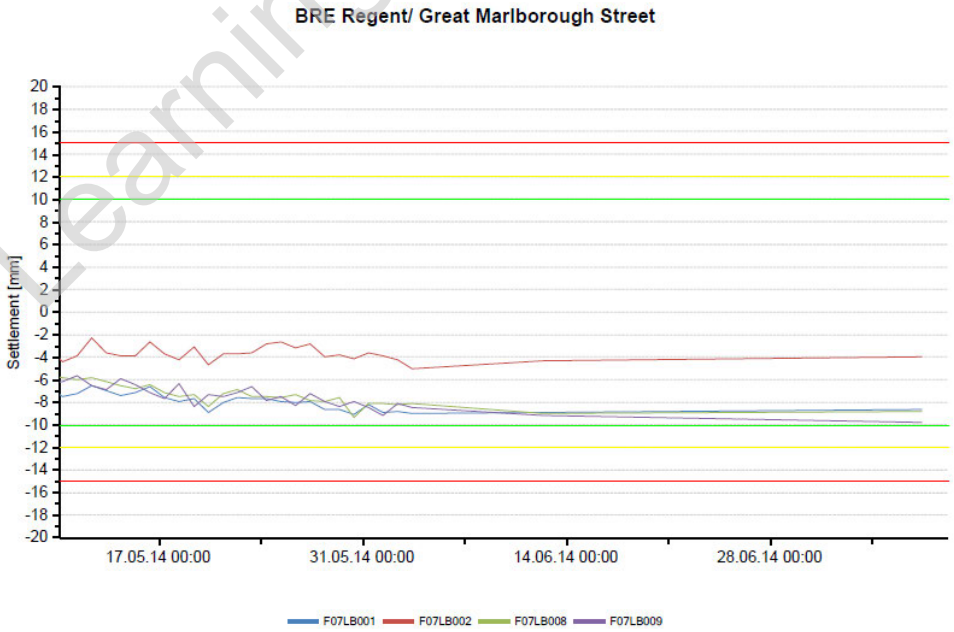


Figure 12: BREs absolute settlements, from CP 4a main excavation

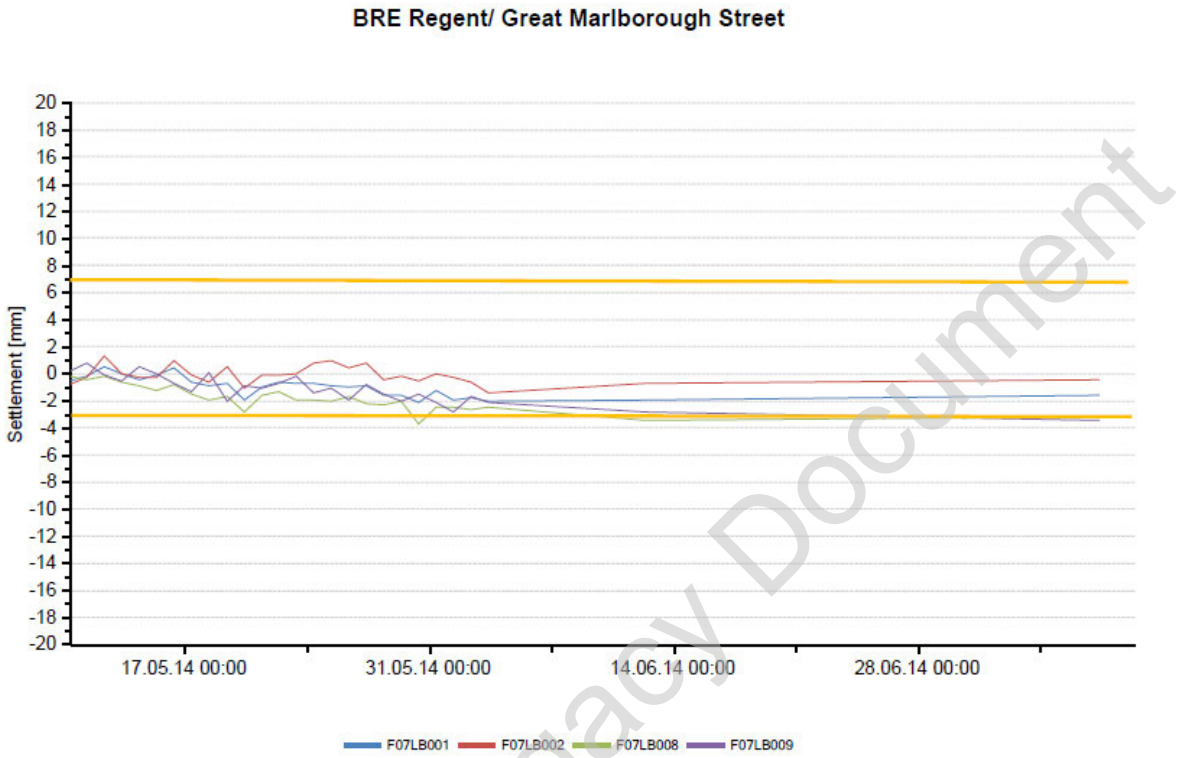


Figure 13: BREs time referenced data, from CP 4a main excavation

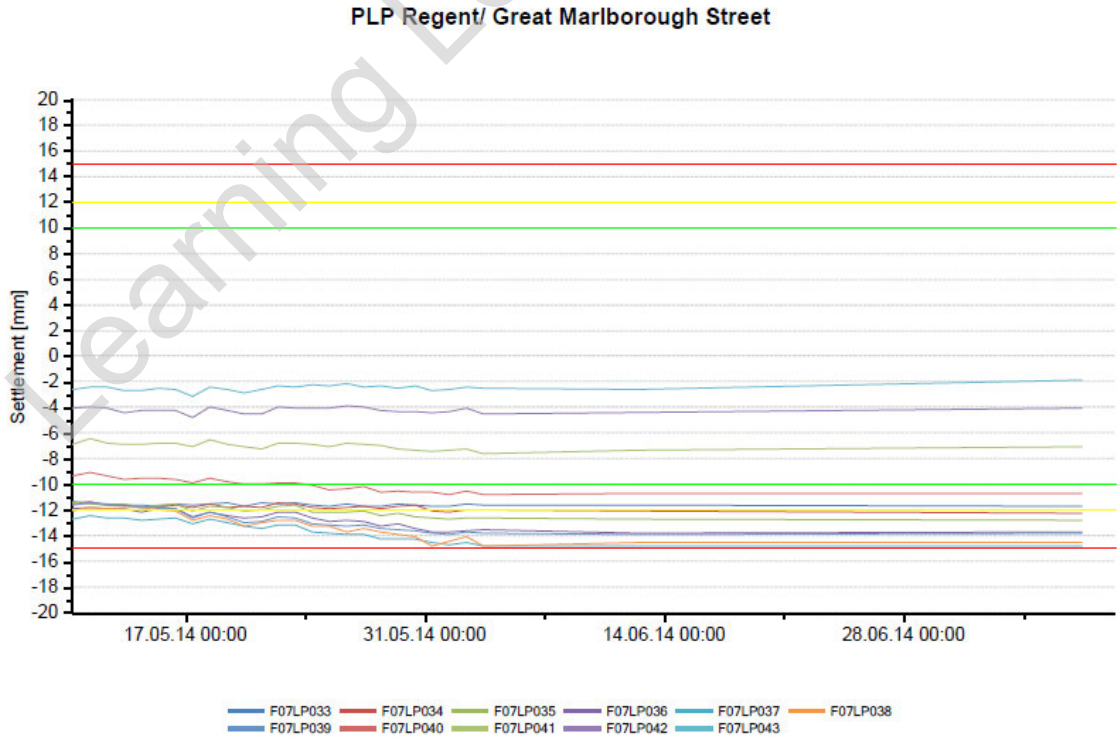


Figure 14: PLPs absolute settlements, from CP 4a main excavation

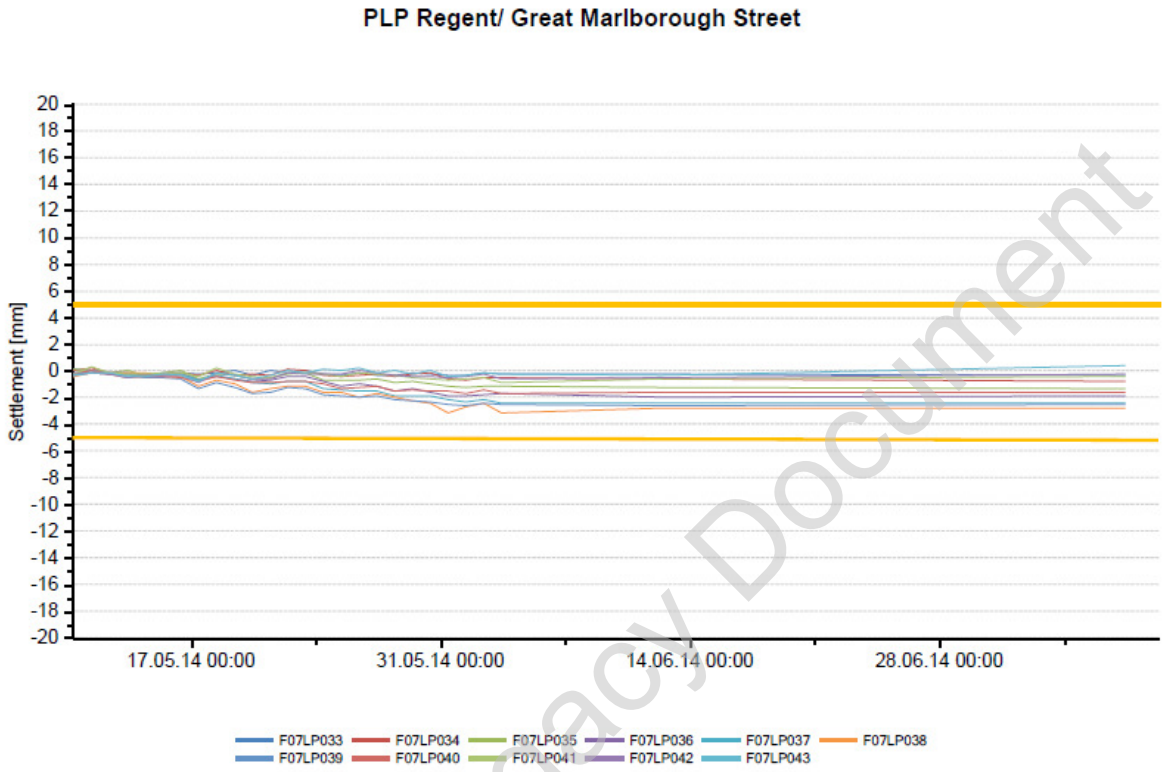


Figure 15: PLPs time referenced data, from CP 4a main excavation

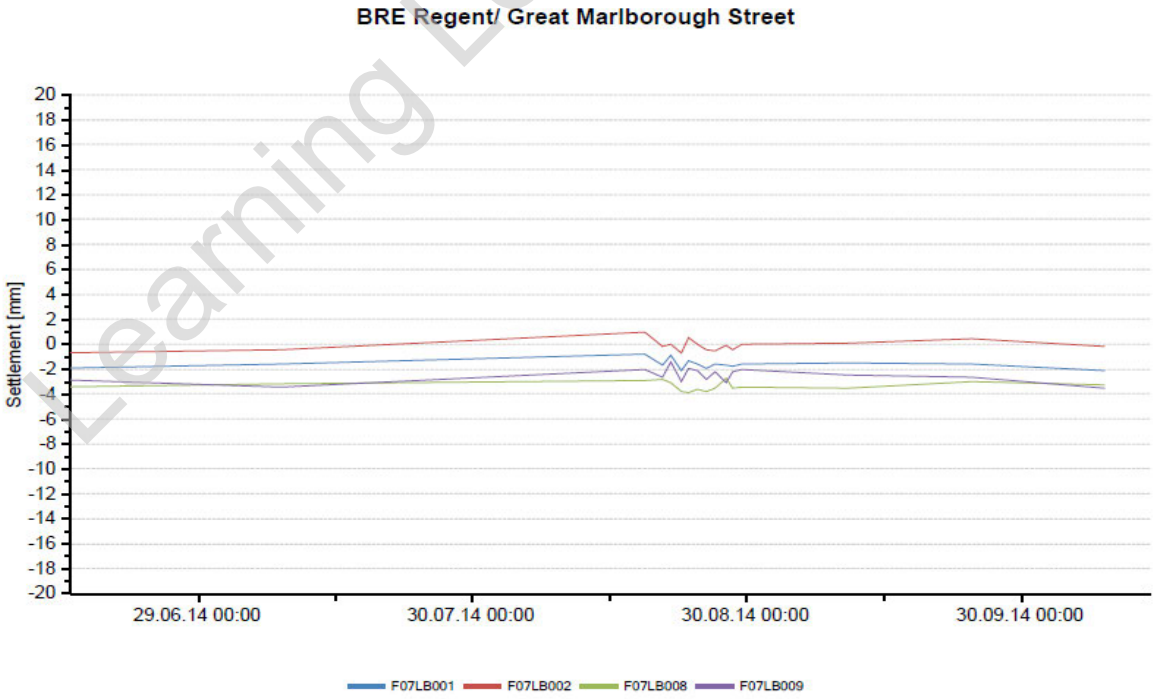


Figure 16: BREs time referenced data, from CP 4a back excavation

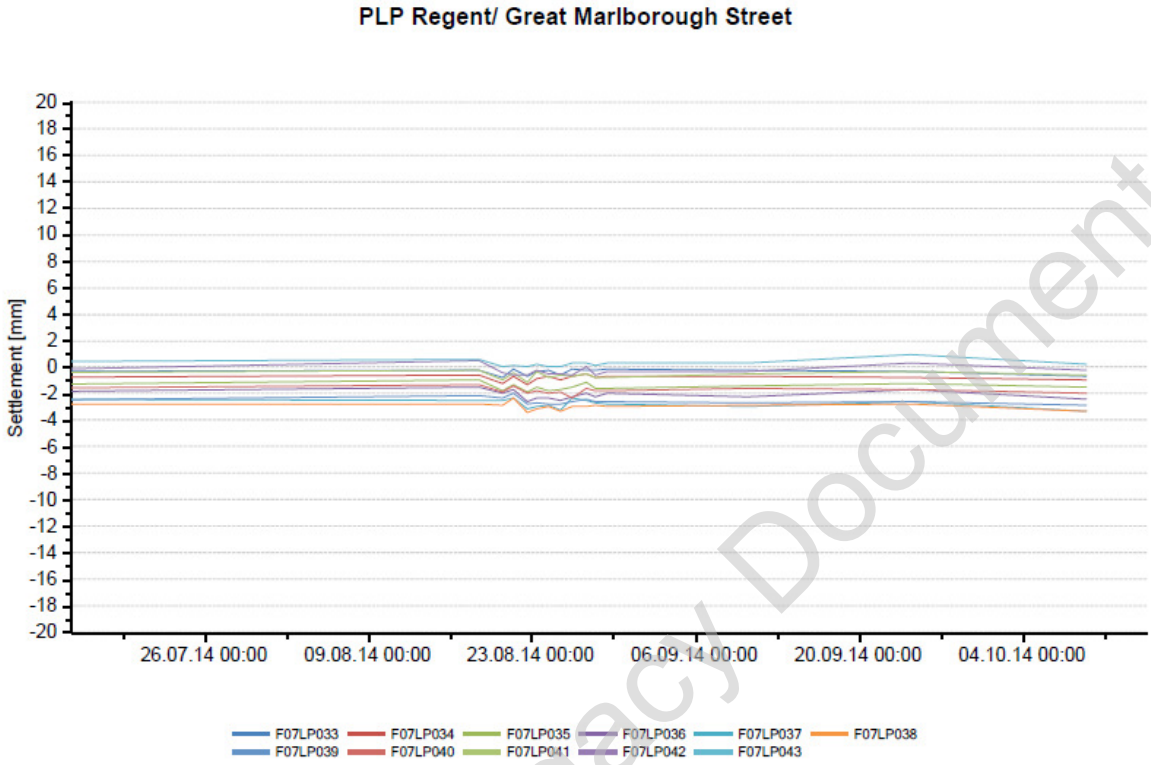


Figure 17: PLPs time referenced data, from CP 4a back excavation

2.5.2. Comment

The maximum settlement due to the CP4a main excavation during May / June 2014 was approx.. 3mm recorded on both PLPs and BREs. The effect of the back excavation was negligible in August 2014. The post works behavior is stable. The associated residual risk is considered to be negligible.

The impact of the running tunnels and the CP4a works (both main excavation and back excavation) on the nearby LU Bakerloo and Victoria lines running tunnels is given in Appendix 6.

2.6. Argyll Street PLPs

2.6.1. Data

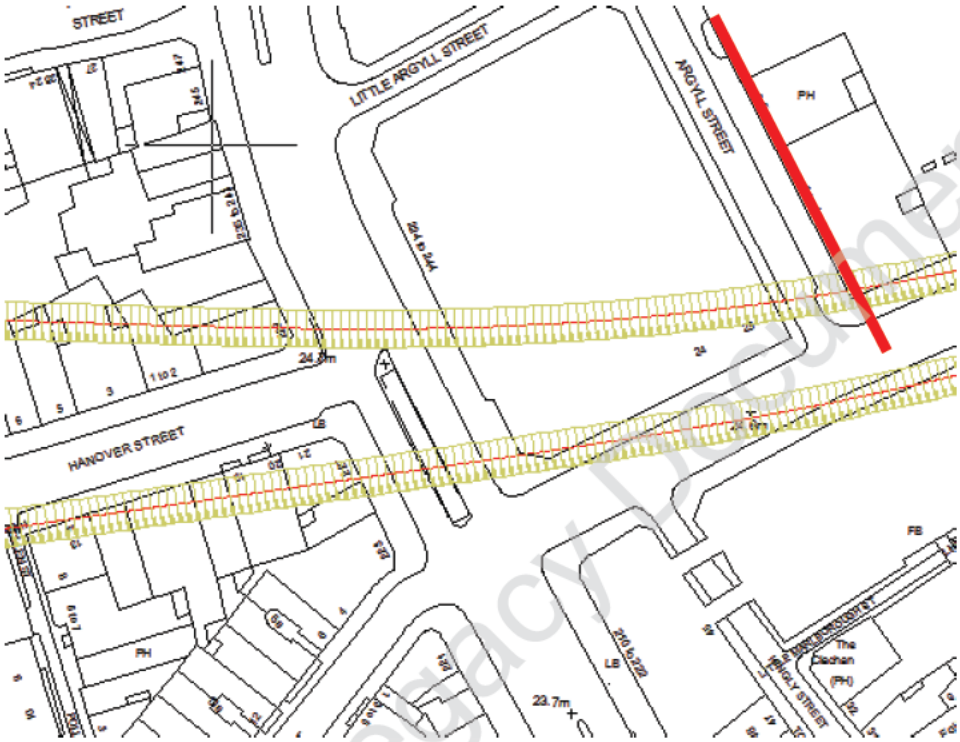


Figure 18: Location

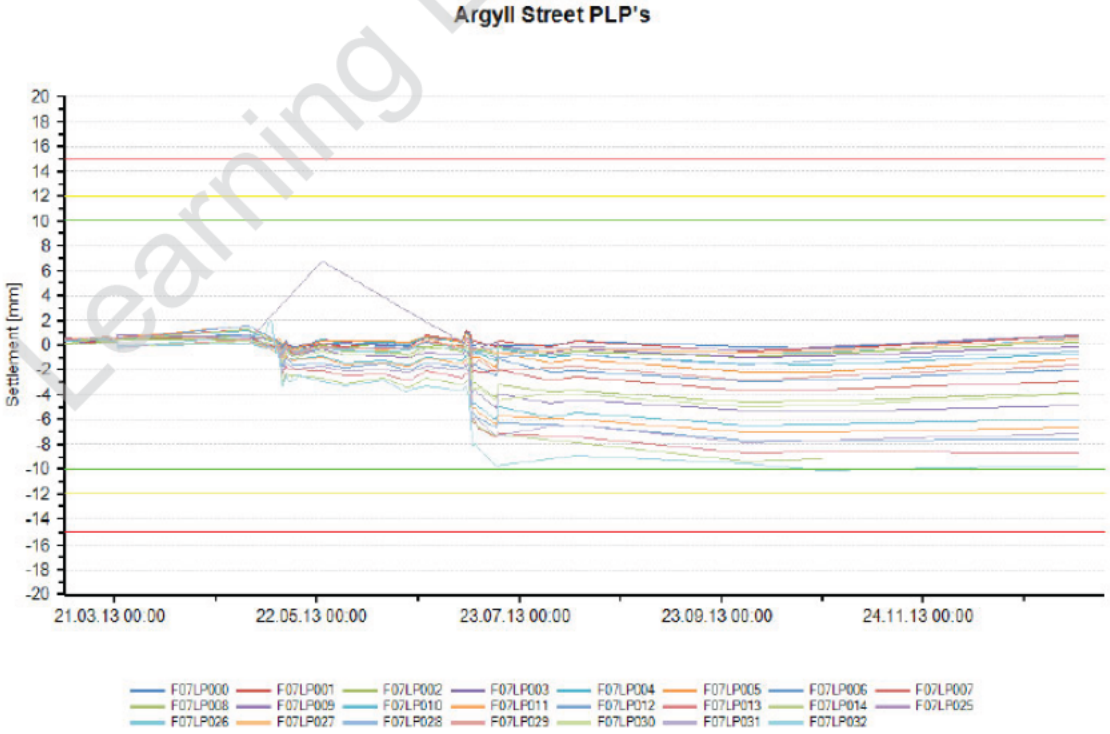


Figure 19: data time-plots - comparison against settlement triggers

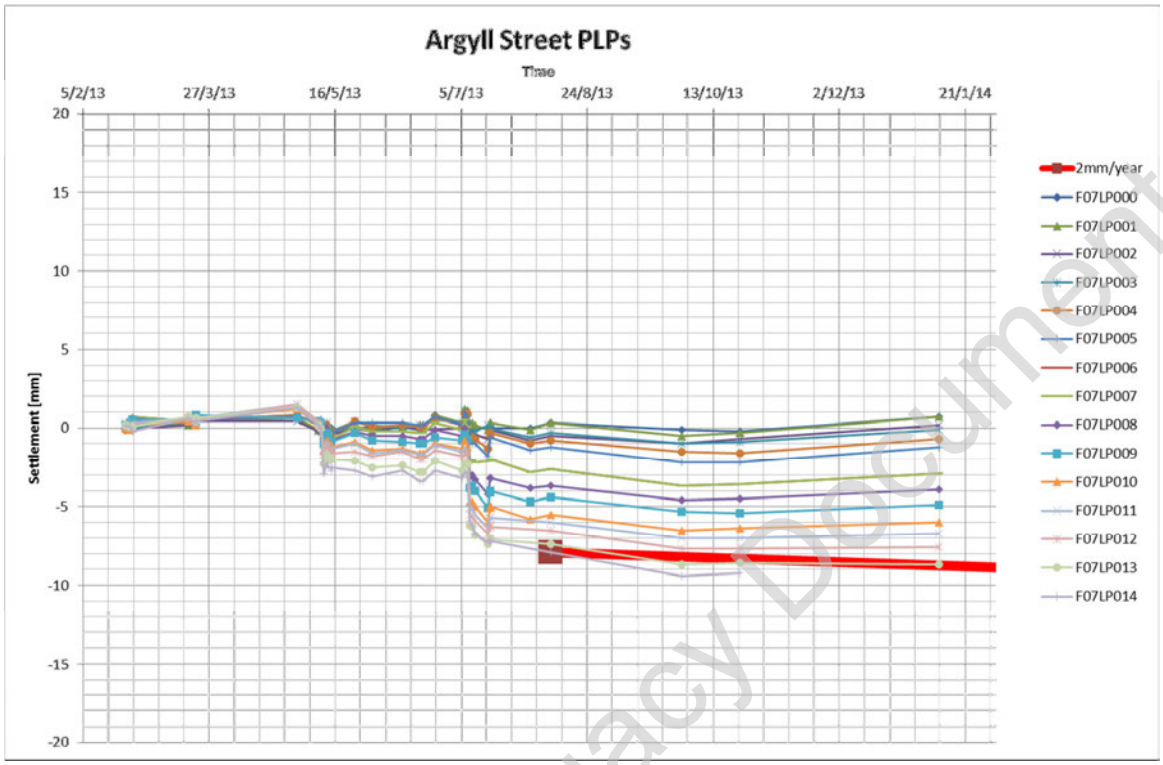


Figure 20: data time-plots - comparison against 2mm/year set lement rate (long-term)

2.6.2. Comments

The PLPs in Argyll Street settled up to approx. 9mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots. No settlement trigger has been breached. The long term rate of settlement is less than 2mm/year.

The residual risk assoc ated with long-term settlements is considered to be negligible.

2.7. 31-38 Great Marlborough Street PLPs and BREs

2.7.1. Data

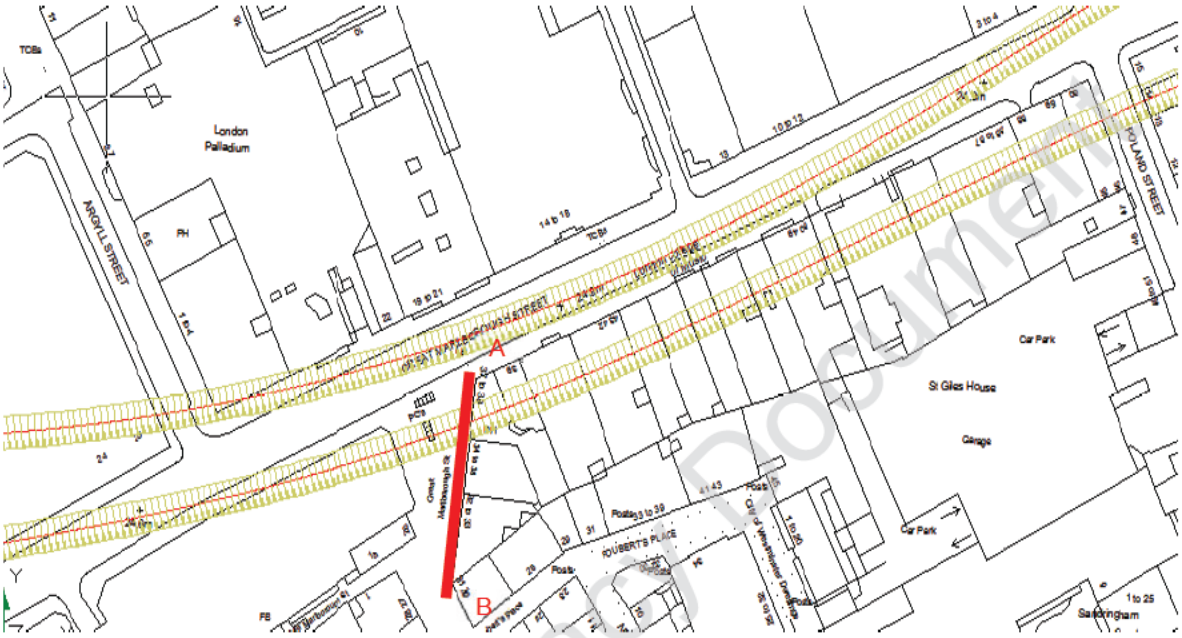
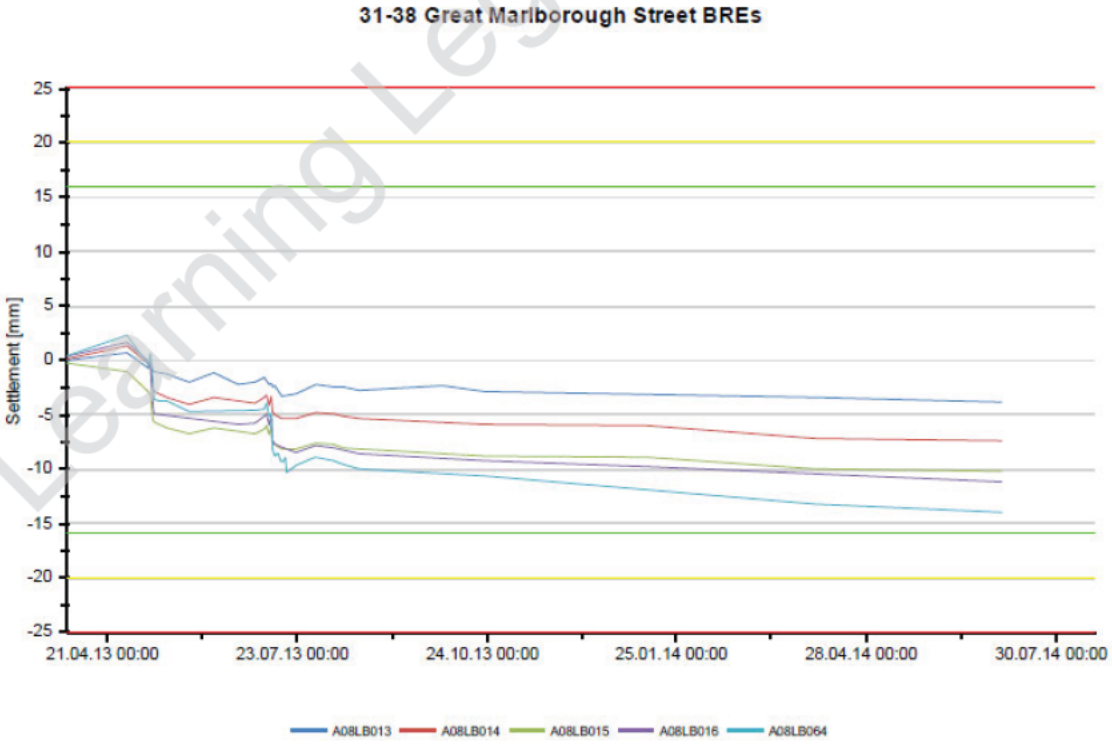


Figure 21: Location



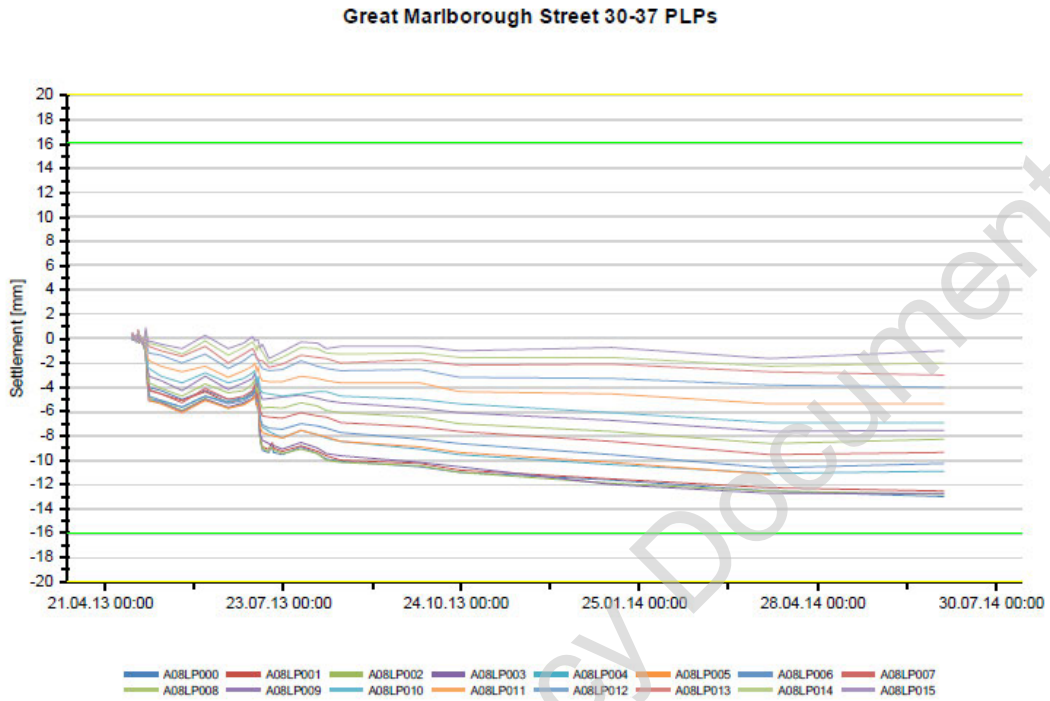
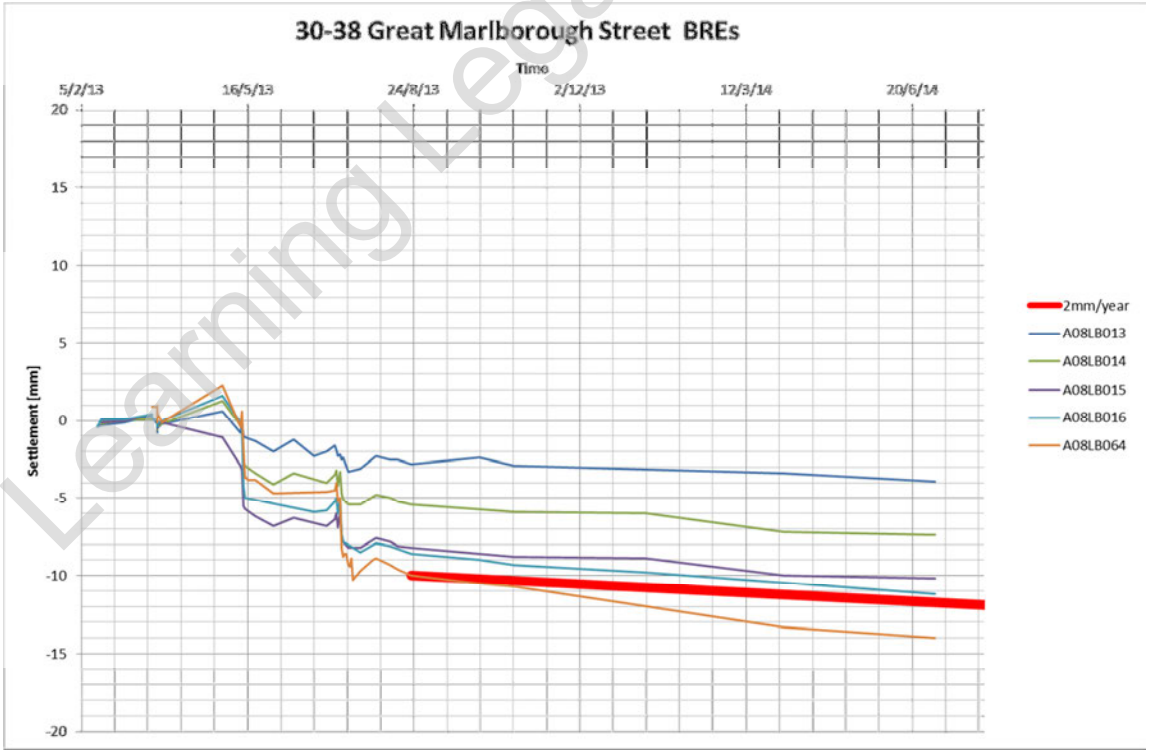


Figure 22a,b: data time-plots - comparison against settlement trigger



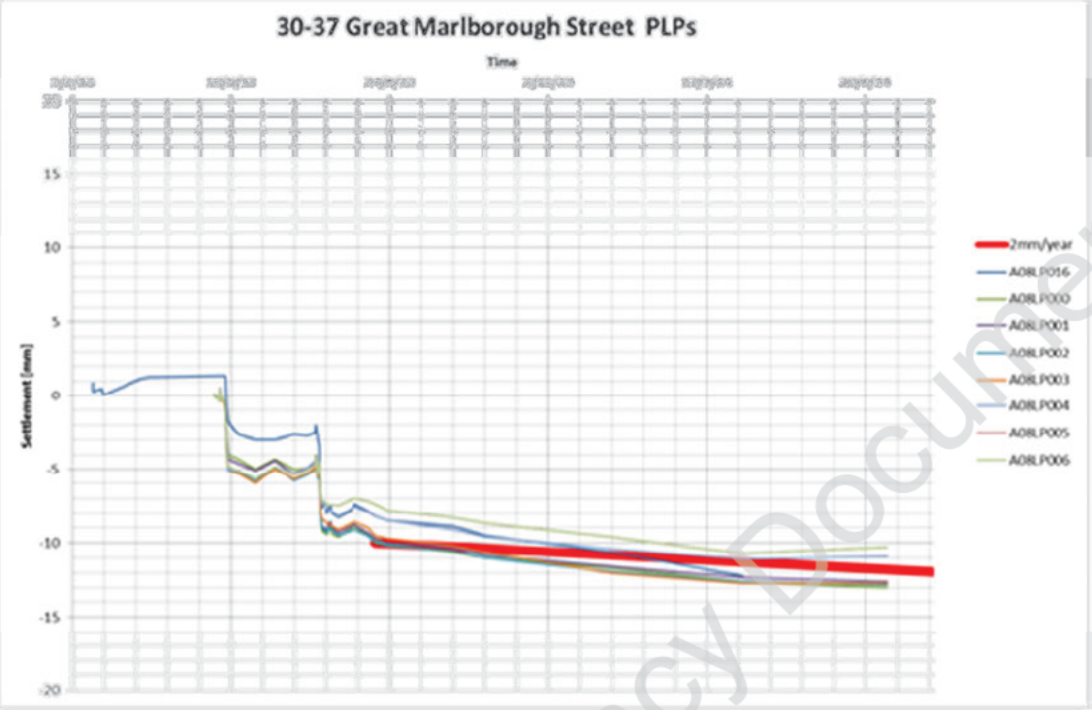


Figure 23 a,b: data time-plots - comparison against 2mm/year settlement rate (long-term)

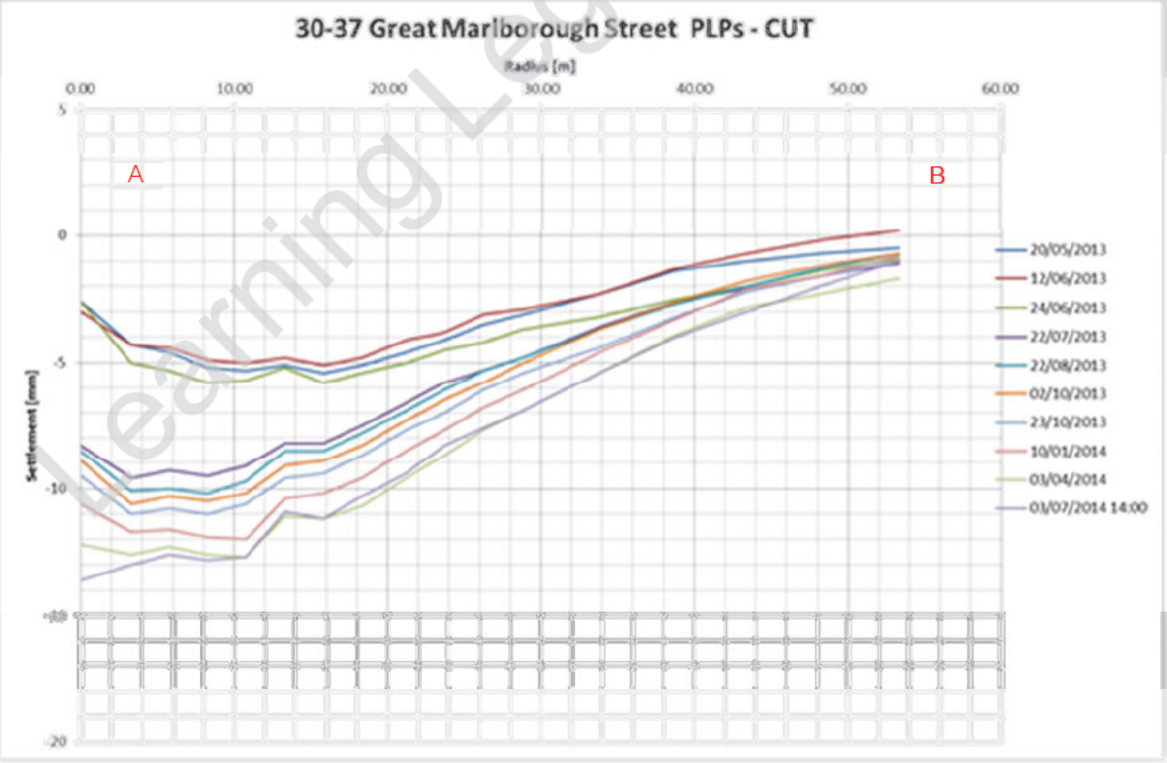


Figure 24: cut

Worst case deflection ratio on 30-37 Great Marlborough street PLPs (average of 3 values) [1/-]	Trigger
6,300	no

2.7.2. Comments

The PLP and BRE on and adjacent to 30 – 38 Great Marlborough Street settled up to approx. 13mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots. No settlement trigger has been breached.

The time-plots and the cuts are showing stabilising settlement trend, and the long term average appears to be slightly over 2mm/year. The latest measurements show a trend approaching stability.

2.8. 39-60 Great Marlborough Street PLPs

2.8.1. Data

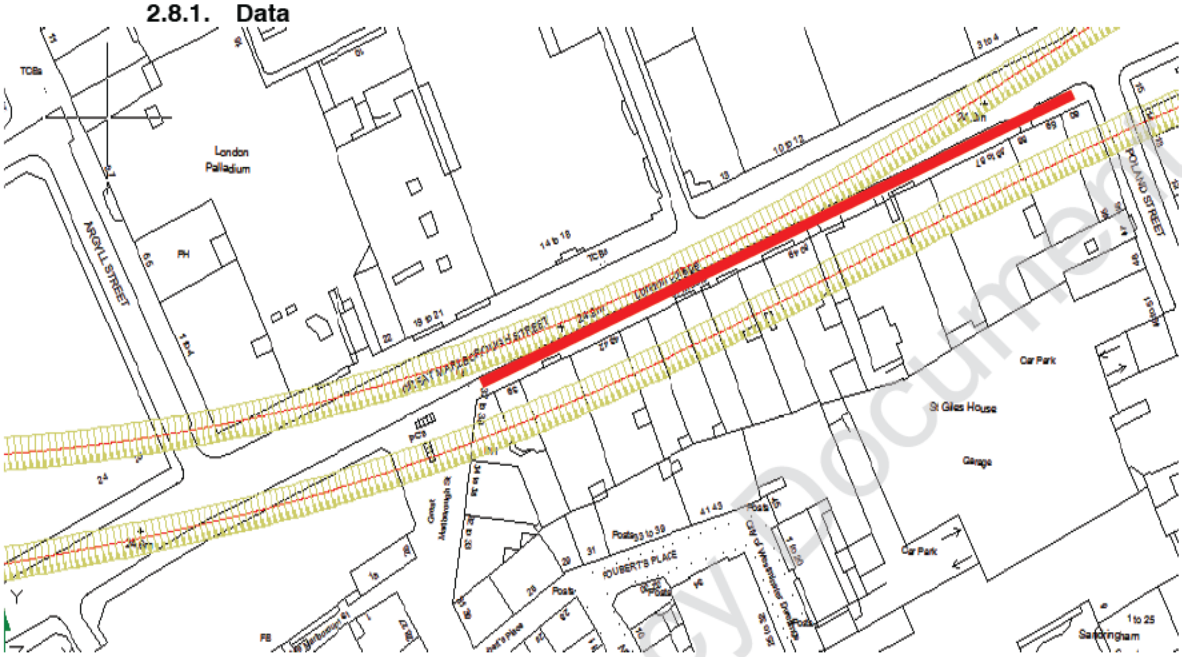


Figure 20: Location

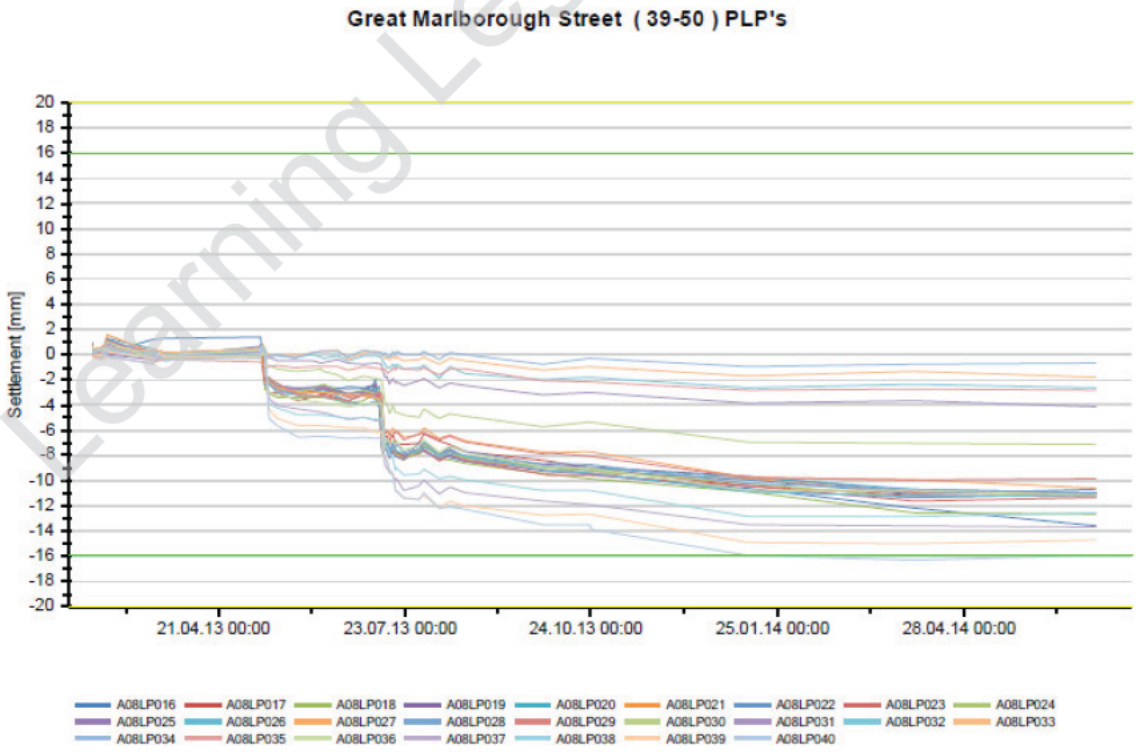


Figure 21: data time-plots - comparison against settlement triggers

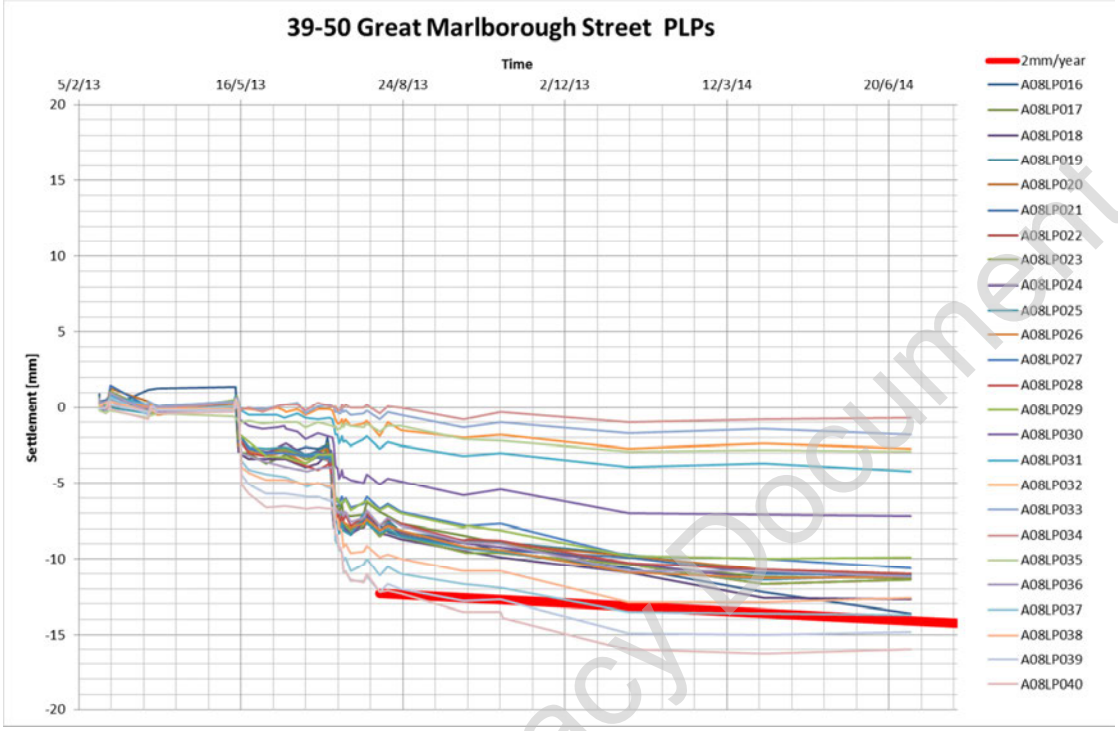


Figure 22: data time-plots - comparison against 2mm/year settlement rate (long-term)

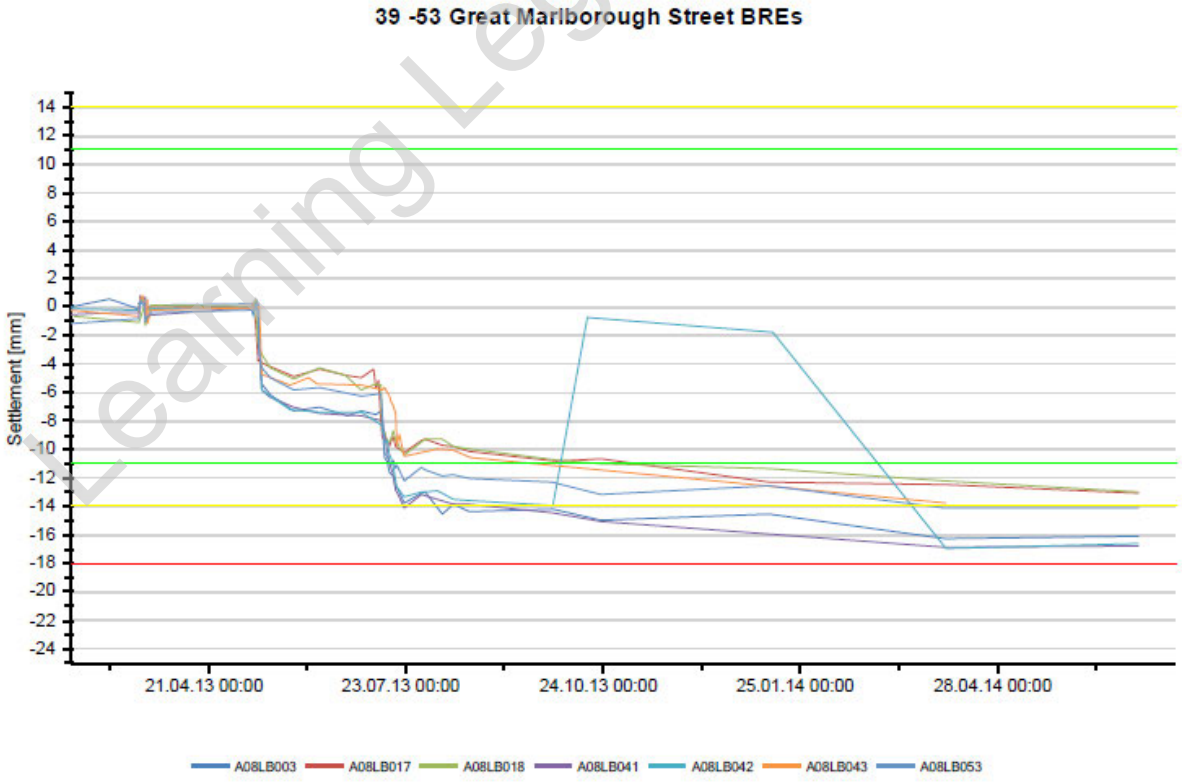


Figure 23: data time-plots - comparison against settlement triggers

Table 5a,b: Achieved Triggers – settlements, deflections, slopes

Point Code	Point type	Achieved Trigger
A08LB003	BRE	Amber
A08LB041	BRE	Amber
A08LB042	BRE	Amber
A08LB043	BRE	Green
A08LB074	BRE	Green
A08LB022	BRE	Green
A08LB023	BRE	Green
A08LP040	PLP	Green

Worst case deflection ratio (average of 3 values) [1/-]	Trigger
7,900	no

Worst case slope [1 -]	Trigger
5,500	no

2.8.2. Comments

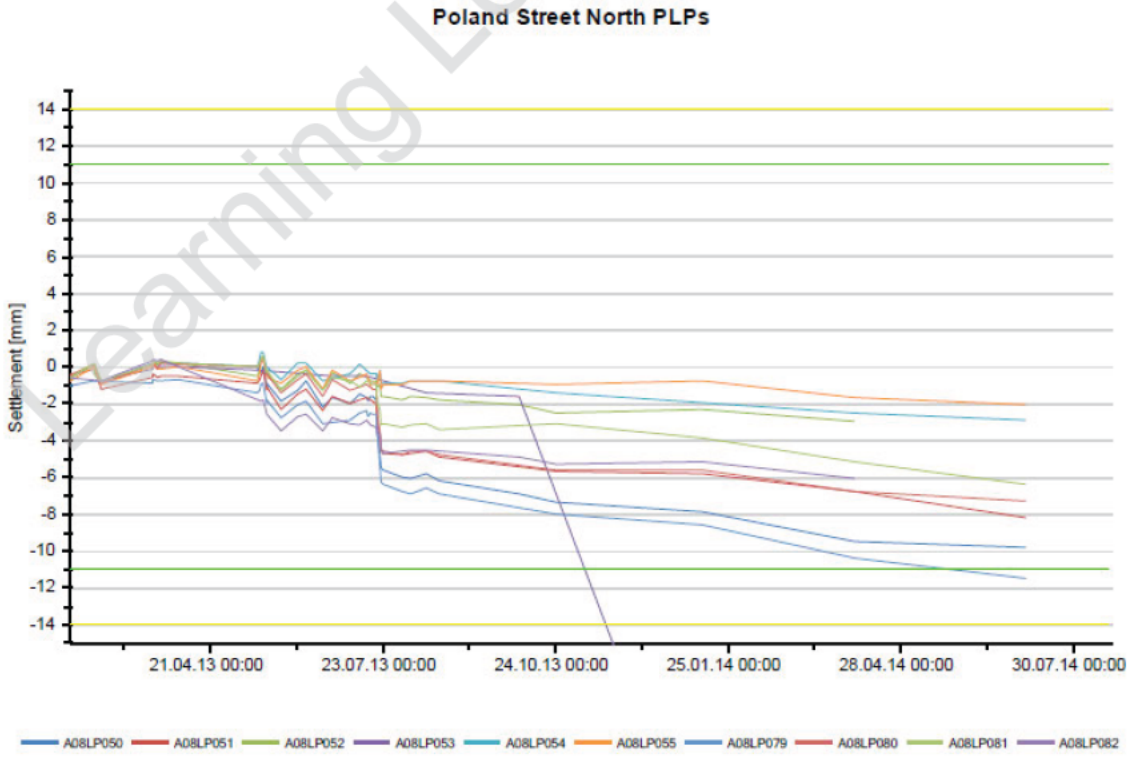
The BRE and PLP on and adjacent to 39-50 Great Marlborough Street settled up to approx. 17mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots. Five points breached settlement green trigger and three the amber trigger.

The time-plots and the cuts are showing on-going settlements, and the long term behaviour appears to be slightly over the 2mm/year, but with a trend to a reducing rate with time.

2.9. Poland Street PLPs

2.9.1. Data

Figure 24: Location



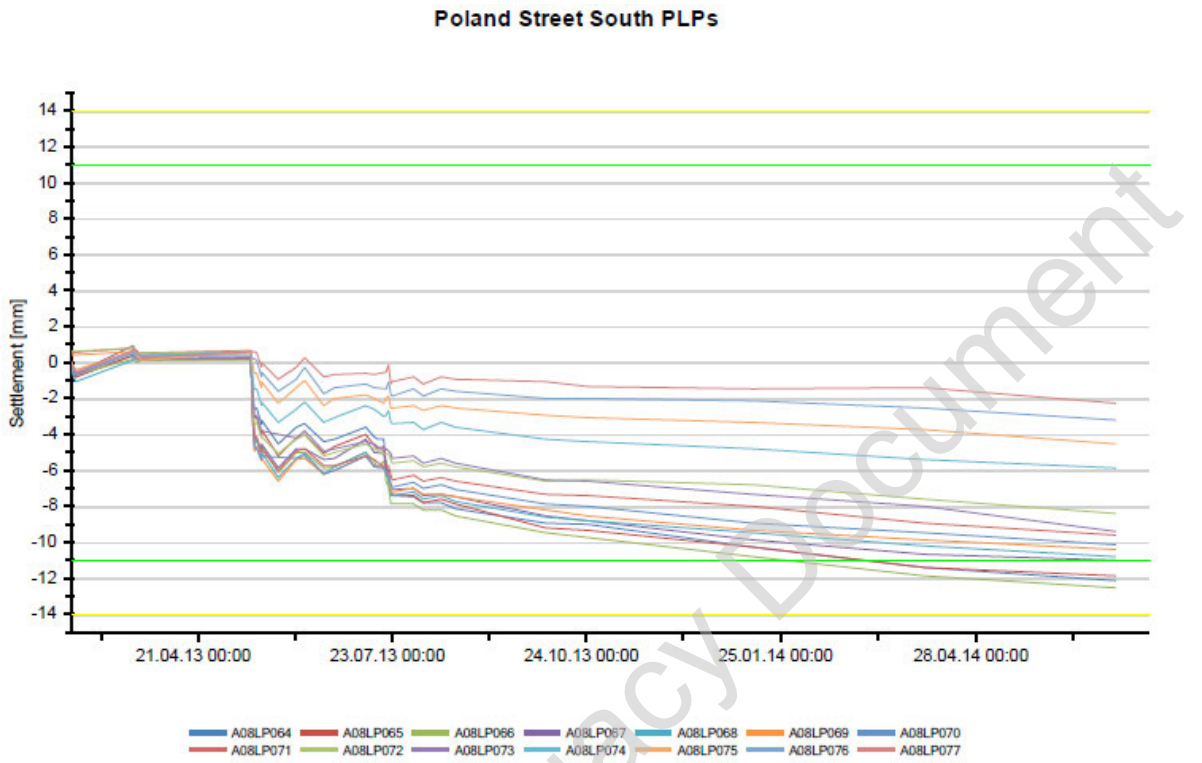


Figure 25a,b: data time-plots - comparison against settlement triggers

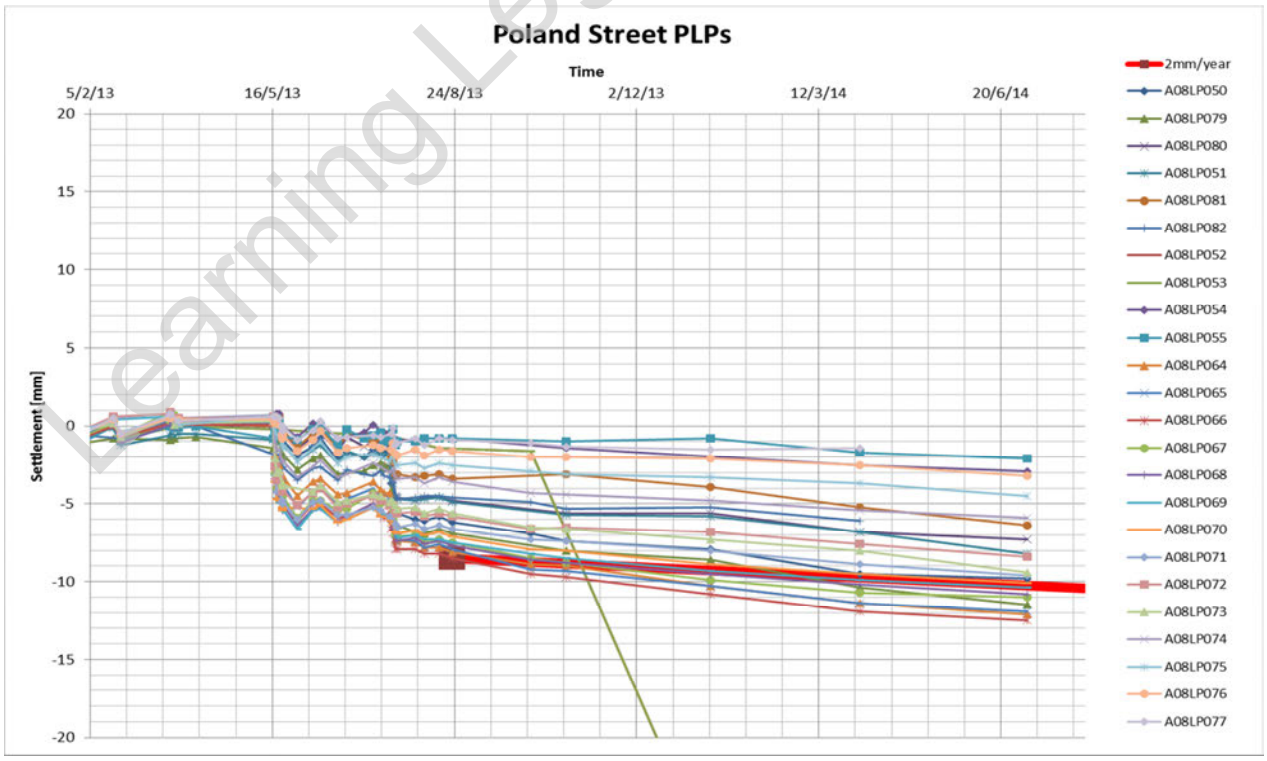


Figure 26: data time-plots - comparison against 2mm/year settlement rate (long-term)

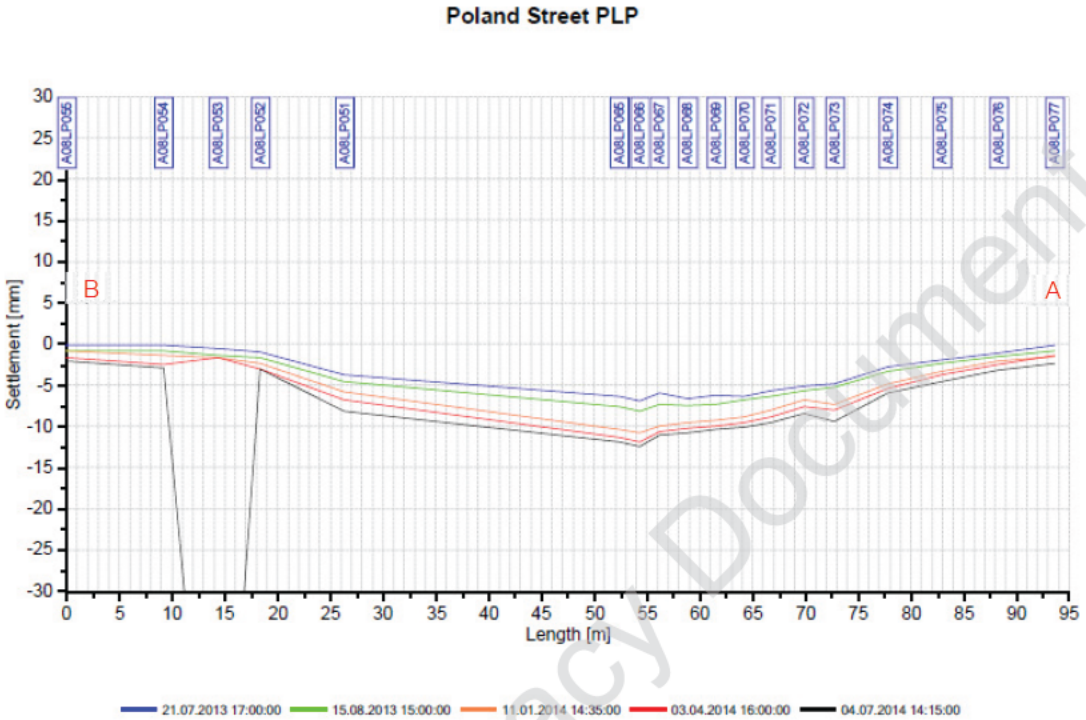


Figure 27: Poland Street cut

Table 6a,b: Achieved Triggers – settlements, deflections, slopes

Point Code	Point type	Achieved Trigger
A08LP064	PLP	Green
A08LP065	PLP	Green
A08LP066	PLP	Green
A08LP079	PLP	Green
A08LB085	BRE	Green

Worst case deflection ratio (average of 3 values) [1/-]	Trigger
2'500	no

2.9.2. Comments

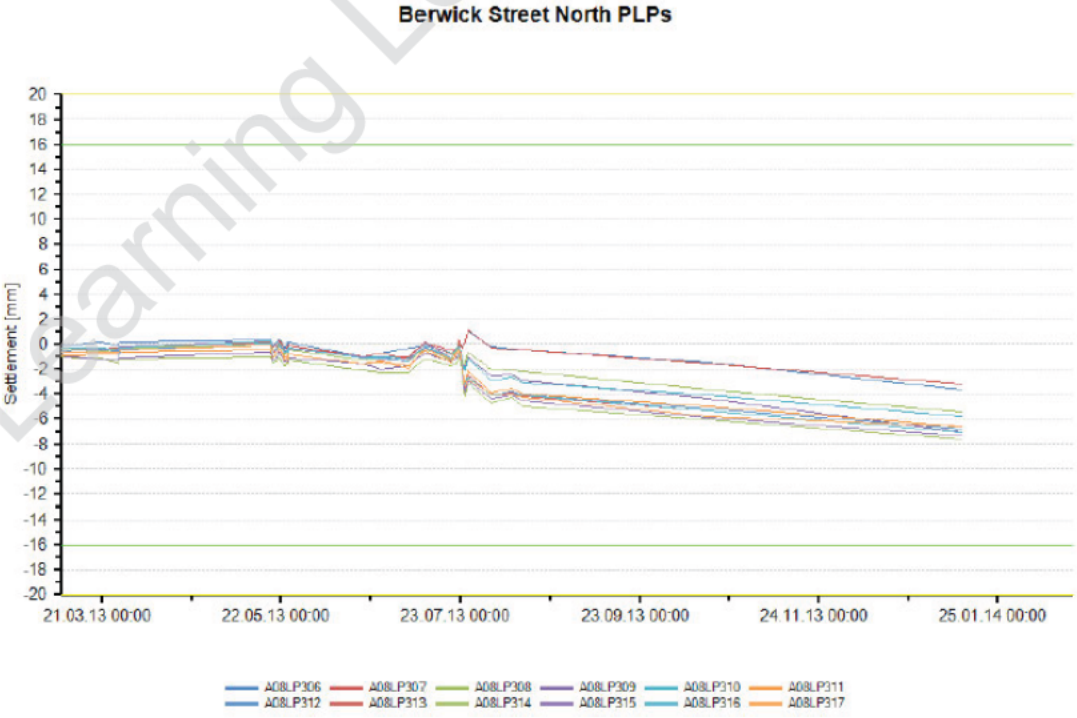
The PLPs in Poland Street settled up to approx. 12mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots. Four points breached settlement green trigger.

The time-plots and the cuts are showing on-going settlements, and the long term behaviour appears to be slightly over the 2mm/year, but with a trend to a reducing rate with time.

2.10. Berwick Street PLPs

2.10.1. Data

Figure 28: Location



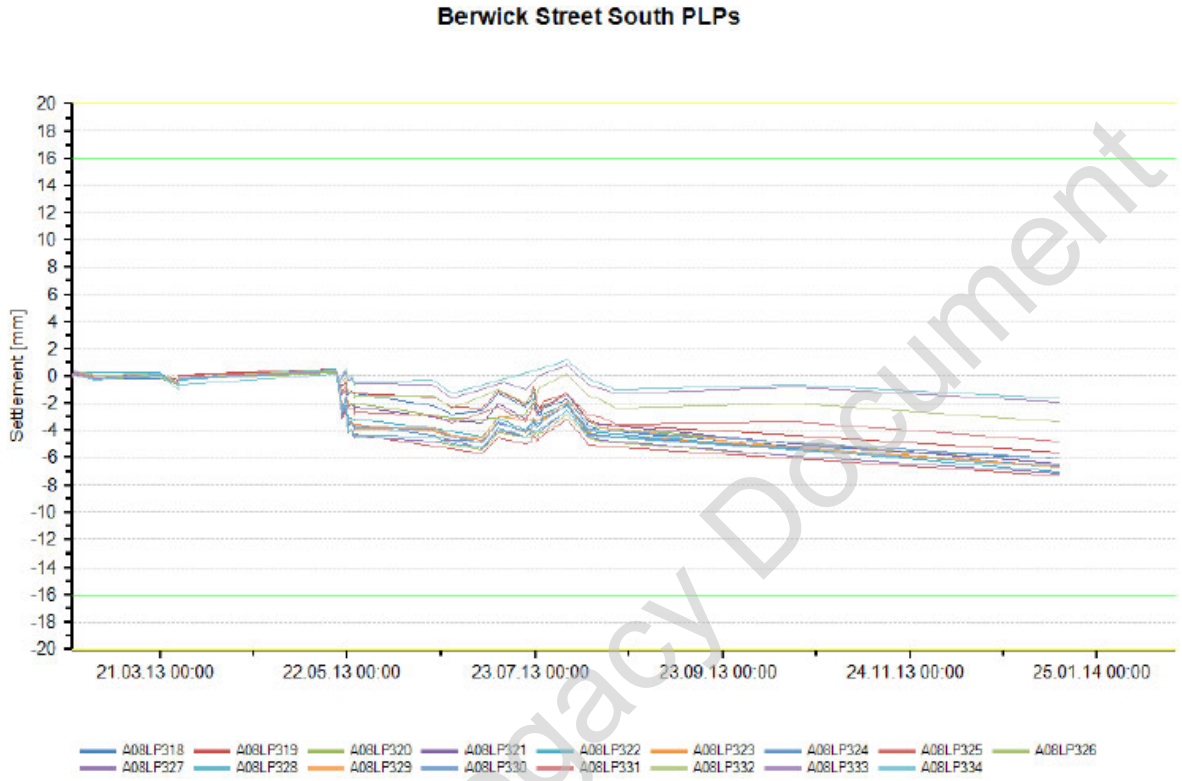


Figure 29a,b: data time-plots - comparison against settlement triggers

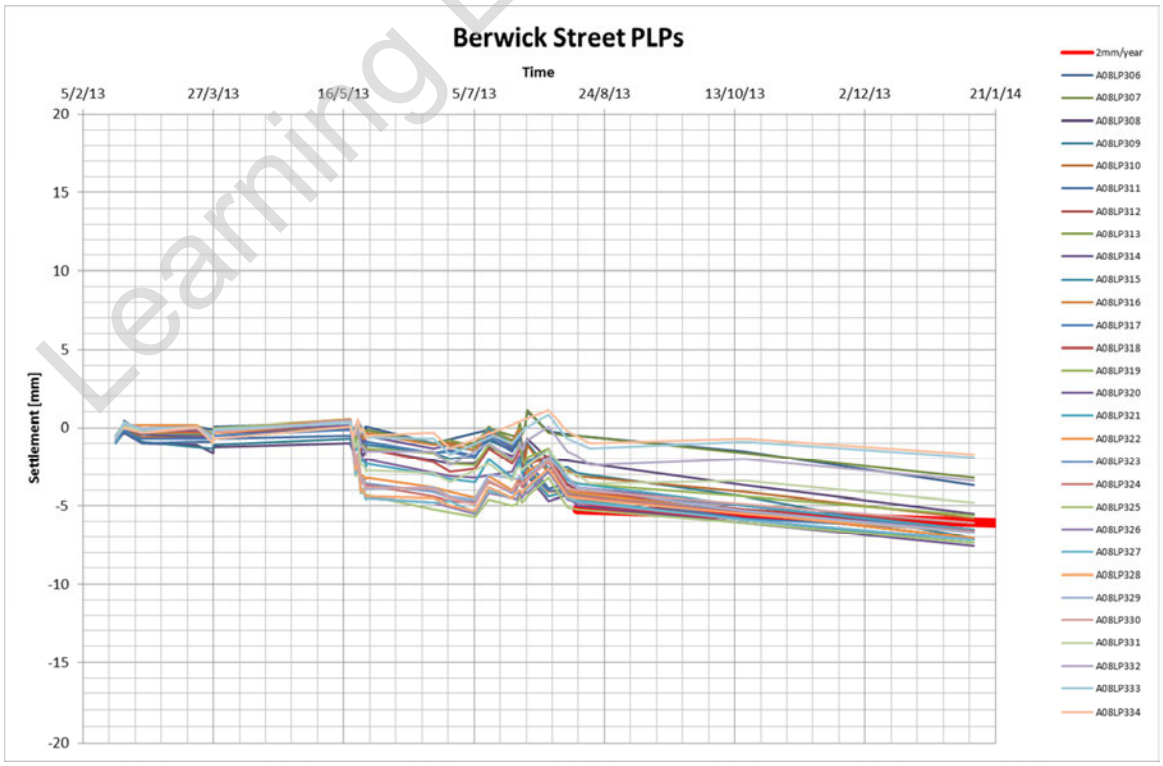


Figure 30: data time-plots - comparison against 2mm/year settlement rate (long-term)

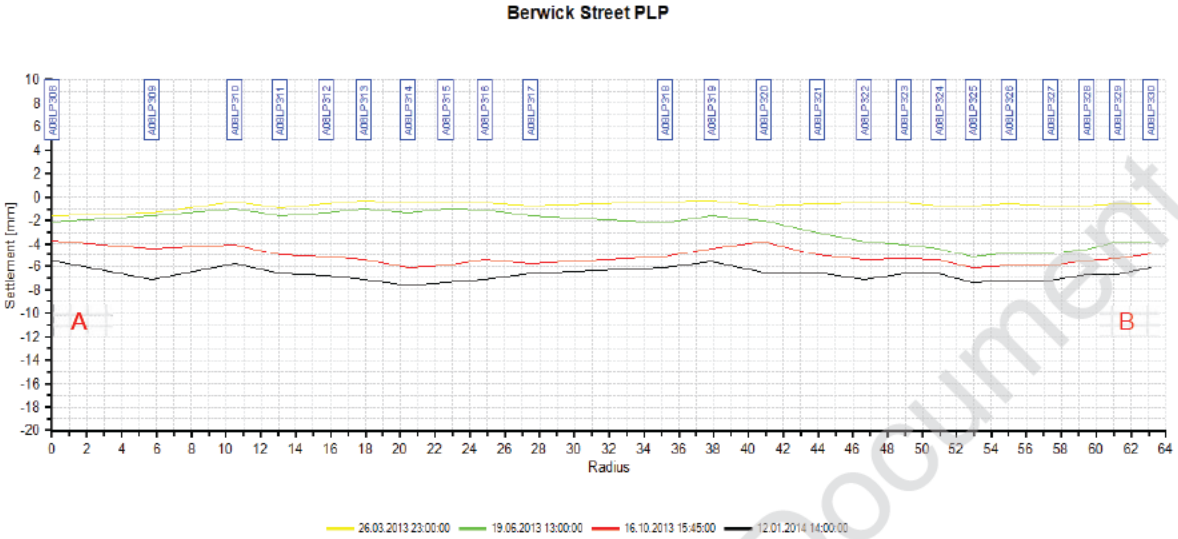


Figure 31: Berwick Street cut

Table 7: Achieved Triggers –deflection ratio

Worst case deflection ratio (average of 3 values) [1/-]	Trigger
1.07E+04	no

2.10.2. Comments

The PLPs in Berwick Street settled up to approx. 7mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs is visible from the settlement time-plots.

The time-plots are showing slight on-going settlements: the long-term settlement rate is slightly over 2mm/year, but all the points of the section are moving together: this suggests an ambient temperature related behaviour, not connected with C300 running tunnels excavation. Taking into account the small total settlement achieved (approx.7mm) after the passage of the EB and WB TBMs, the residual risk is negligible.

2.11. Wardour Street PLPs

2.11.1. Data

Figure 32: Location

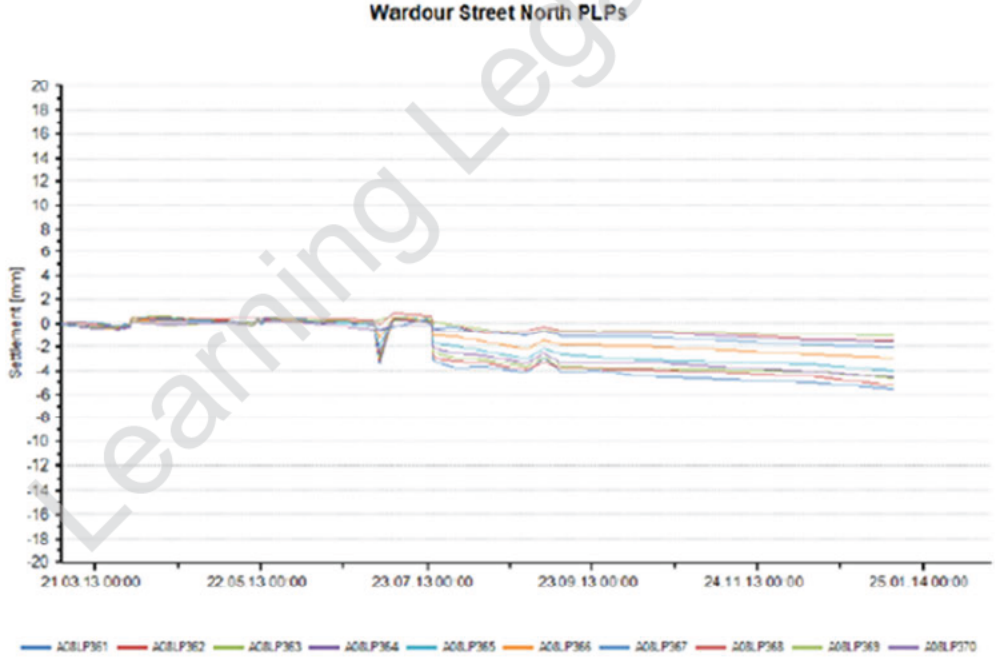


Figure 33a: data time-plots - comparison against settlement triggers

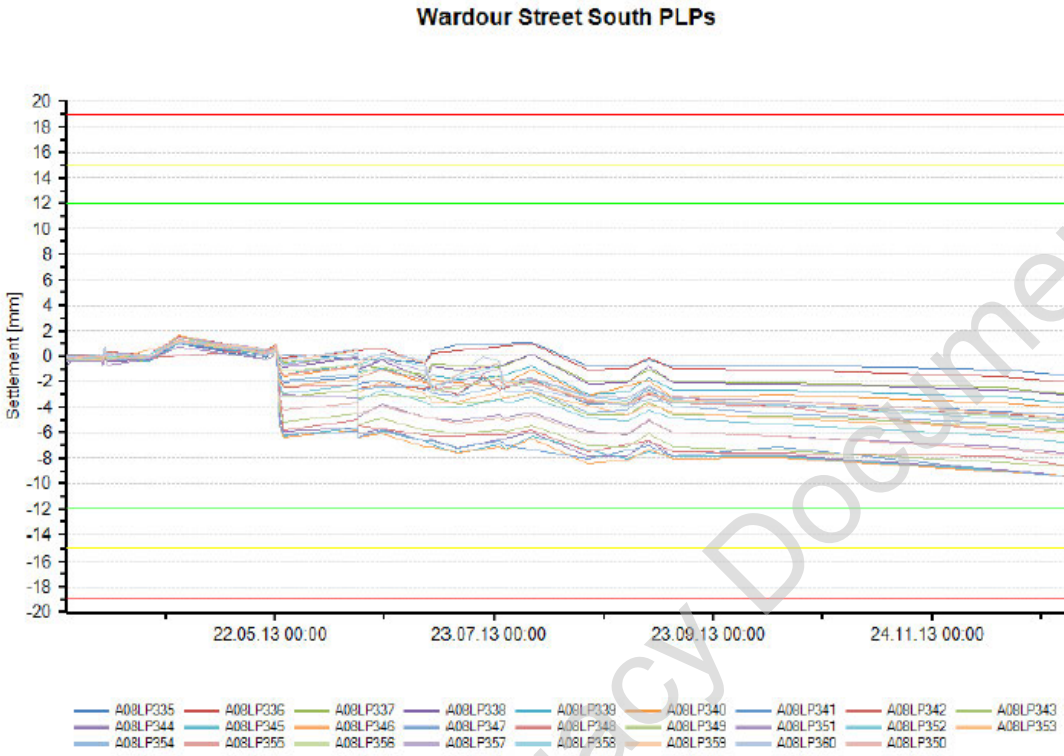


Figure 33b: data time-plots - comparison against settlement triggers

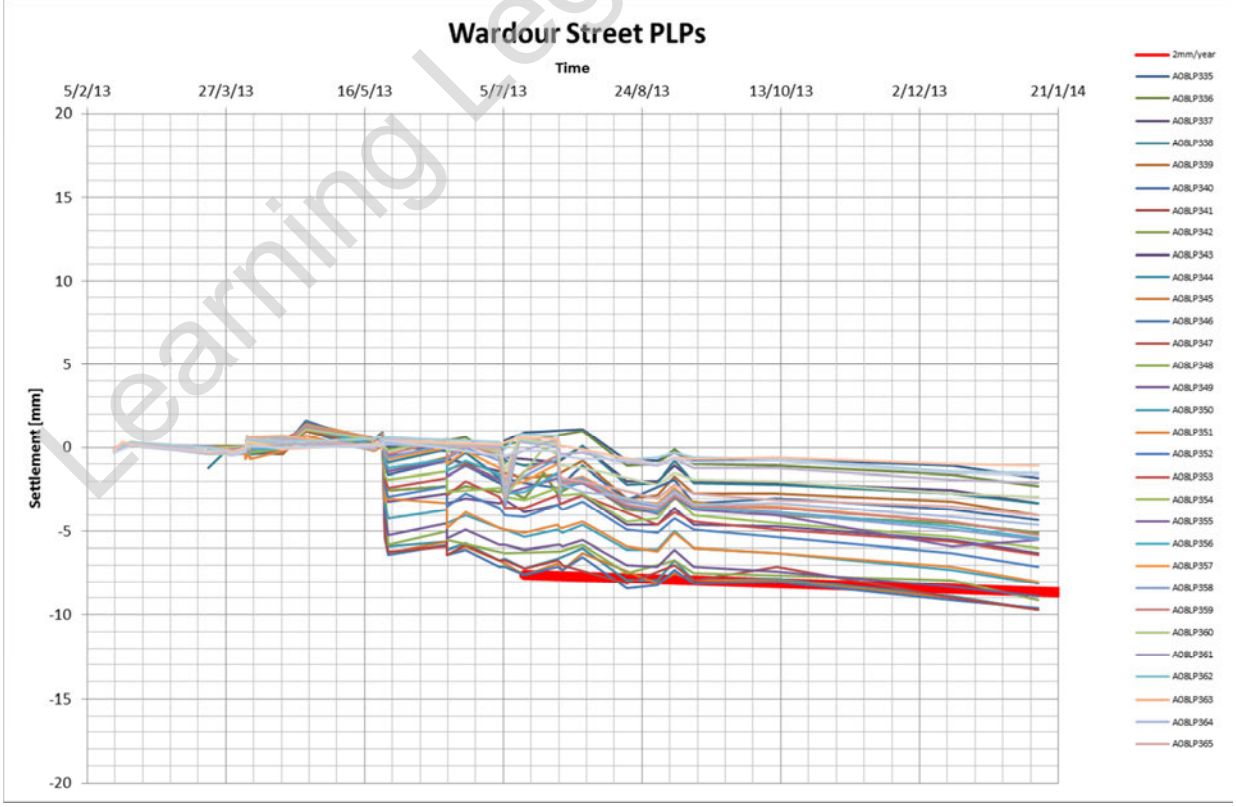


Figure 34: data time-plots - comparison against 2mm/year settlement rate (long-term)

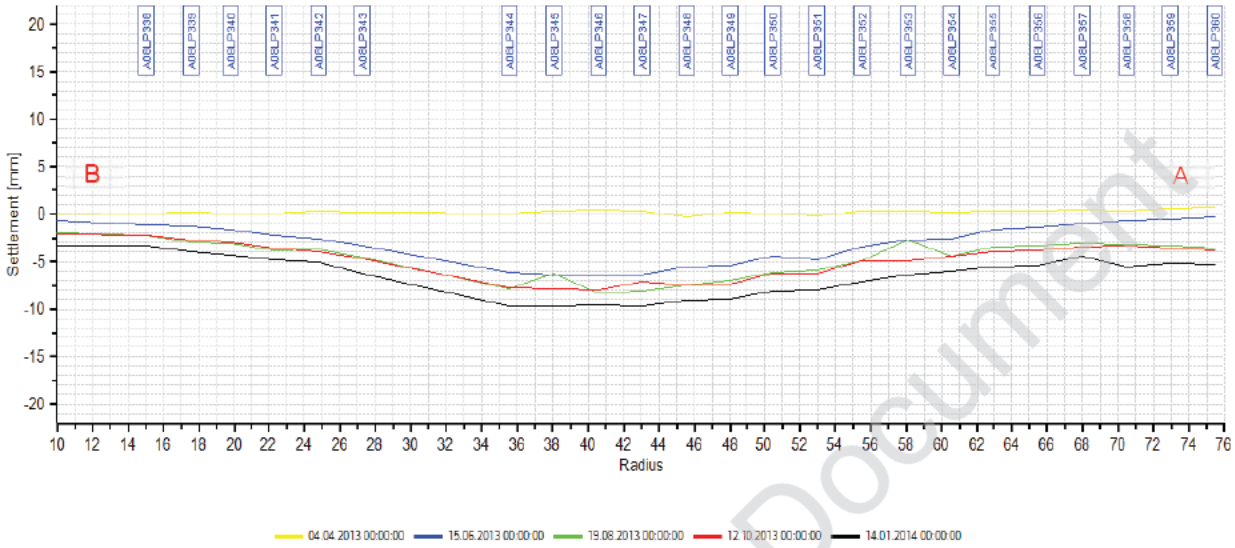


Figure 35: Wardour Street cut

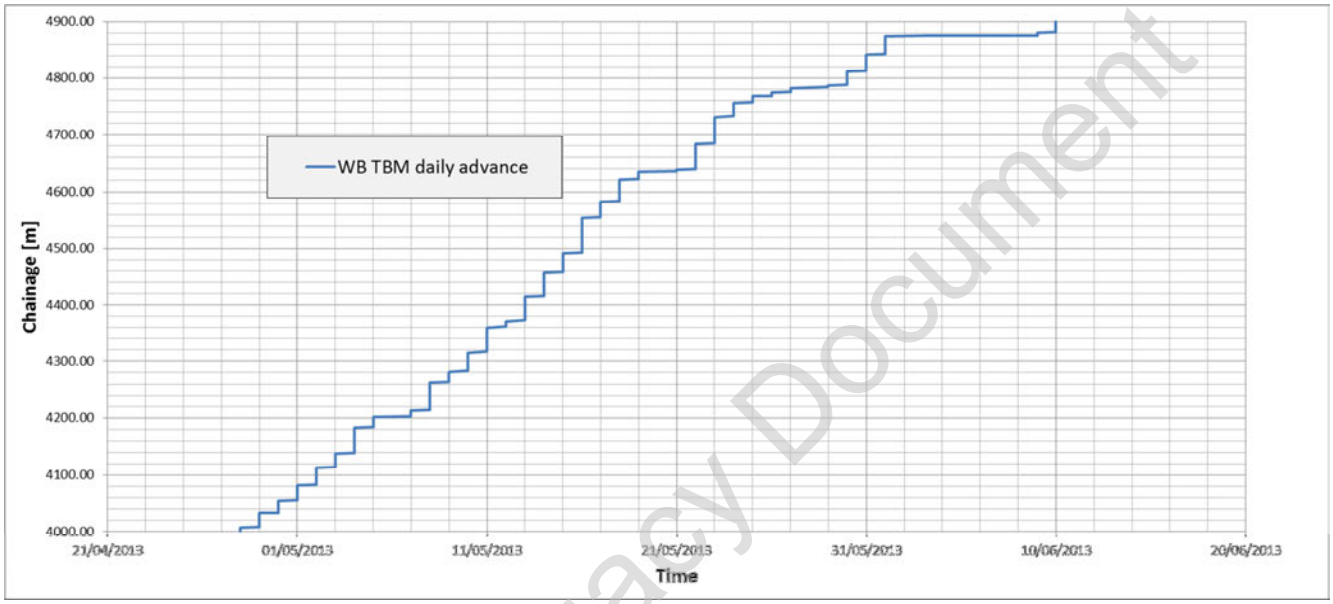
2.11.2. Comments

The PLPs in Wardour Street settled up to less han 10mm due to the C300 running tunnels excavation. The effect of the WB and EB TBMs s visible from the settlement time-plots.

The time-plots are showing slight on-going settlements: the long-term settlement rate is slightly over 2mm/year, but all the points of the section are moving together: this suggests an ambient temperature related behaviour, not connected with C300 running tunnels excavation. Taking into account the small total settlement achieved (approx.10mm) after the passage of the EB and WB TBMs, the residual risk is negligible

Appendix 1. TBMs charts and sections' chainages

TBMs progress chart



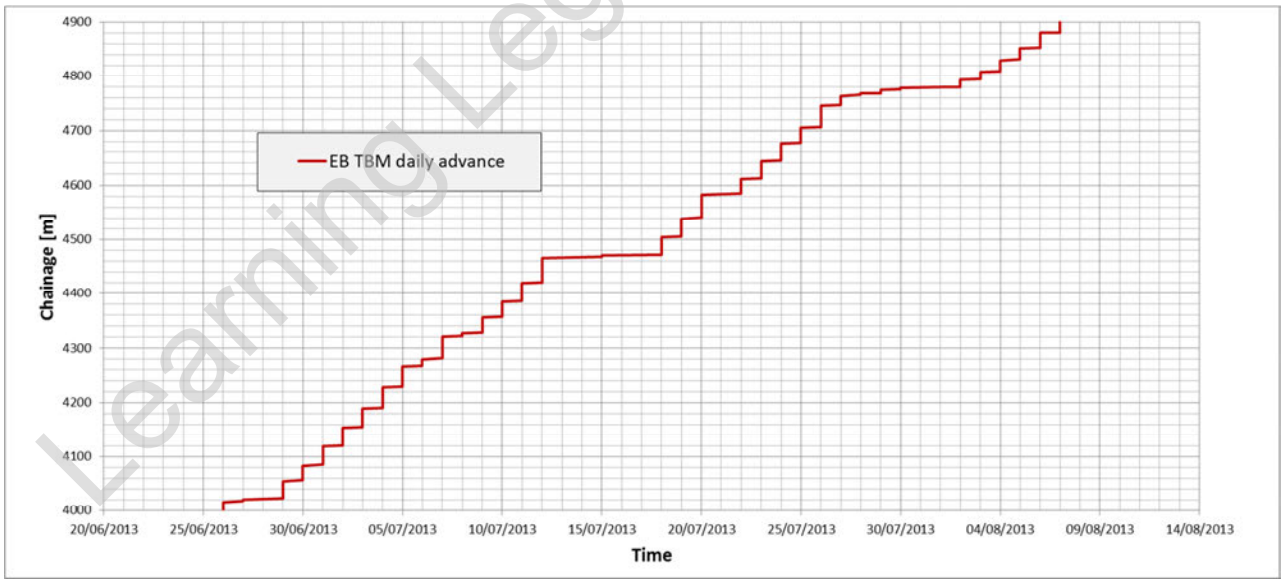


Figure 36: WB and EB TBMs progress charts along BOS-TCR drive

Table 8: Reference EB chainages

Section Location	Approx. EB Chainage
Regent Street	4217
Argyll Street	4304
31-38 Great Marlborough Street	4371
Poland Street	4544
Berwick Street	4620
Wardour Street	4672

NOTE: the EB and WB running tunnels from PAD to BOS are generally parallel and the chainages are very similar. Therefore, only the EB chainages are reported in the above table

Appendix 2. BREs, PLPs and Prisms data

Appendix 3. Reference documents

Code	Document
C300-BFK-C4-STP-CRT00 ST005-	MANAGEMENT PLAN FOR THE CONTROL OF GROUND MOVEMENTS: ADDENDUM
C122-OVE-C2-RGN-CRG01-50076	Instrumentation & Monitoring Plan C300 Running Tunnels Ground Movement And Asset Protection
C122-OVE-U-RGN-CRG01-50003	Instrumentation and Monitoring Plans: Thames Water Assets: Drive X (C300) Instrumentation Plan for Large or Deep Sewers
C300-BFK C4-RGN-CRT00_ST005-51941	Grout Report Route-wide subsurface
C300 BFK-C4-RGN-CRT00_ST005-50570	Installation og geodetic prisms and BRE's BOS St to TCR
C300-BFK-C4-RGN-CRT00_ST005-50656	Installation report for PLP's in Regent St Crown Estates (PMI274)
C300-BFK-C4-RGN-CRT00_ST005-50749	Installation of PLP BOS-TCR
C300-BFK-C4-RGN-CRT00_ST005-50767	Pre installation report for Crown Estates Properties on Regent St (PMI341)

Appendix 4. Thames Water Assets summary table

Area	Type	Sewer Name	Address	Alert Value (mm)	Deflection Alert Value	Deflection Amber Trigger Value	Deflection achieved (average of 3 values)
BOS-TCR	Sewer	TW19 Regent Street Sewer	Regent Street	-	1 in 4600	-	1 in 13800
	Water Main	Regent Street	Regent Street West	-	1 in 2800	-	
	Water Main	Argyle Street	1 street west of Regents Street	-	1 in 2600	-	1 in 70000
	Sewer	TW22 Great Marlborough Street and Poland Street Sewer	Carnaby Street - Marlborough St - Poland Street	-	-	-	
	Sewer	TW23 Northumberland Street Sewer	Wardour Street	-	1 in 3600		1 in 7600

Appendix 5. C300 Buildings Claims

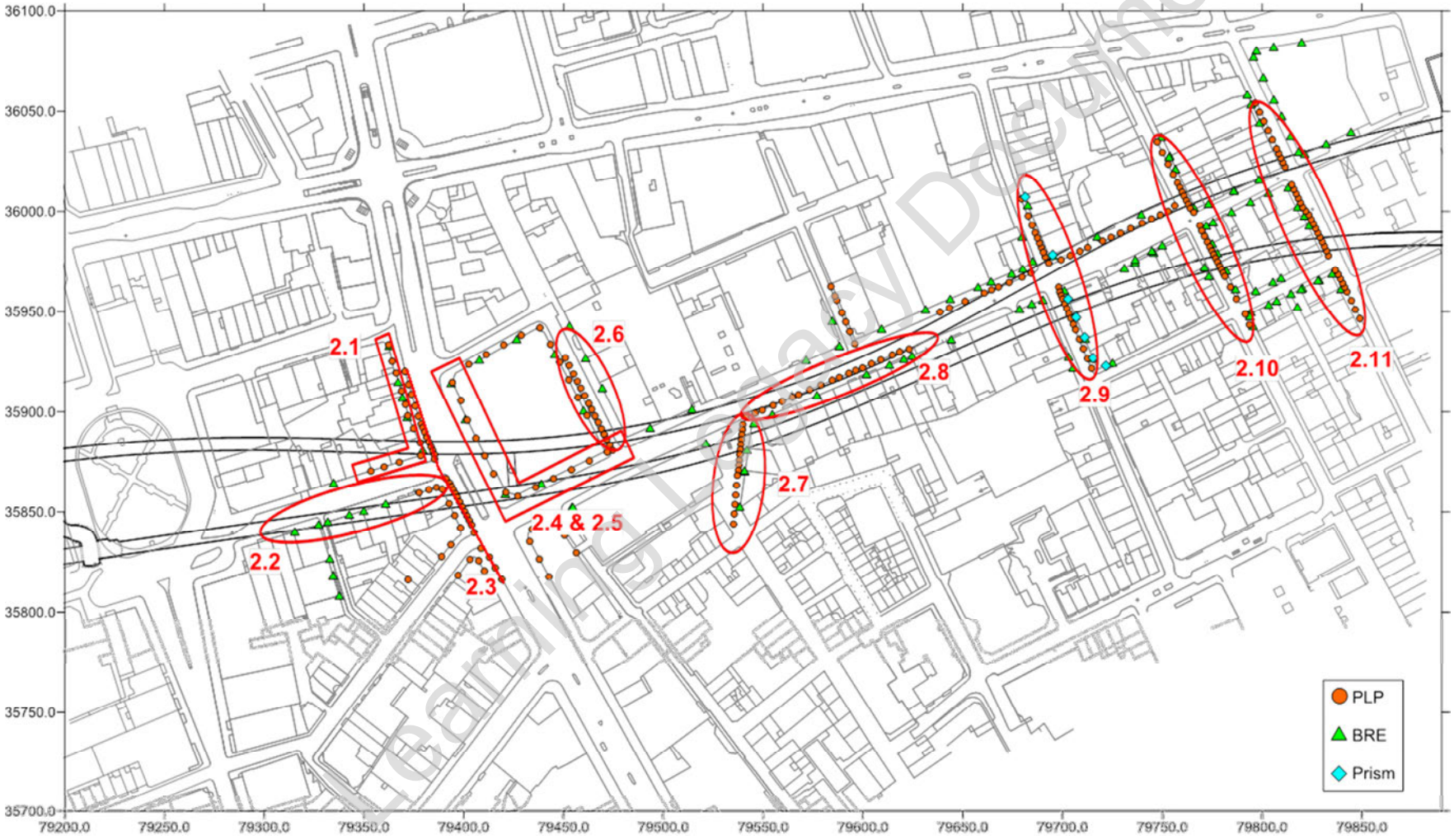
The following sketches show the locations of the buildings for which damages claims were raised. The building addresses are reported in the yellow boxes and the position on the plan is indicated with a red arrow. This information was provided by C122. . These sketches are reported at the end of this document.

Appendix 6. LU data

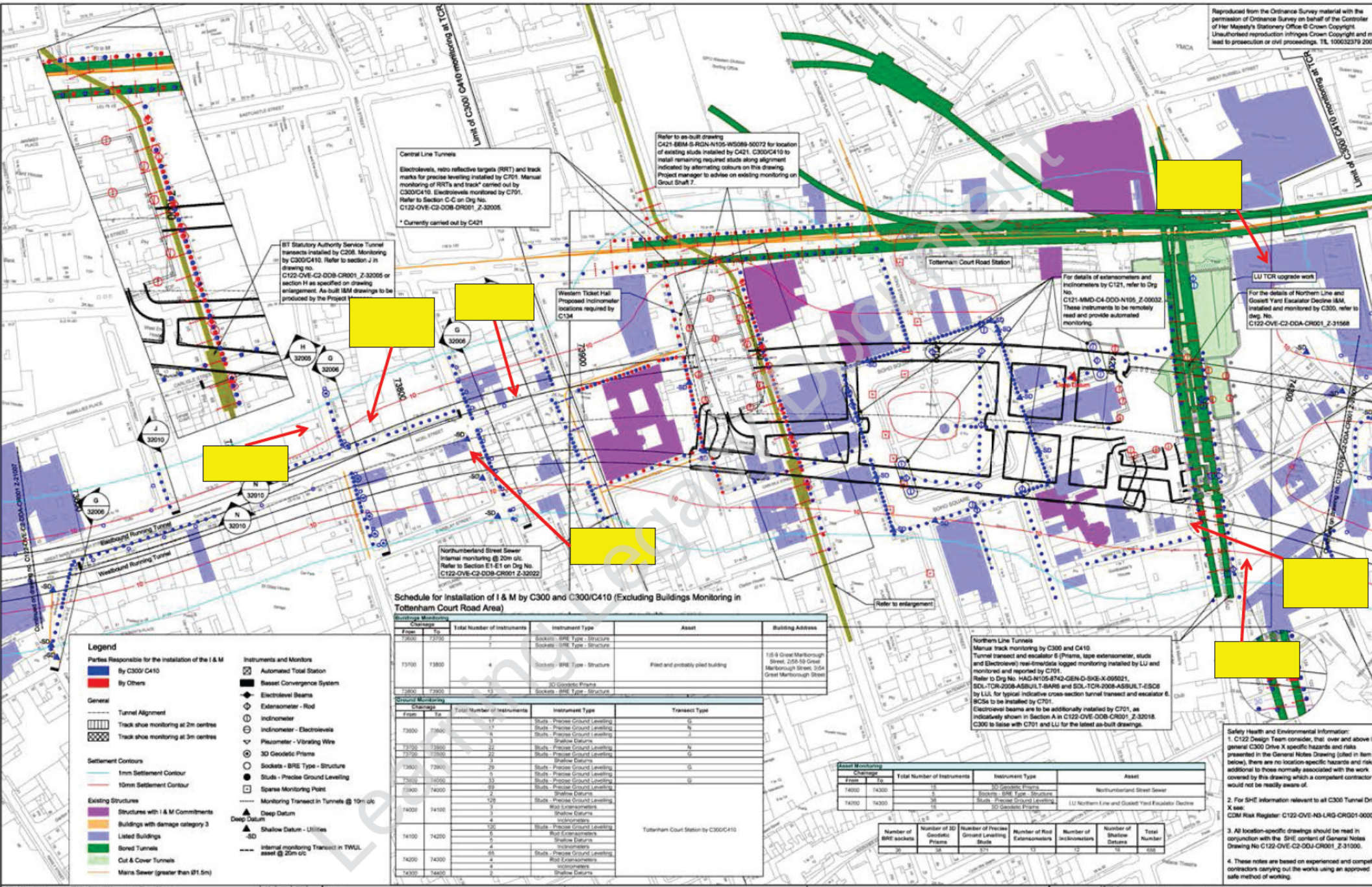
Report attached at the end of this document.

Appendix 7. Summary Plots

Location and Section Numbers for data presented



Summary of Final Settlements



Schedule for Installation of I & M by C300 and C300/C410 (Excluding Buildings Monitoring in Tottenham Court Road Area)

Buildings Monitoring

Chainage From	Chainage To	Total Number of Instruments	Instrument Type	Asset	Building Address
73600	73700	7	Sockets - BRE Type - Structure		
		7	Sockets - BRE Type - Structure		
73700	73800	4	Sockets - BRE Type - Structure	Piled and probably piled building	1/5-9 Great Marlborough Street, 2/58-59 Great Marlborough Street, 3/54 Great Marlborough Street
			3D Geodetic Prisms		
73800	73900	13	Sockets - BRE Type - Structure		

Ground Monitoring

Chainage From	Chainage To	Total Number of Instruments	Instrument Type	Transect Type
73600	73800	17	Studs - Precise Ground Levelling	G
		17	Studs - Precise Ground Levelling	N
		6	Studs - Precise Ground Levelling	J
		1	Shallow Datums	
73700	73900	22	Studs - Precise Ground Levelling	N
73700	73800	22	Studs - Precise Ground Levelling	G
		3	Shallow Datums	
73800	73900	29	Studs - Precise Ground Levelling	G
74000	74050	5	Studs - Precise Ground Levelling	
74000	74050	33	Studs - Precise Ground Levelling	G
73900	74000	69	Studs - Precise Ground Levelling	
		2	Shallow Datums	
74000	74100	126	Studs - Precise Ground Levelling	
		3	Rod Extensometers	
		1	Shallow Datums	
		4	Inclinometers	
74100	74200	100	Studs - Precise Ground Levelling	
		5	Rod Extensometers	
		3	Shallow Datums	
		4	Inclinometers	
74200	74300	65	Studs - Precise Ground Levelling	
		4	Rod Extensometers	
		4	Inclinometers	
74300	74400	3	Shallow Datums	

Tottenham Court Road Station by C300/C410

Asset Monitoring

Chainage From	Chainage To	Total Number of Instruments	Instrument Type	Asset
74000	74300	18	3D Geodetic Prisms	Northumberland Street Sewer
		5	Sockets - BRE Type - Structure	
74200	74300	38	Studs - Precise Ground Levelling	LU Northern Line and Goslett Yard Escalator Decline
		18	3D Geodetic Prisms	

Number of BRE sockets	Number of 3D Geodetic Prisms	Number of Precise Ground Levelling Studs	Number of Rod Extensometers	Number of Inclinometers	Number of Shallow Datums	Total Number
36	58	571	13	12	16	656

Legend

Parties Responsible for the installation of the I & M
- By C300/ C410
- By Others

General
- Tunnel Alignment
- Track shoe monitoring at 2m centres
- Track shoe monitoring at 3m centres

Settlement Contours
- 1mm Settlement Contour
- 10mm Settlement Contour

Existing Structures
- Structures with I & M Commitments
- Buildings with damage category 3
- Listed Buildings
- Bored Tunnels
- Cut & Cover Tunnels
- Mains Sewer (greater than Ø1.5m)

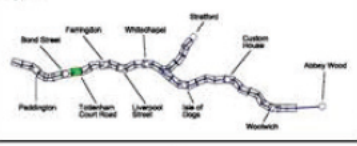
Instruments and Monitors
- Automated Total Station
- Basset Convergence System
- Electrolevel Beams
- Extensometer - Rod
- Inclinometer
- Inclinometer - Electrolevels
- Piezometer - Vibrating Wire
- 3D Geodetic Prisms
- Sockets - BRE Type - Structure
- Studs - Precise Ground Levelling
- Sparse Monitoring Point
- Monitoring Transect in Tunnels @ 10m c/c
- Deep Datum
- Shallow Datum - Utilities
- Internal monitoring Transect in TWUL asset @ 20m c/c

Safety Health and Environmental Information:
1. C122 Design Team consider, that over and above the general C300 Drive X specific hazards and risks presented in the General Notes Drawing (cited in item below), there are no location-specific hazards and risks additional to those normally associated with the work covered by this drawing which a competent contractor would not be readily aware of.
2. For SHE information relevant to all C300 Tunnel Drive X see:
CDM Risk Register: C122-OVE-N0-LRG-CRG01-0002
3. All location-specific drawings should be read in conjunction with the SHE content of General Notes Drawing No C122-OVE-C2-DDJ-CR001_Z-31000.
4. These notes are based on experienced and competent contractors carrying out the works using an approved safe method of working.

Rev.	Date	Description	By	Chkd	App	Auth
P02	20/11/2009	Issued for Tender Purposes	AB	AN	RM	
P03	12/03/2010	Released for Tender Purposes	JC	AS	RM	
P04	29/04/2010	Released for Tender Addendum Purposes	AB	AS	RM	
P05	14/12/2010	Issued for Confirmed Set	JF	AS	RM	
P06	11/05/2011	Designer's Recommendations for Use by Contractors	JG	CC	PC	
P07	24/05/2011	Minimum Requirements for Instrumentation and Monitoring	JG	AS	RM	
P08	25/01/2012	Minimum Requirements for Instrumentation and Monitoring	DB	JW	PC	
P09	03/02/2012	Minimum Requirements for Instrumentation and Monitoring	GP	JA	RM	
C01	17/02/2012	Issued as Fit for construction	GP	JA	RM	IT
P10	09/05/2012	Minimum requirements for Instrumentation and Monitoring	GP	JA	RM	-
P11	10/05/2012	Minimum Requirements for Instrumentation and Monitoring	GP	JA	RM	-
C02	28/05/2012	Issued as Fit for construction	GP	JA	RM	IT

Notes
1. For instrumentation and monitoring general notes, monitoring frequencies and summary schedule, refer to Drg. No. C122-OVE-C2-DDJ-CR001_Z-31000; C122-OVE-C2-DDJ-CR001_Z-30002, and C122-OVE-C2-DDJ-CR001_Z-30005 respectively.
2. Building monitoring at Tottenham Court Road Station is not shown on this drawing. Refer to drawing No. C122-OVE-C2-DDB-CR001 Z-31554.
3. For sewers and utilities, additional monitoring to be confirmed by Thames Water.
4. For C121 SCL I&M requirements and details by C300, refer to Drg No. C121-MMD-C4-DDO-N105_Z-00032.

Key Plan



N

20m 0 20m 40m 60m 80m 100m

Crossrail Limited
25 Canada Square
Canary Wharf
London
E14 5LQ
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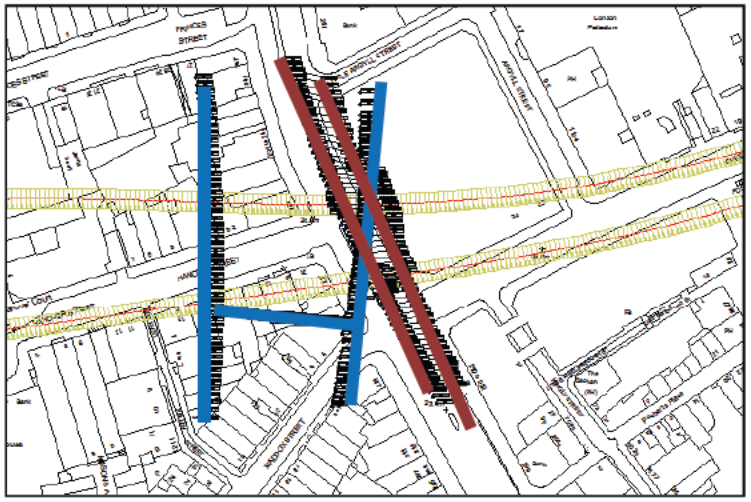
www.crossrail.co.uk

Contract: Bored Tunnels (Alignment and Track)
Originator: Ove Arup & Partners Limited
Location: Crossrail General
Title: Instrumentation and Monitoring Combined I & M Routewide Plan Sheet 8 of 38 C300, C410
By: G.POTTER
Chk: J.APTED
App: R.MCCRAE
Auth: I.THOMSON
Scale: 1:1000@ A1
Drawing and CAD file No: C122-OVE-C2-DDA-CR001_Z-31008
Rev: C02
Suitability: A

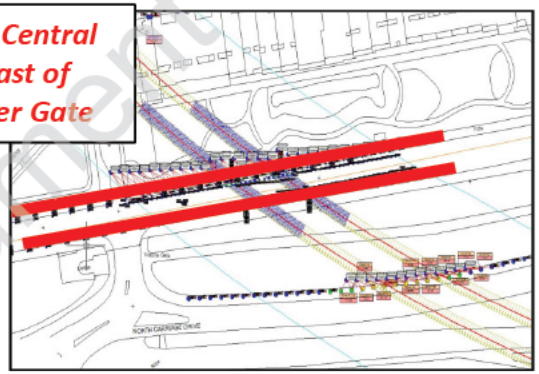
LU-TBMs Interfaces Manual Track Readings decommissioning



LU/08 – Victoria Line South of Oxford Circus

LU/09 – Bakerloo Line South of Oxford Circus

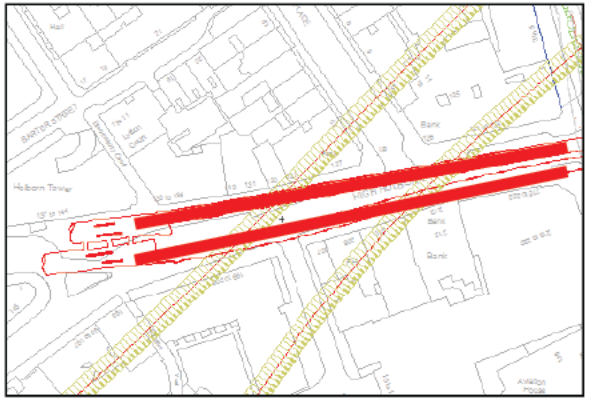
LU/05 – Central Line East of Lancaster Gate



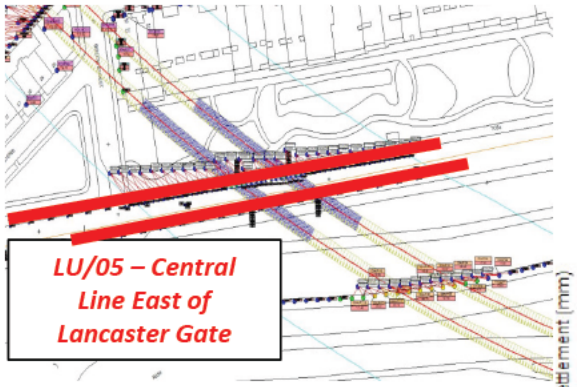
- Electrolevels data
  - Time-settlement plots
  - Cuts
- Rails Geometry
  - Cant
  - 2m base Twist
  - 10m base Twist

LU/11 – Tottenham Court Road Northern Line Station

LU/13 – Central Line West of Holborn



LU-TBMs Interfaces Manual Track Readings decommissioning



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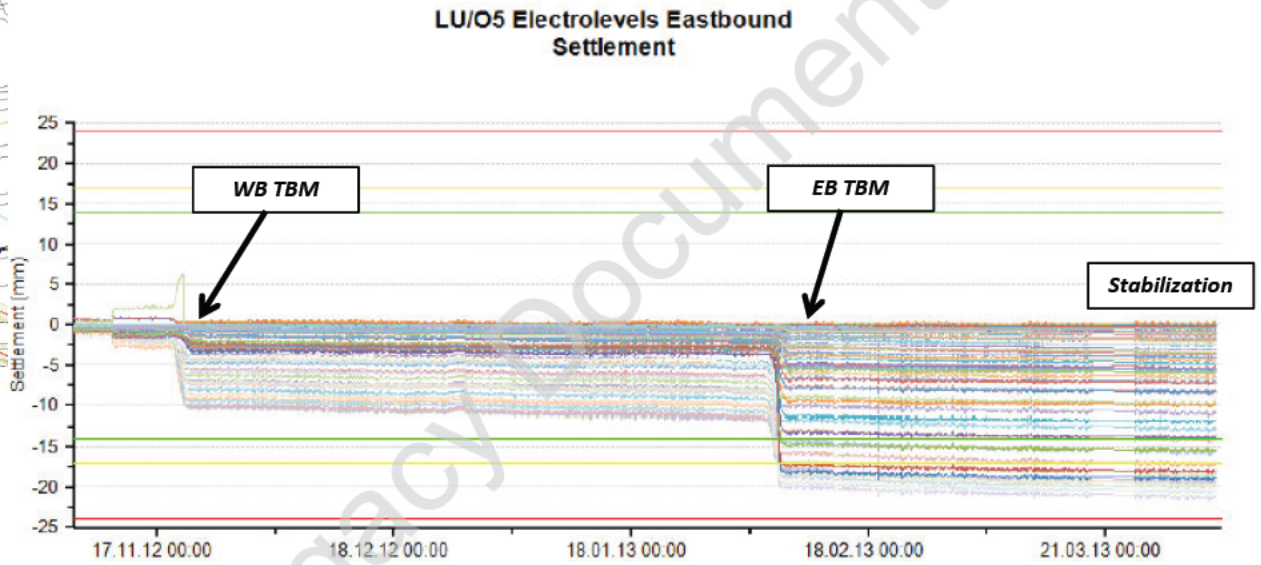
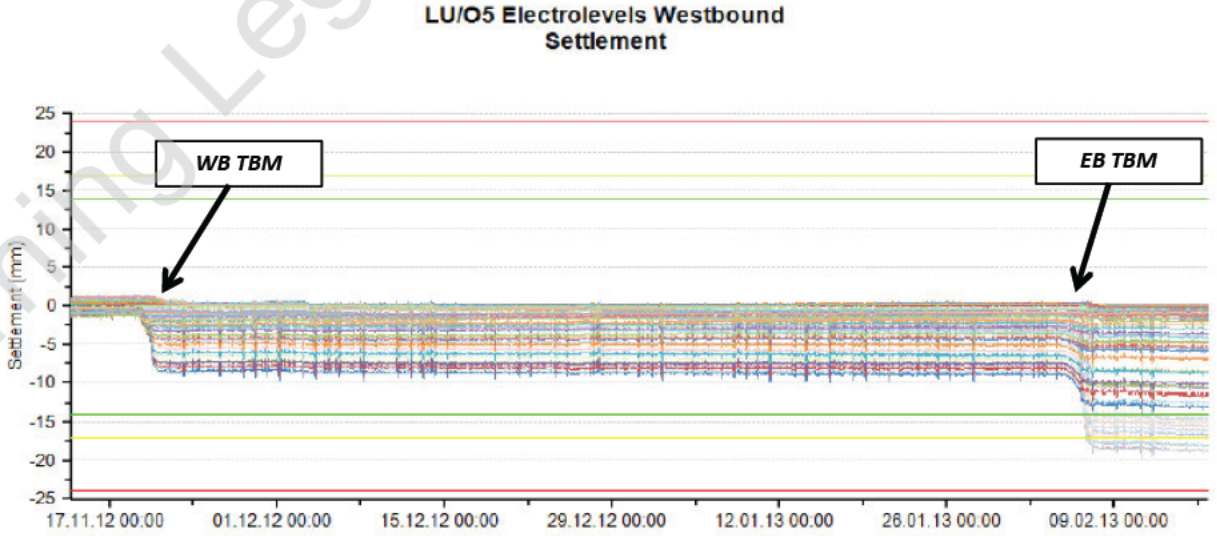
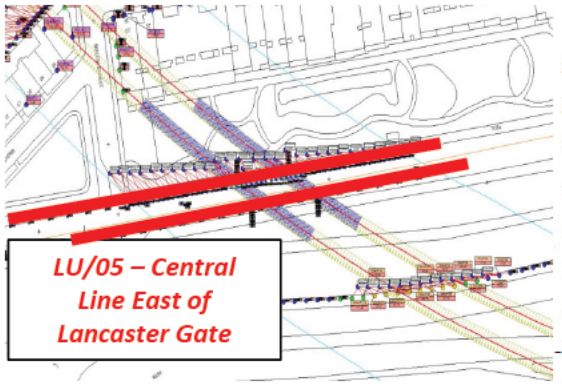




LU-TBMs Interfaces Manual Track Readings decommissioning



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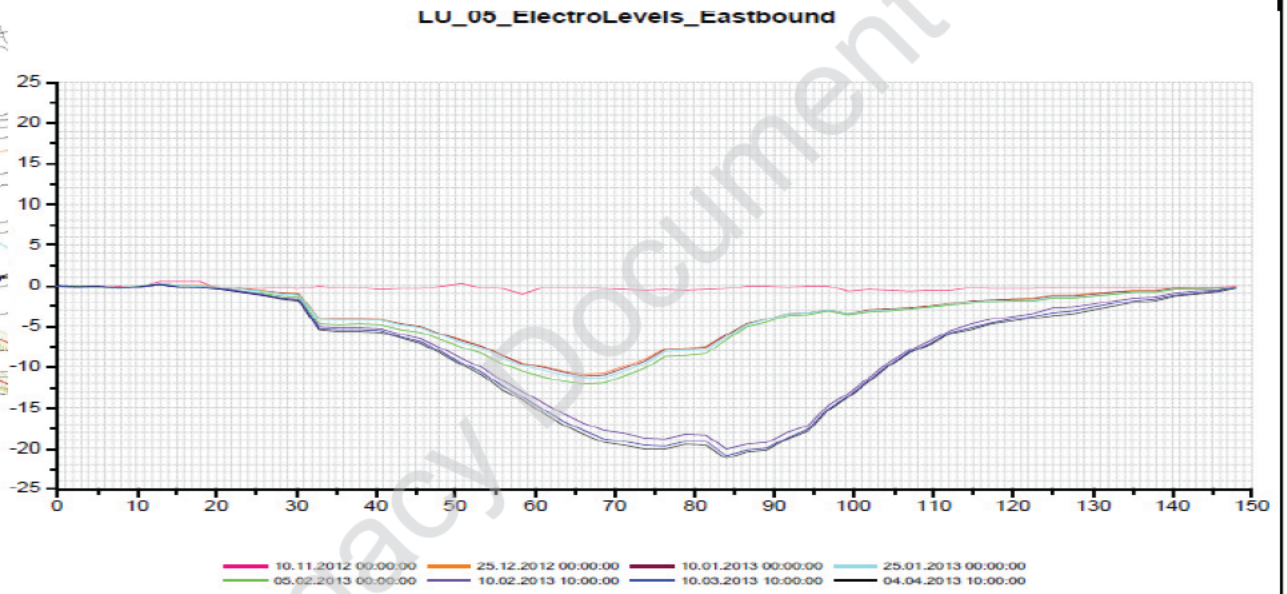
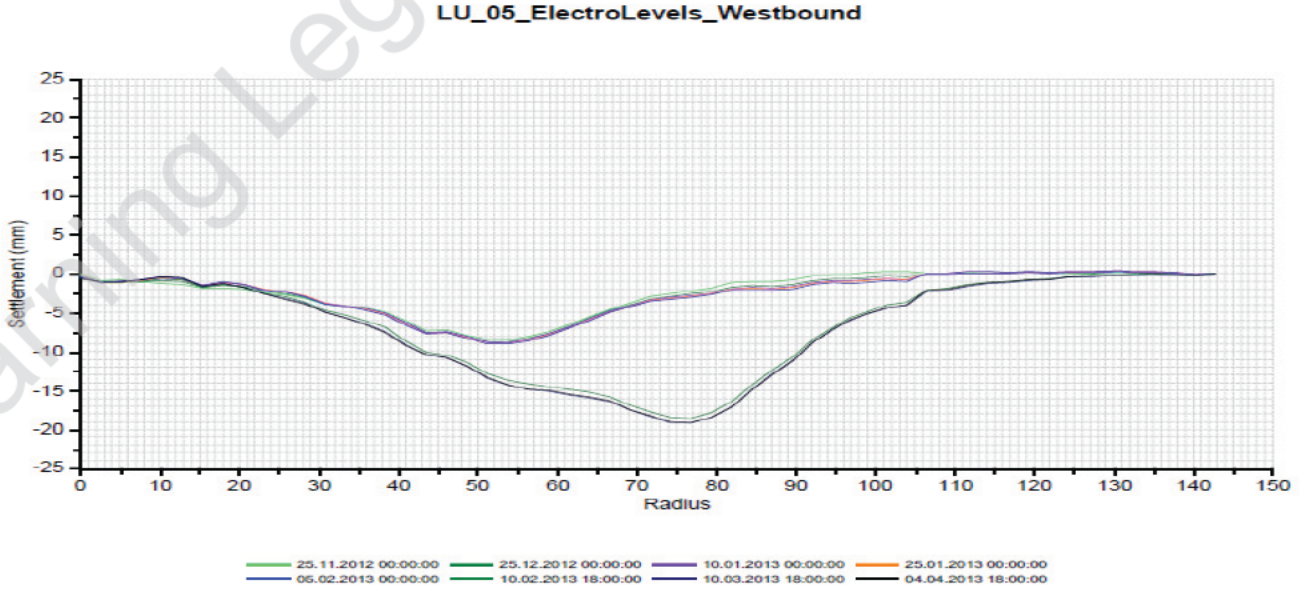
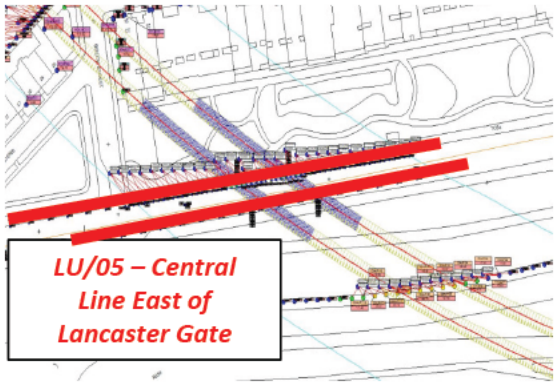


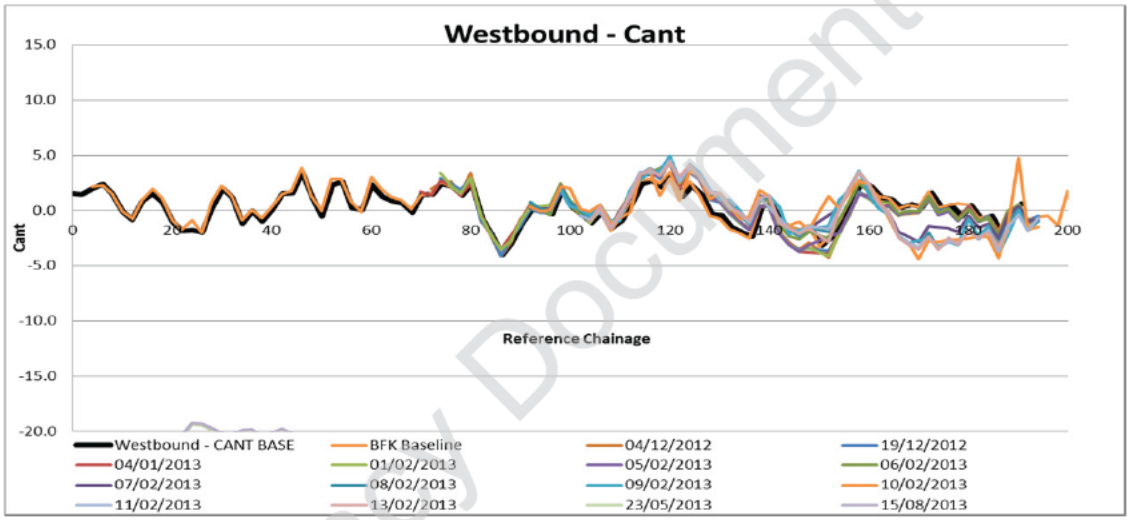


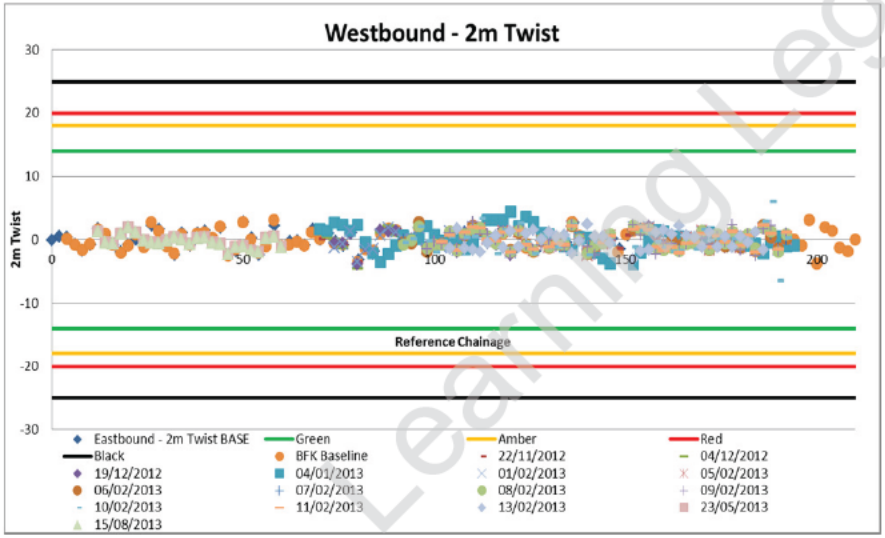
LU-TBMs Interfaces Manual Track Readings decommissioning

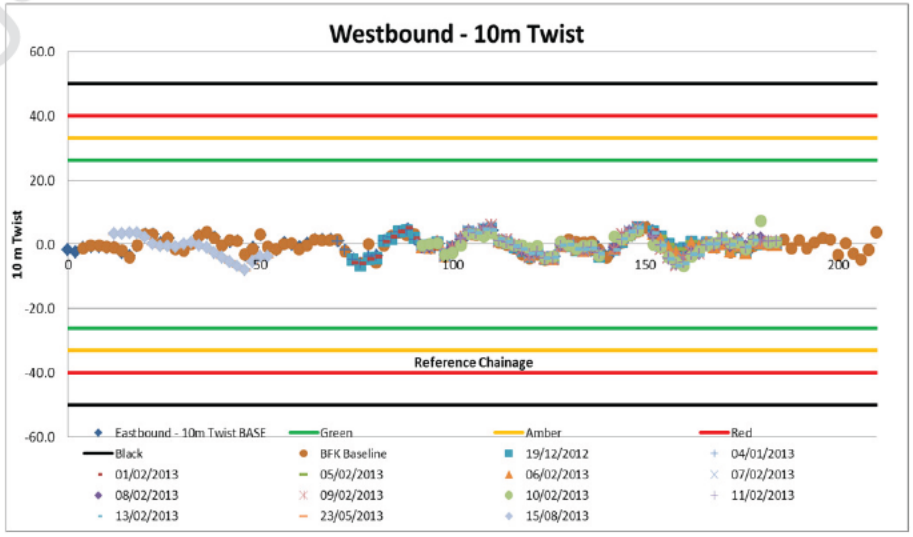


LU/05 – Central Line East of Lancaster Gate

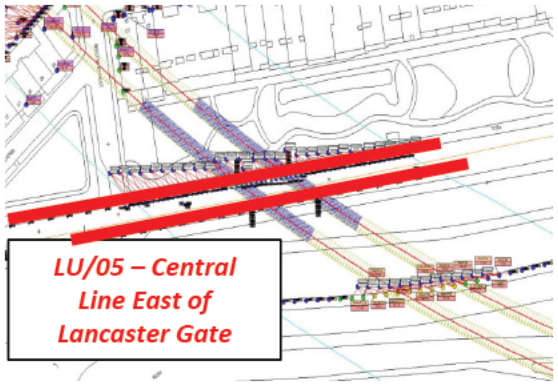
2. Manual Survey results – Westbound



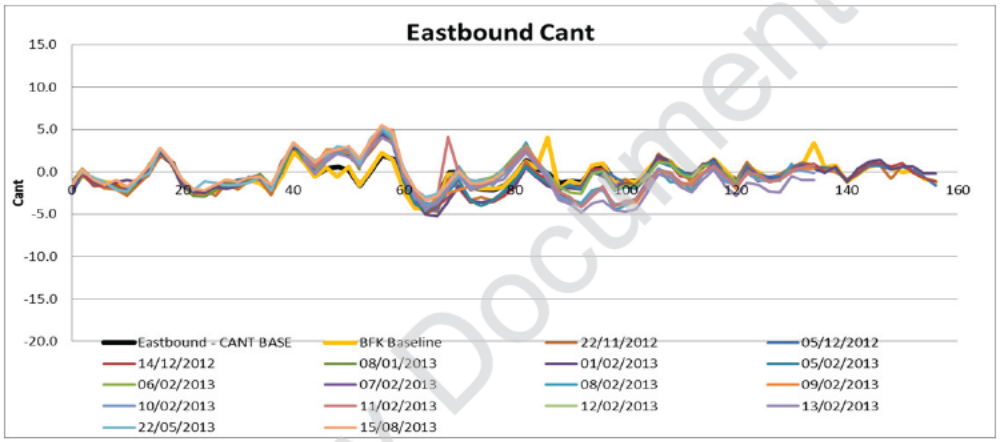


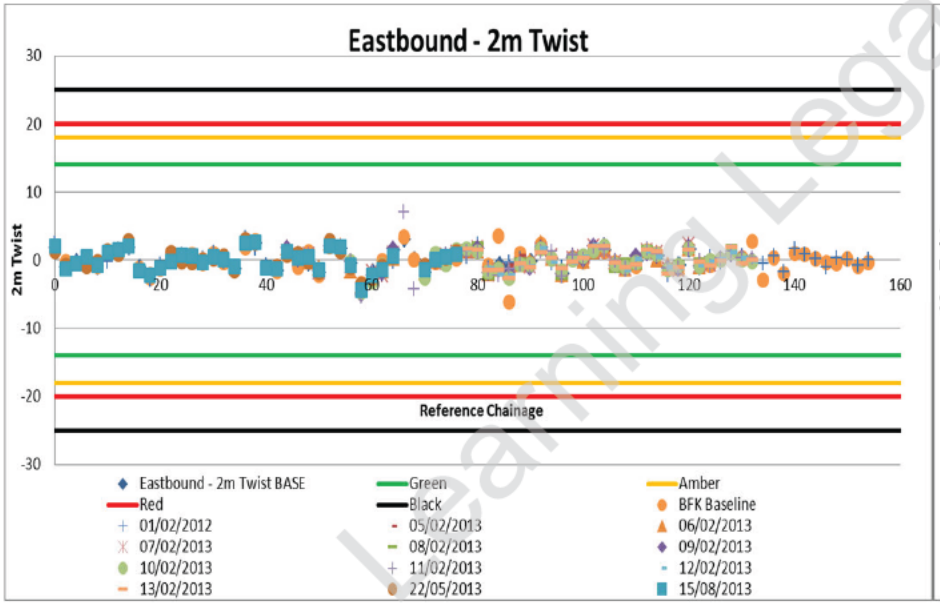


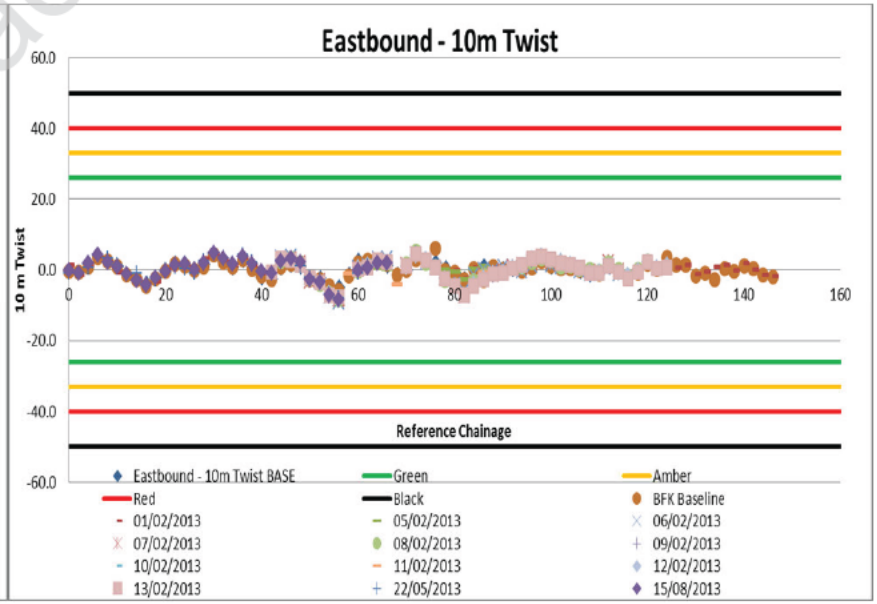
LU-TBMs Interfaces Manual Track Readings decommissioning



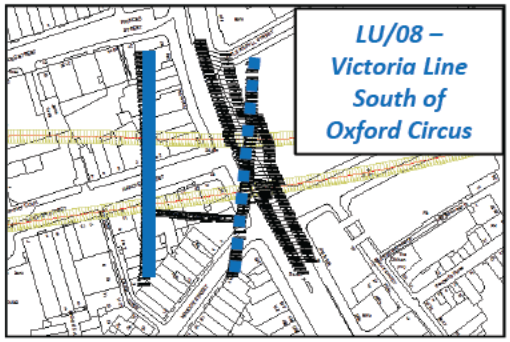
2. Manual Survey results – Eastbound







LU-TBMs Interfaces Manual Track Readings decommissioning



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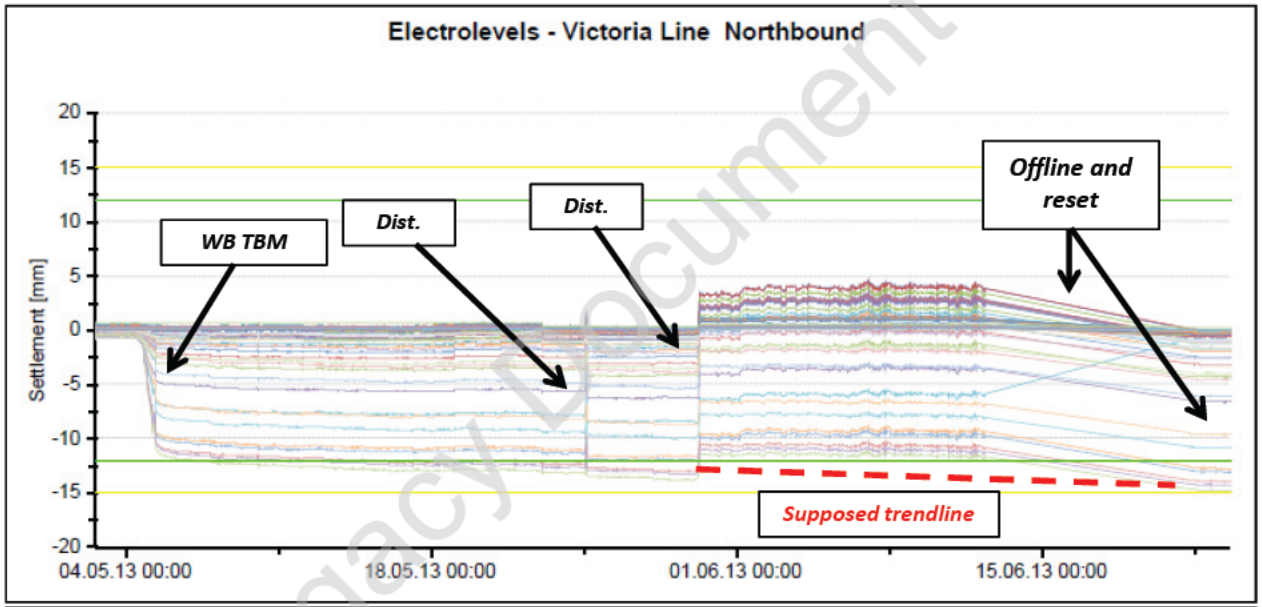
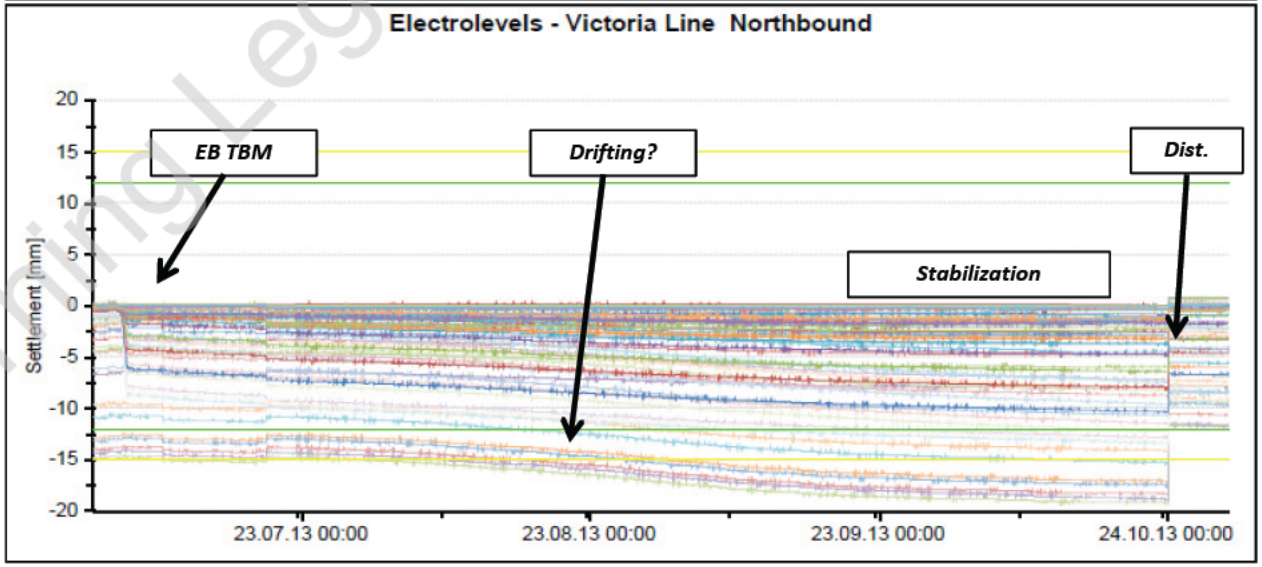
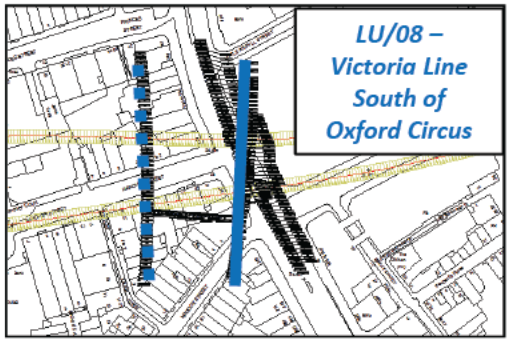




LU-TBMs Interfaces Manual Track Readings decommissioning



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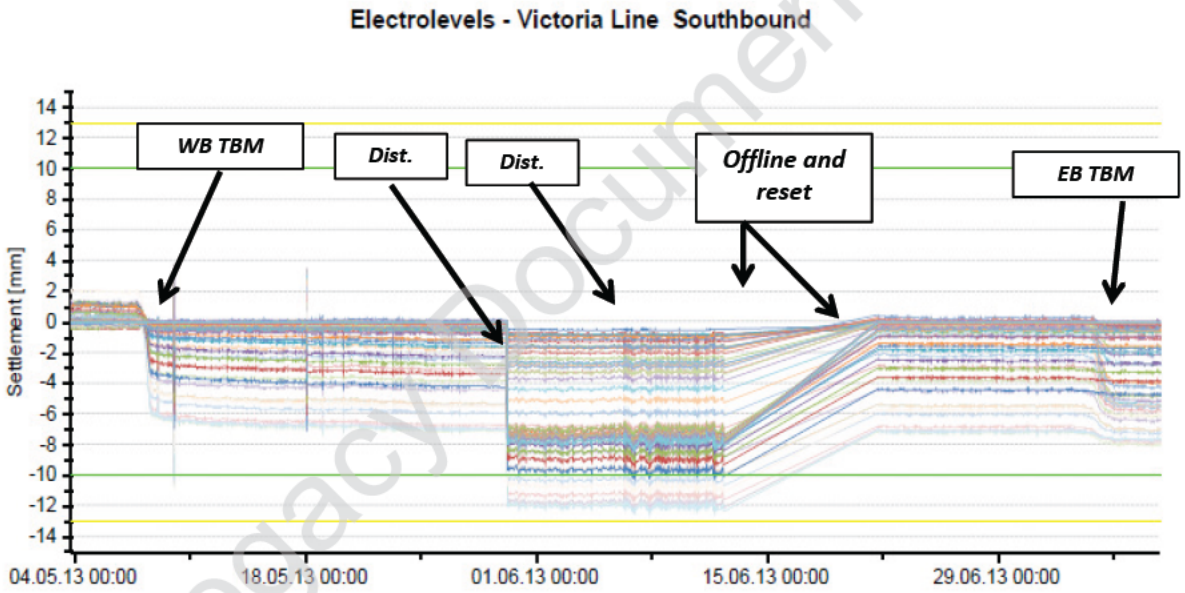
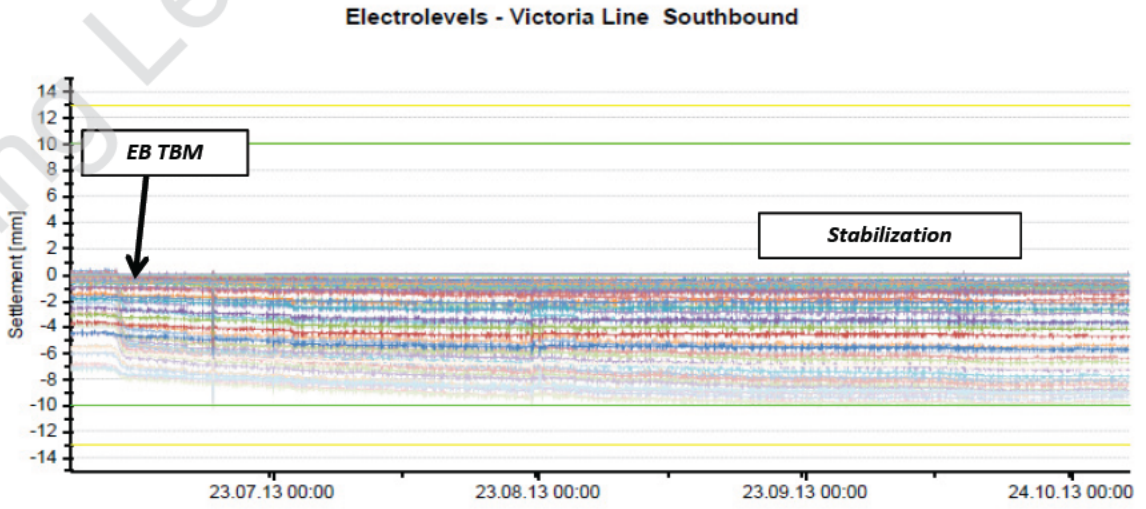
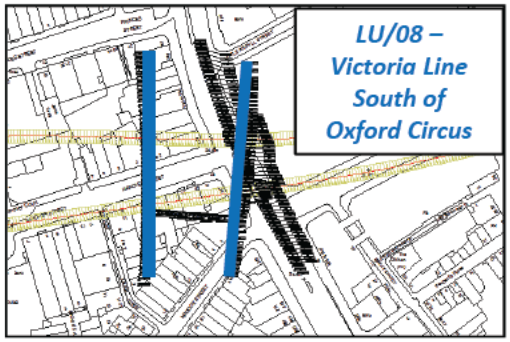




LU-TBMs Interfaces Tracks' Manual Survey decommissioning



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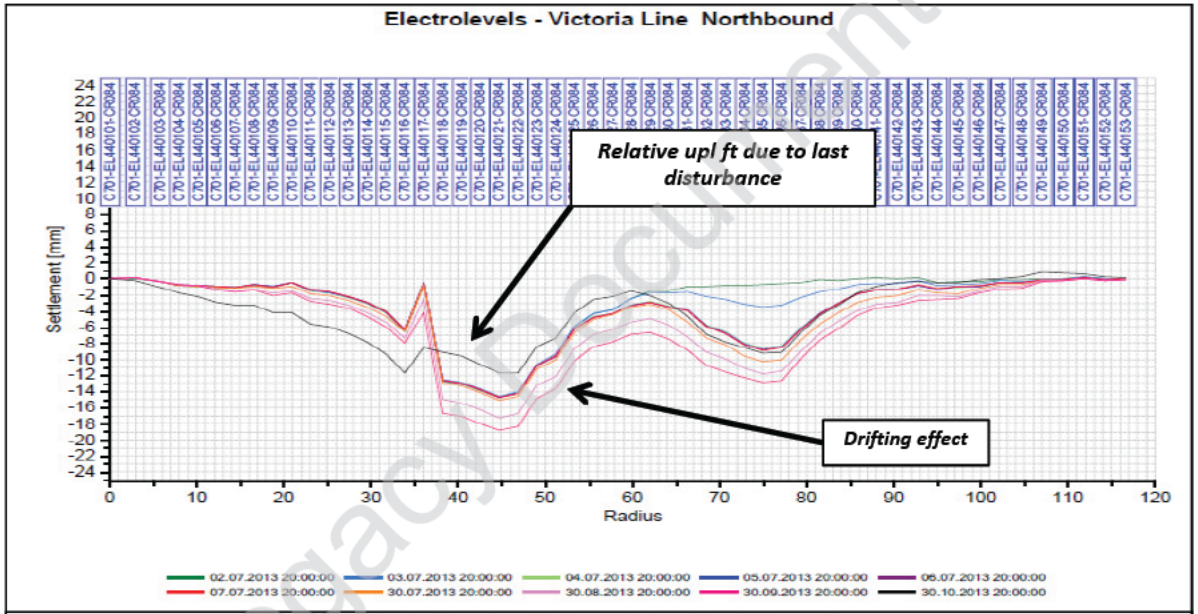
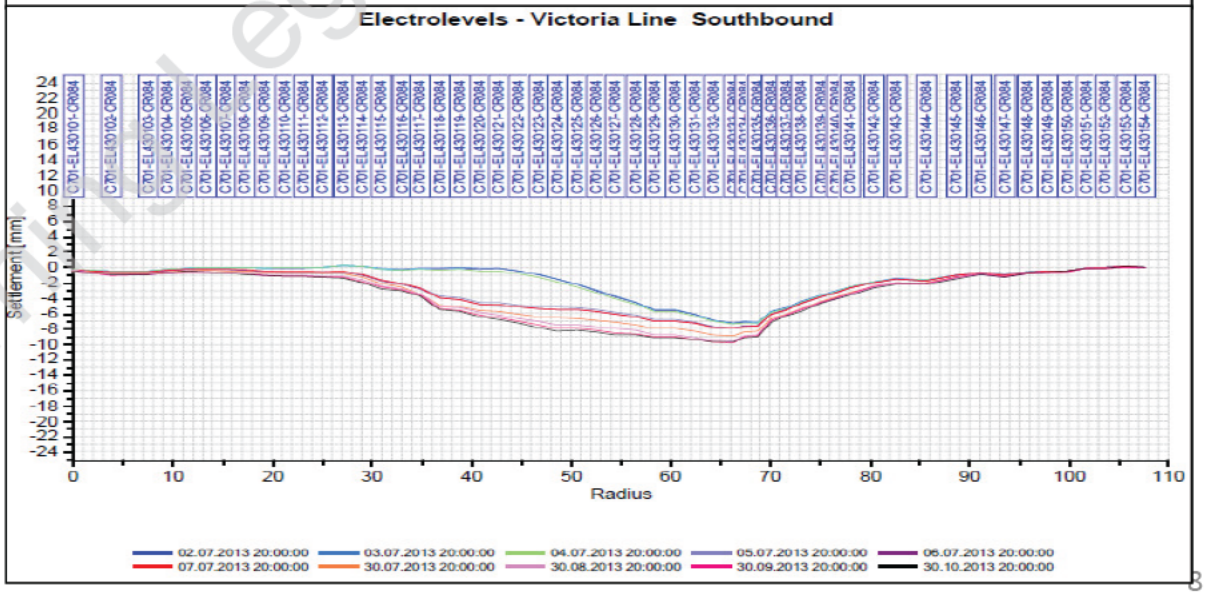
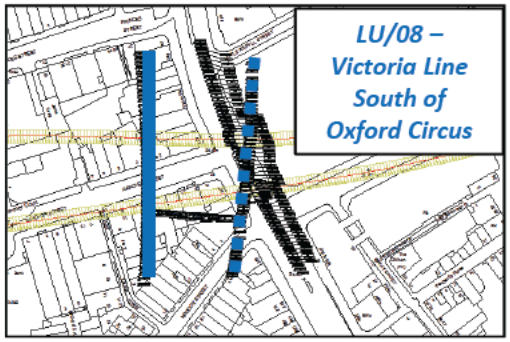
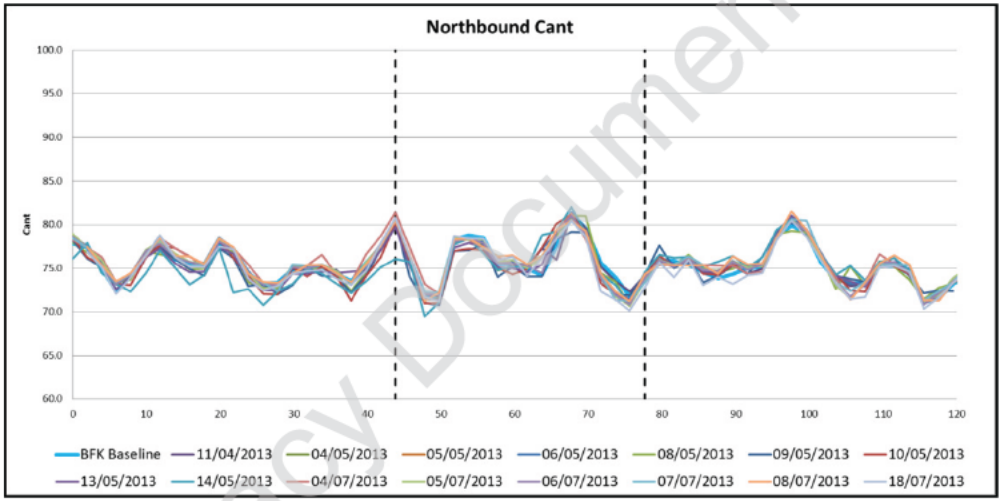


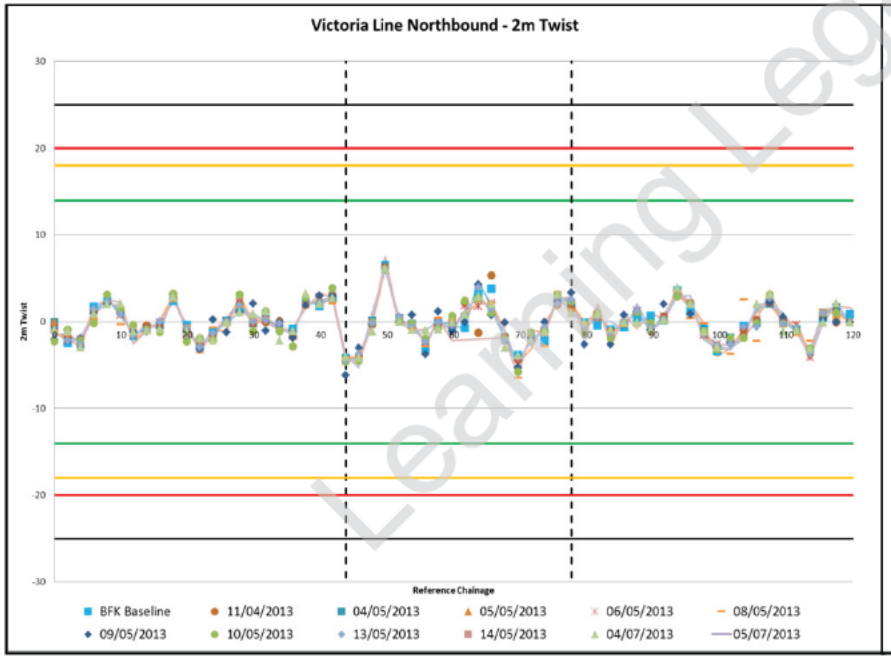


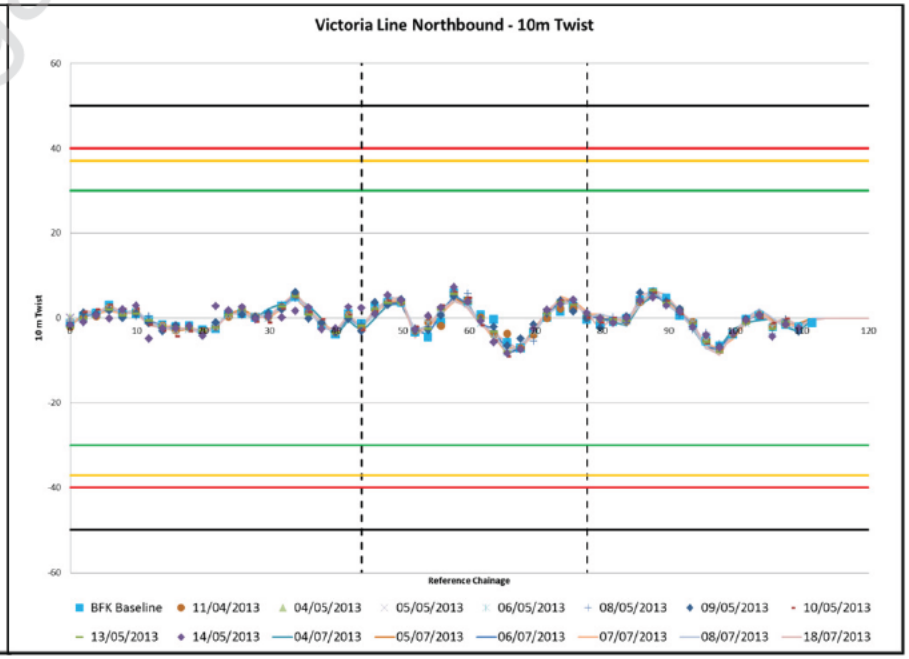
LU-TBMs Interfaces Tracks' Manual Survey decommissioning



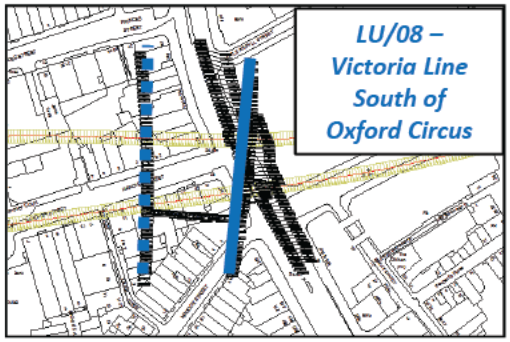
2. Manual Survey results – Northbound



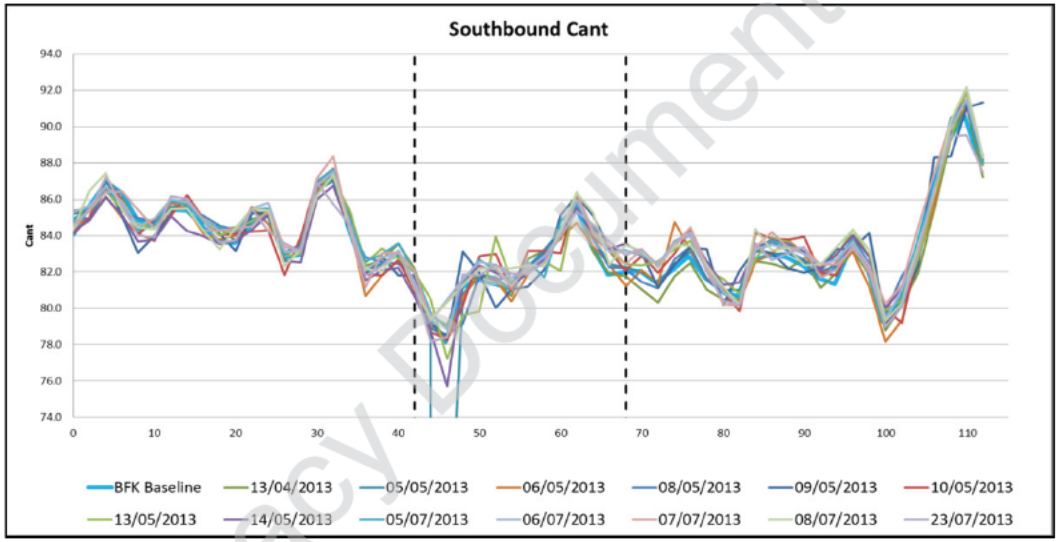


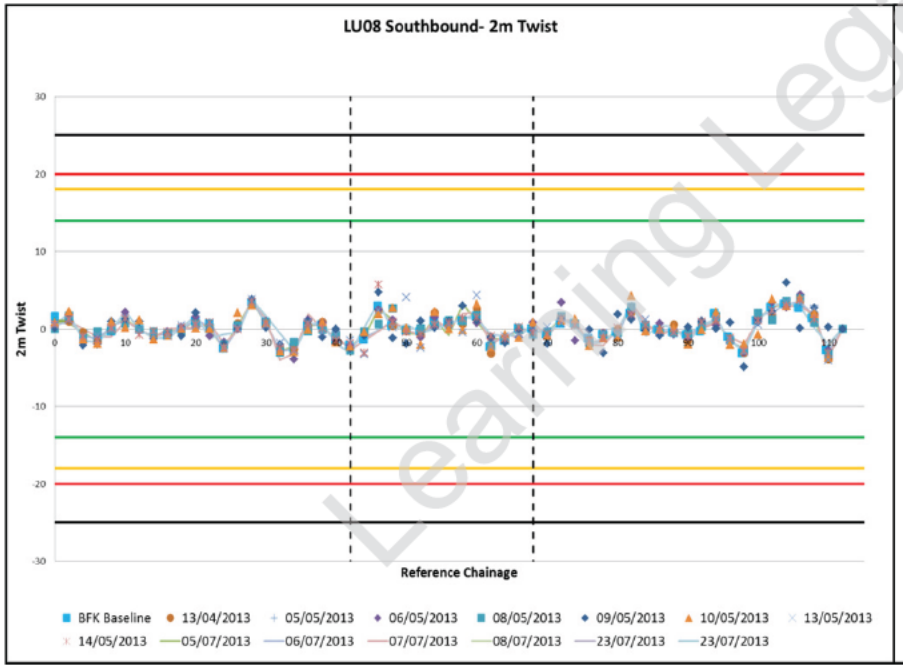


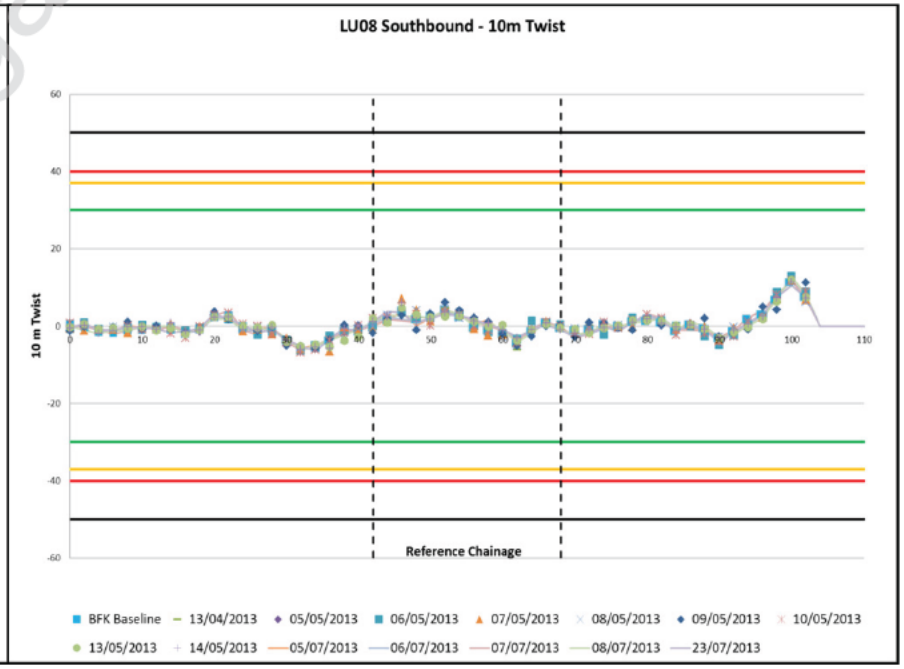
LU-TBMs Interfaces Tracks' Manual Survey decommissioning



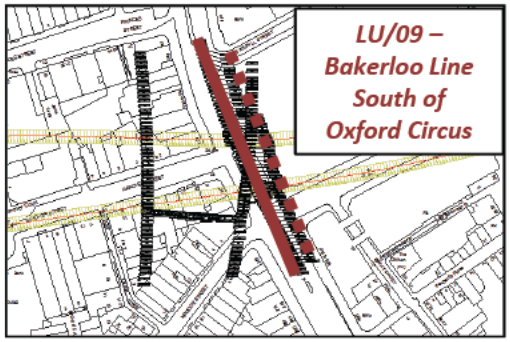
2. Manual Survey results – Southbound



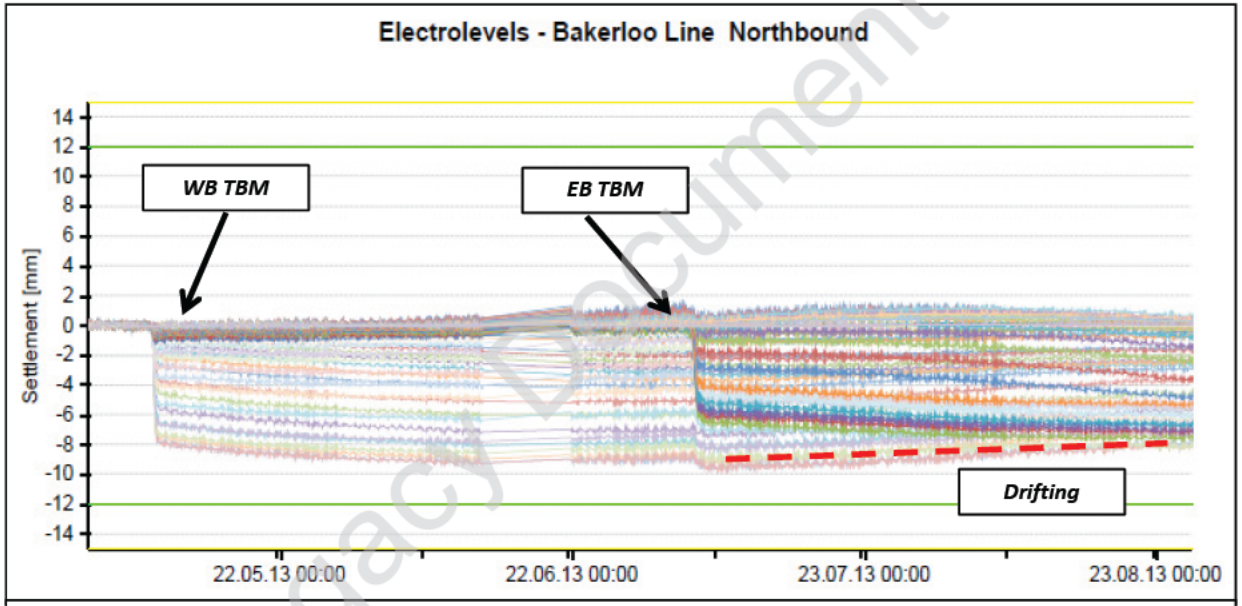


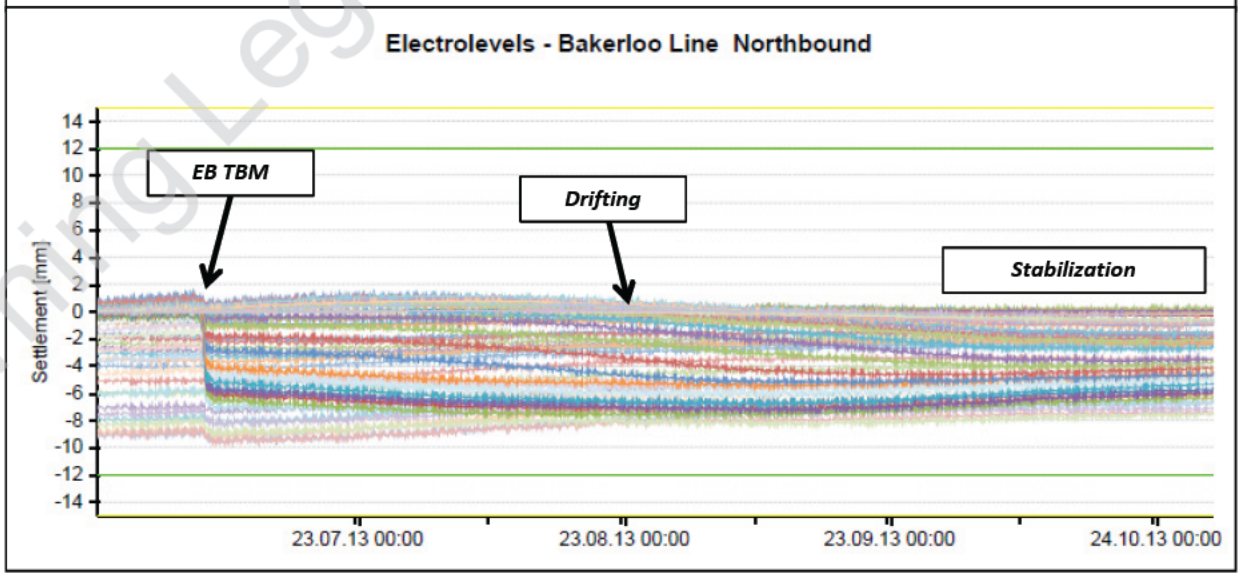


LU-TBMs Interfaces Manual Track Readings decommissioning

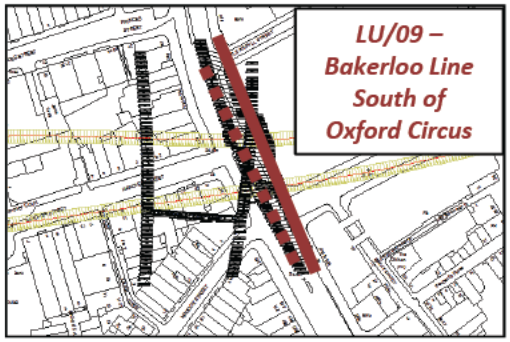


1.Electrolevels data





LU-TBMs Interfaces Manual Track Readings decommissioning



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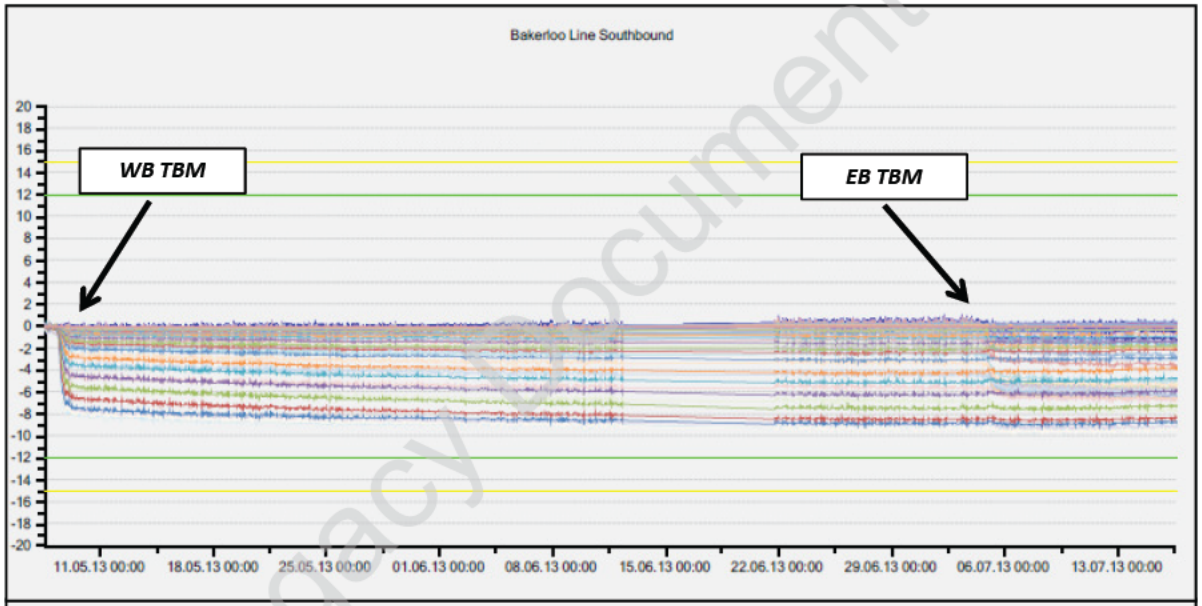
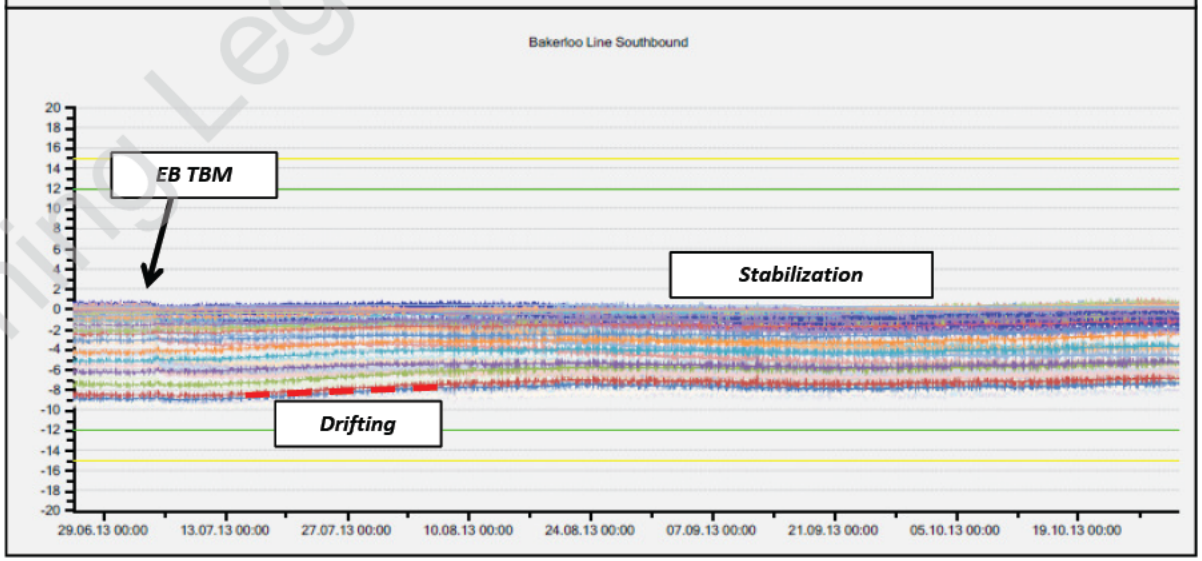
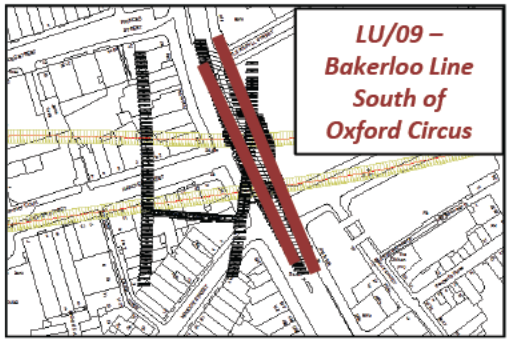




LU-TBMs Interfaces Manual Track Readings decommissioning



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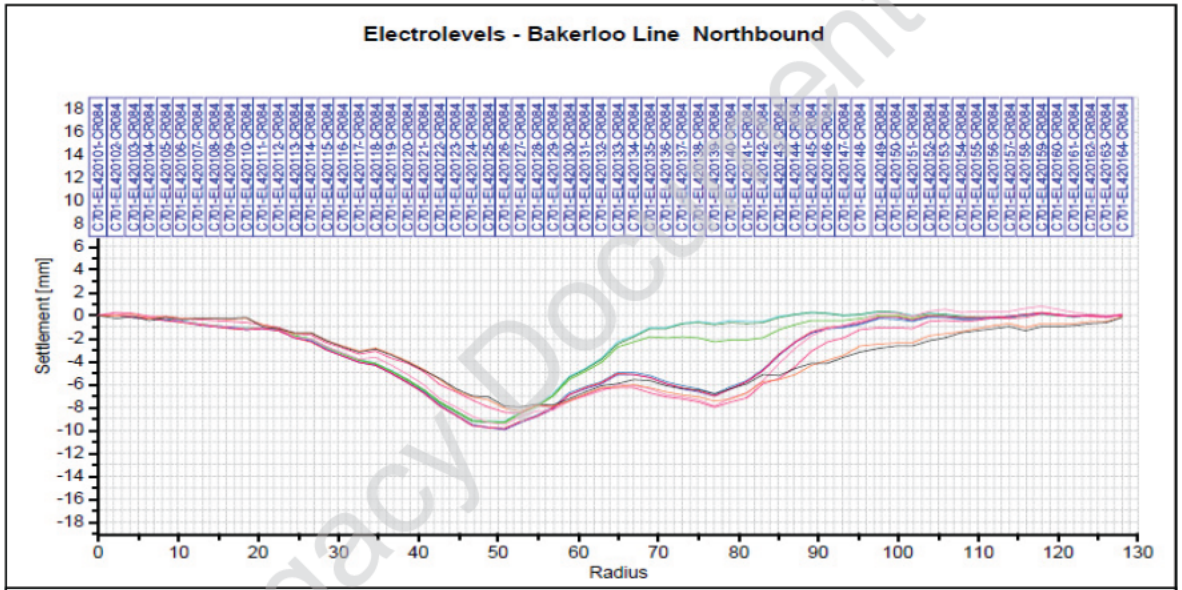
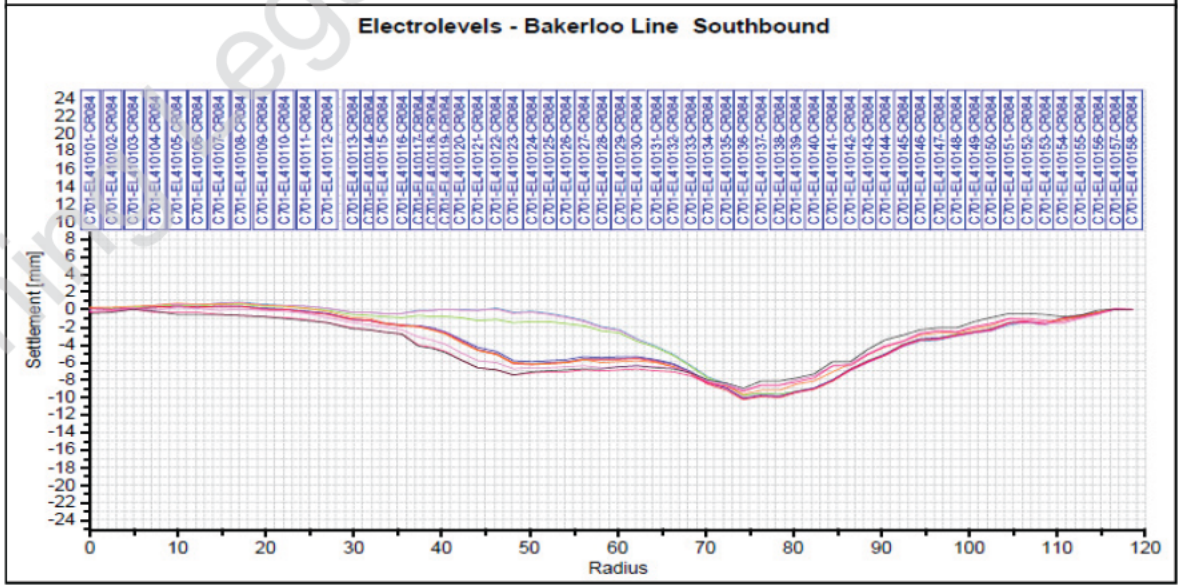
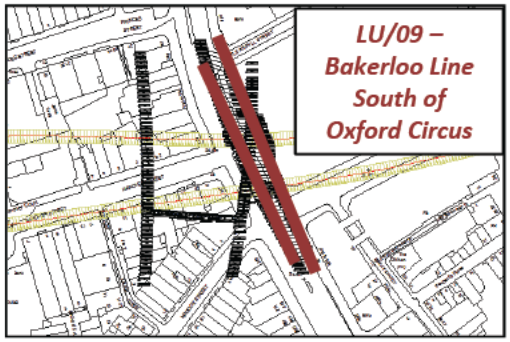
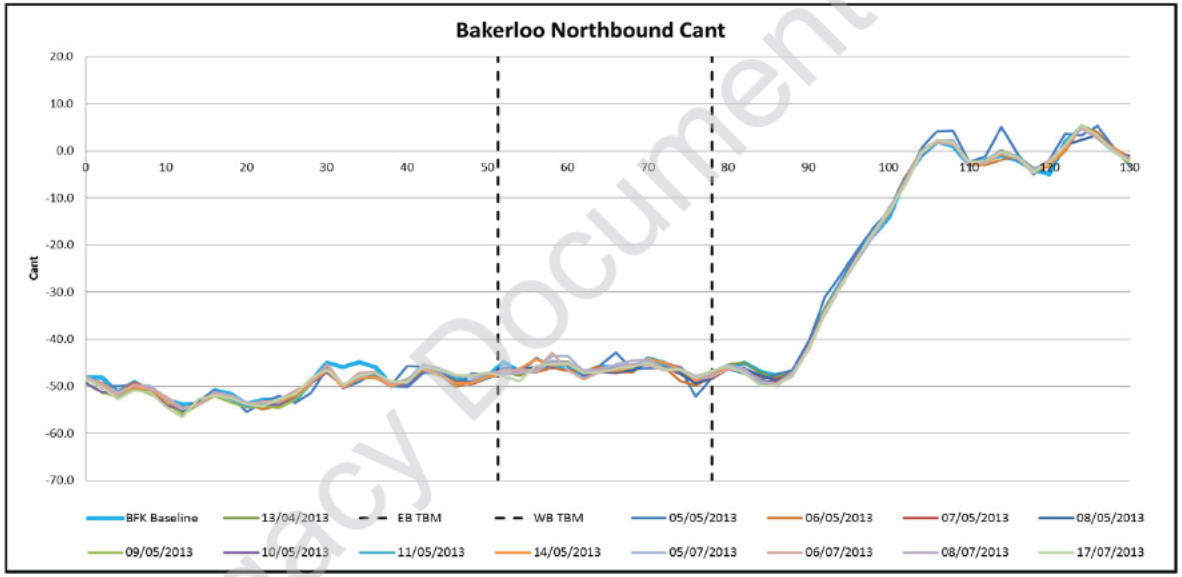


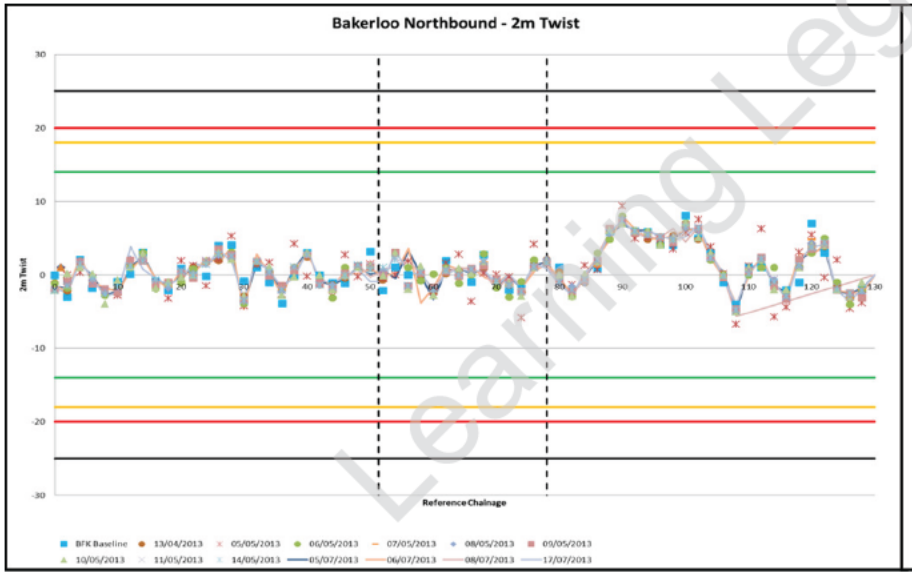


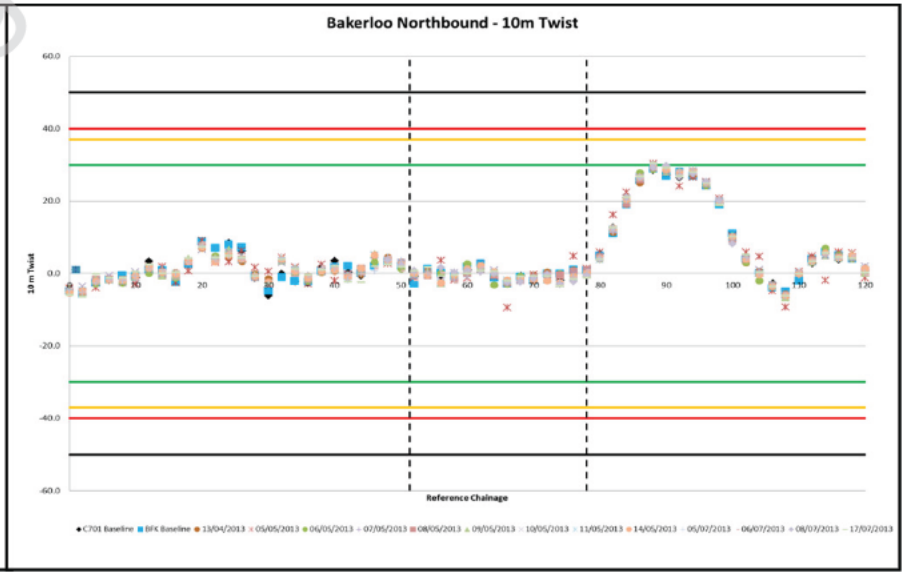
LU-TBMs Interfaces Tracks' Manual Survey decommissioning



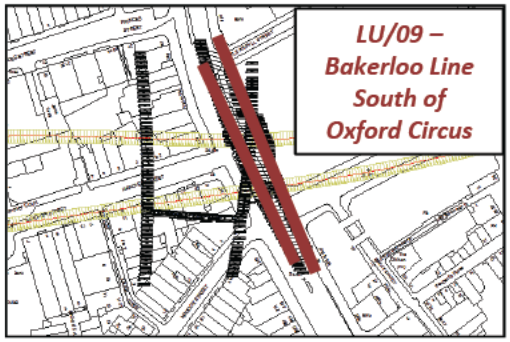
2. Manual Survey results – Northbound



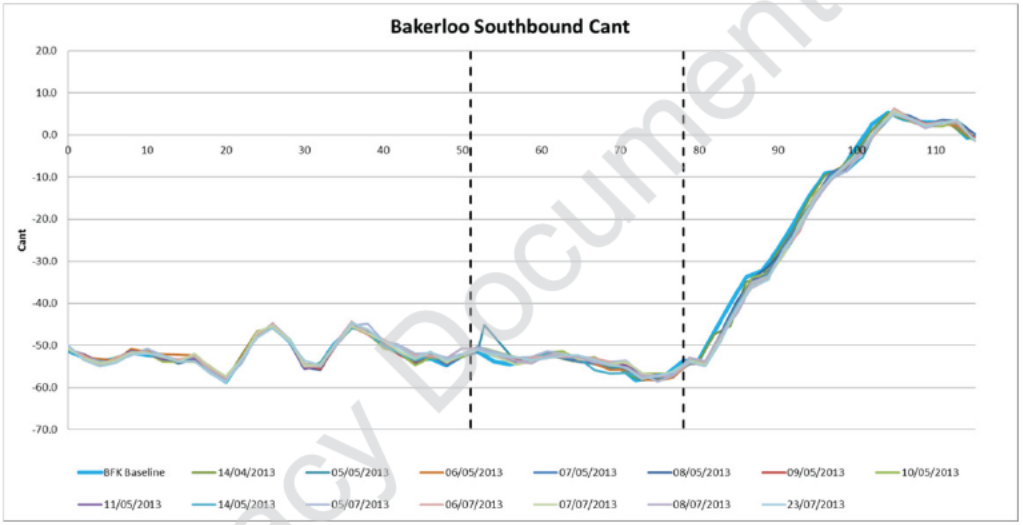


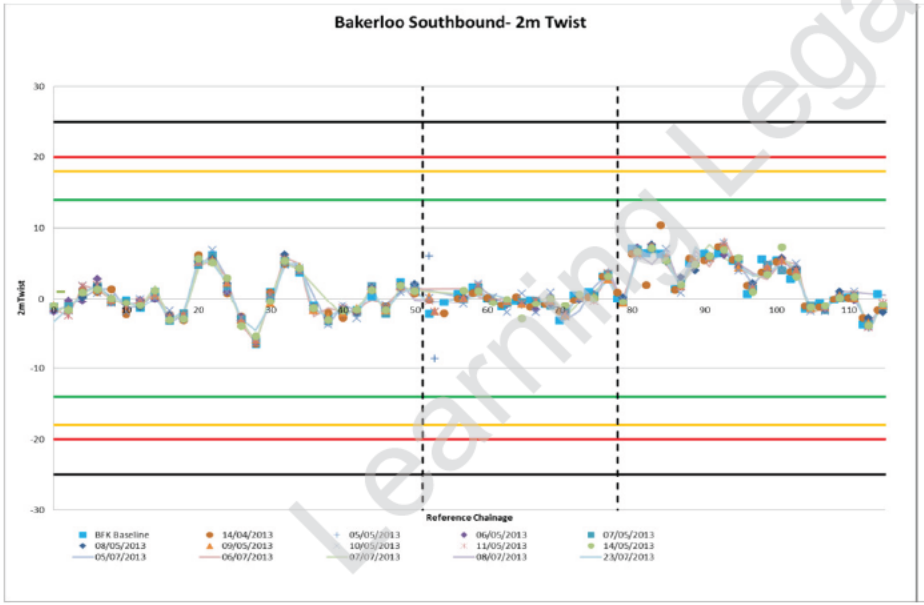


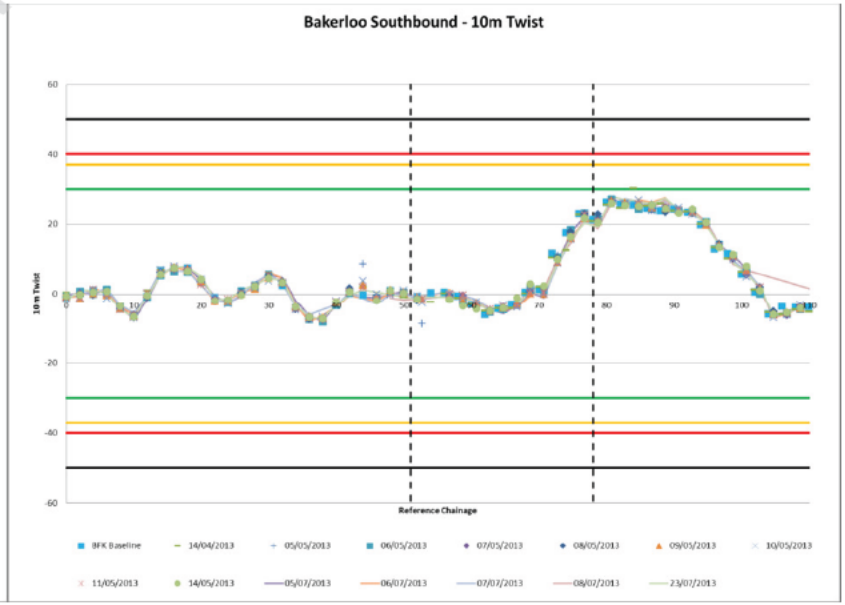
LU-TBMs Interfaces Tracks' Manual Survey decommissioning



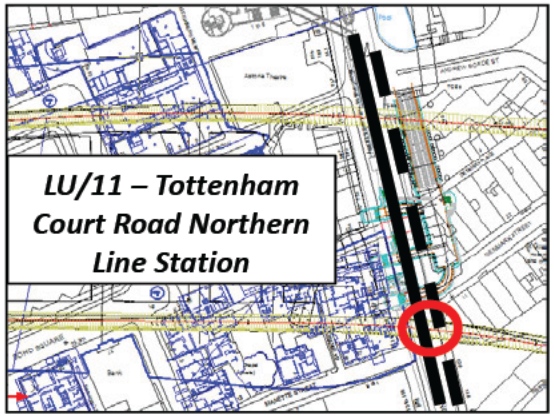
2. Manual Survey results – Southbound







LU-TBMs Interfaces Manual Track Readings decommissioning



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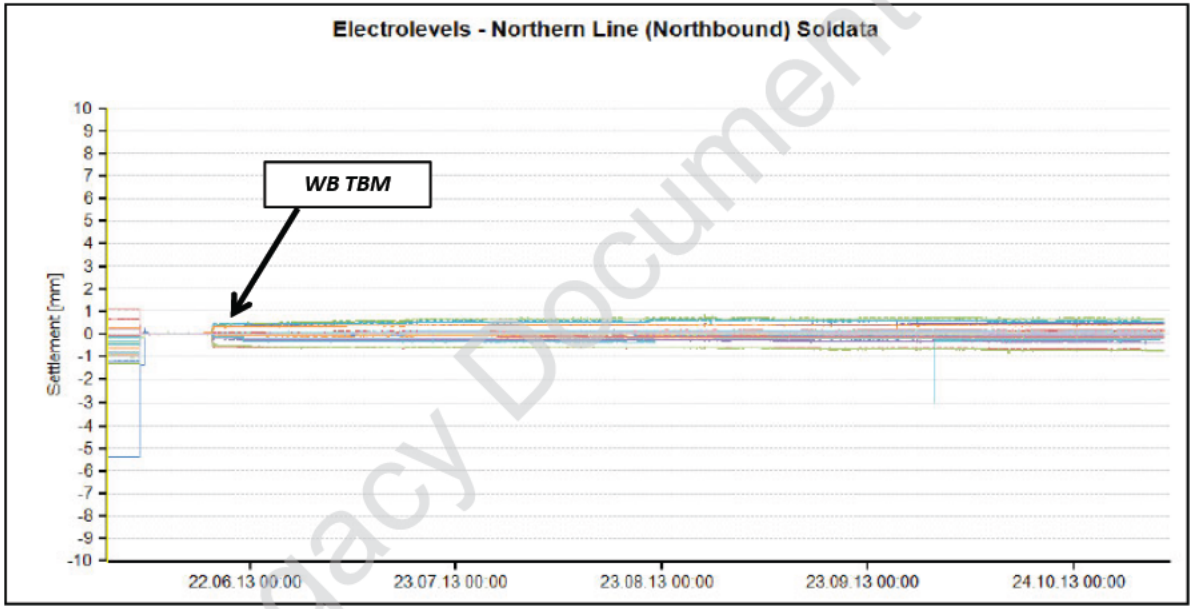
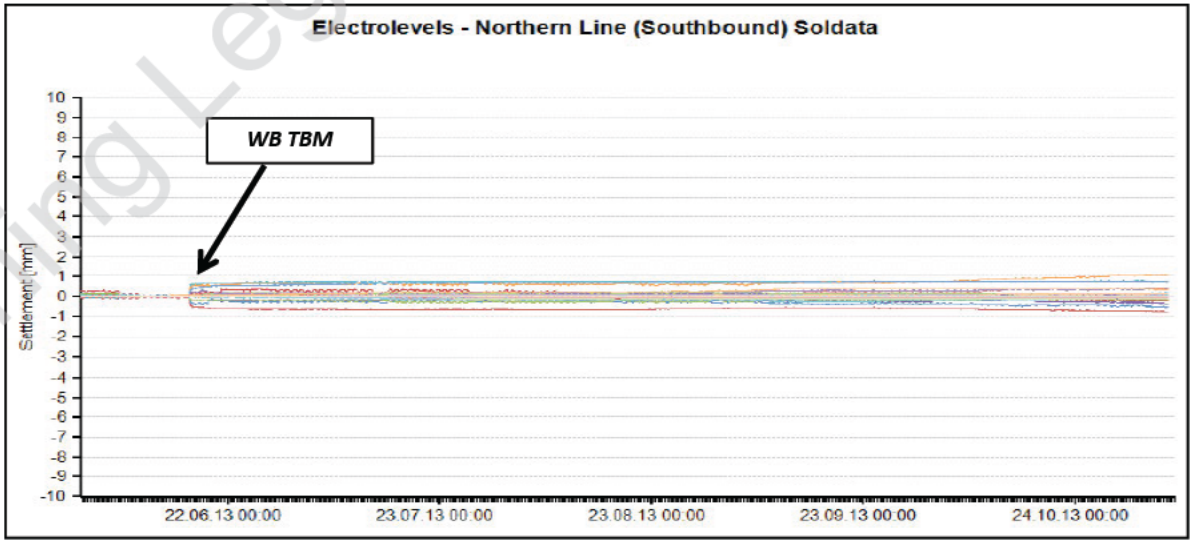
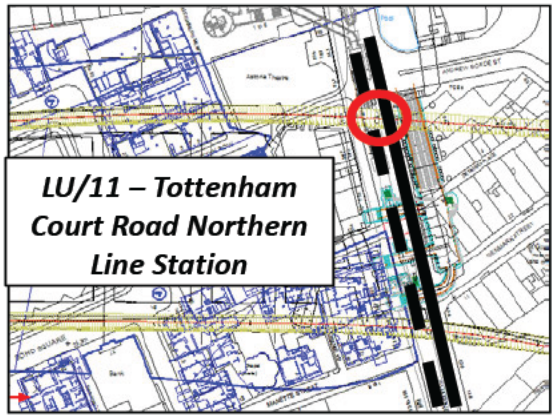




LU-TBMs Interfaces Manual Track Readings decommissioning



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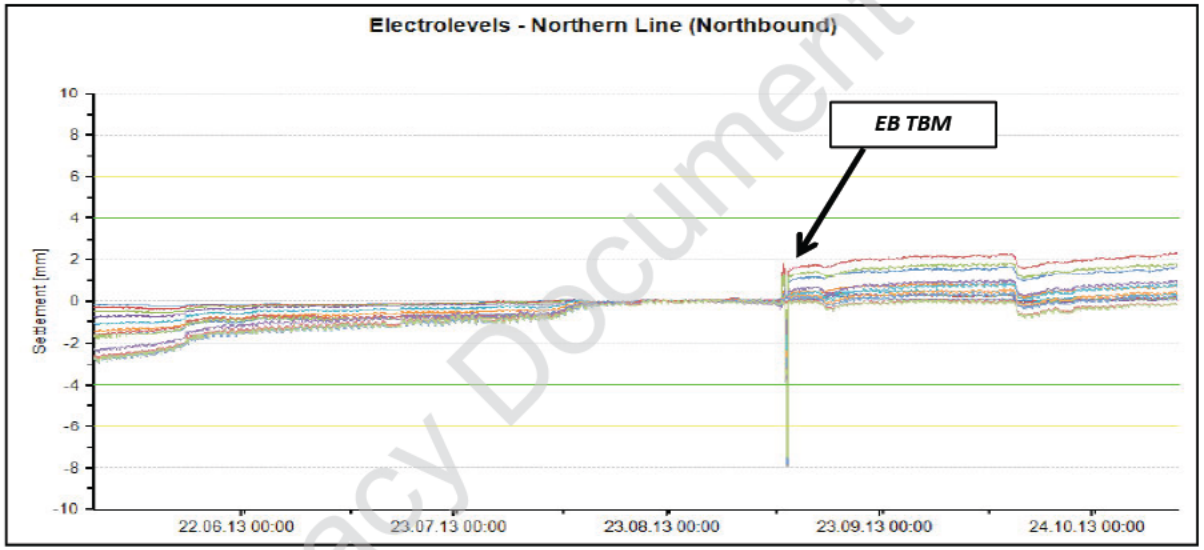
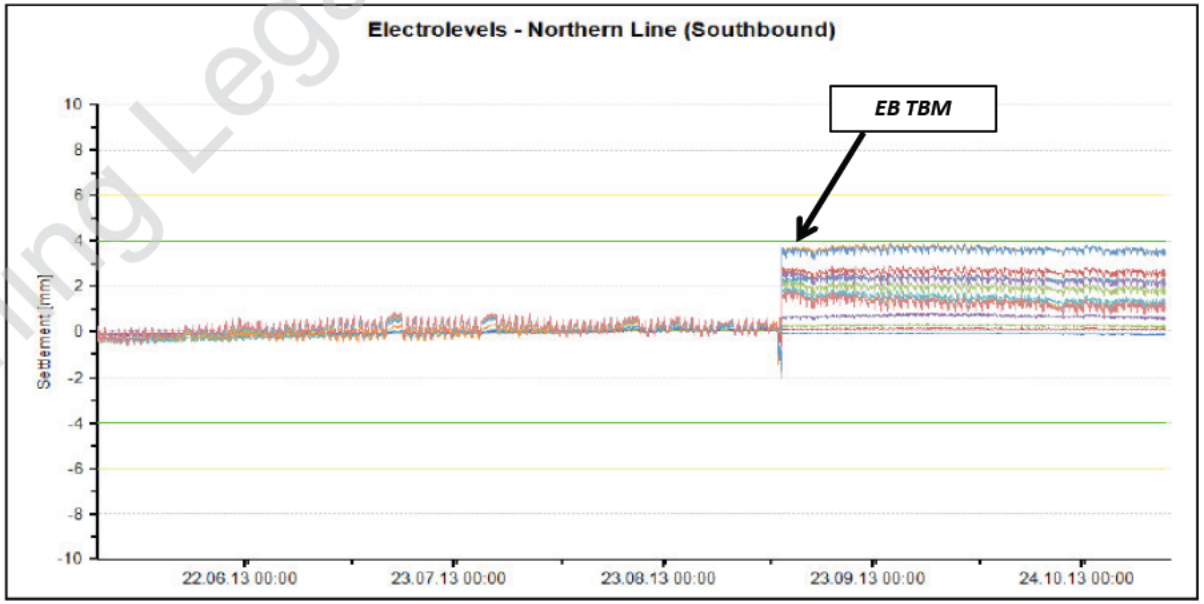
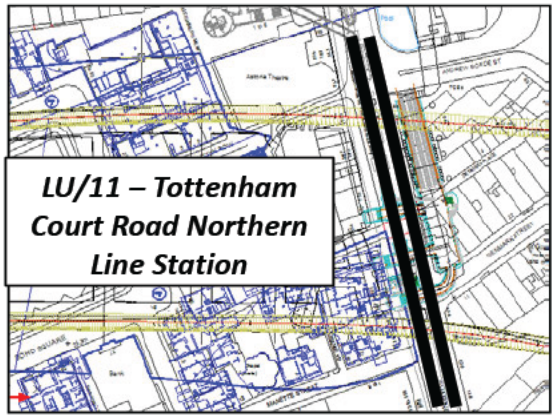




LU-TBMs Interfaces Manual Track Readings decommissioning



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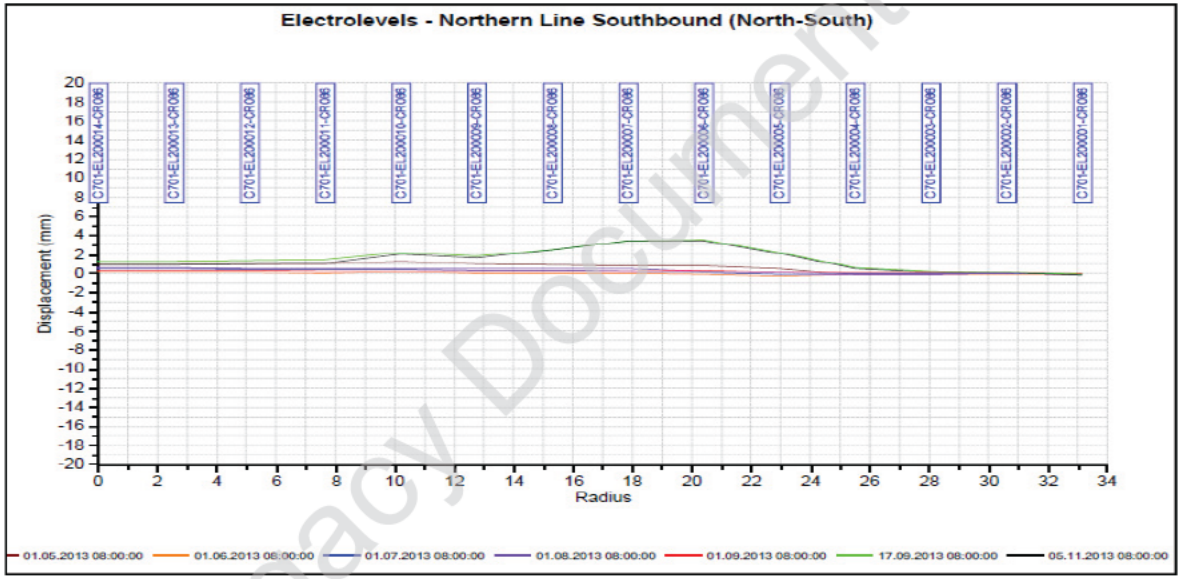
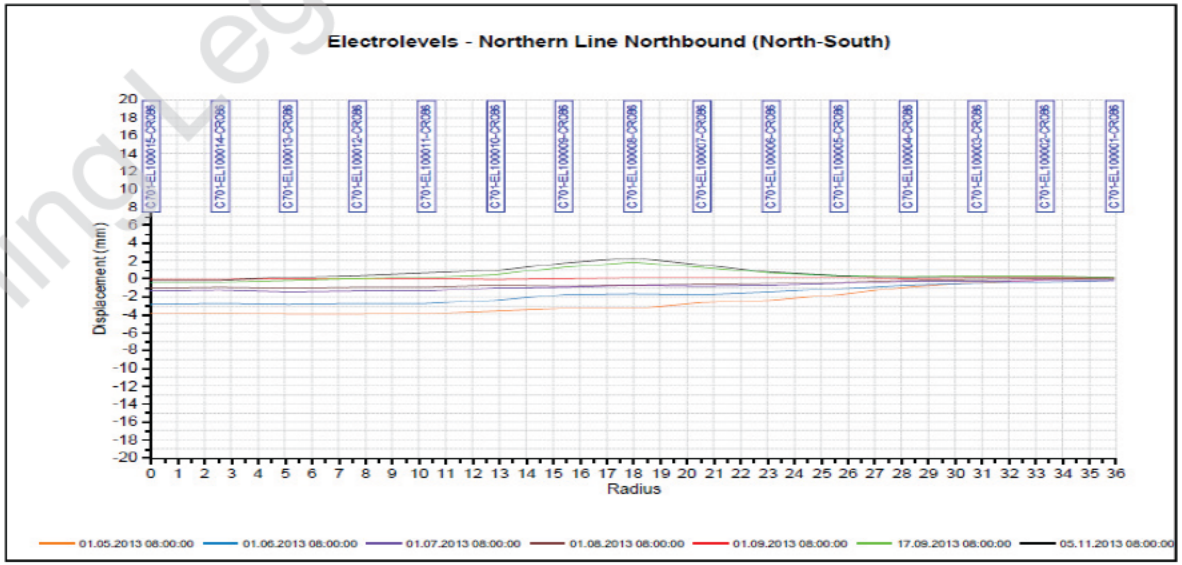
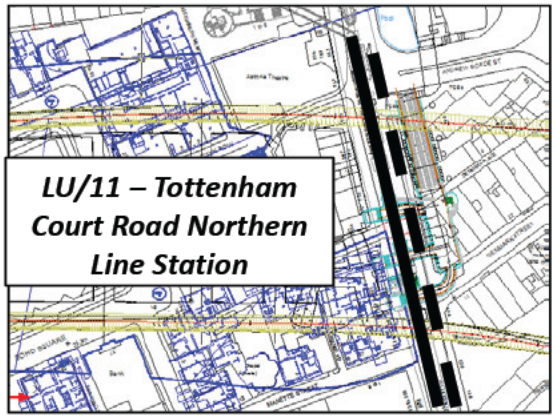
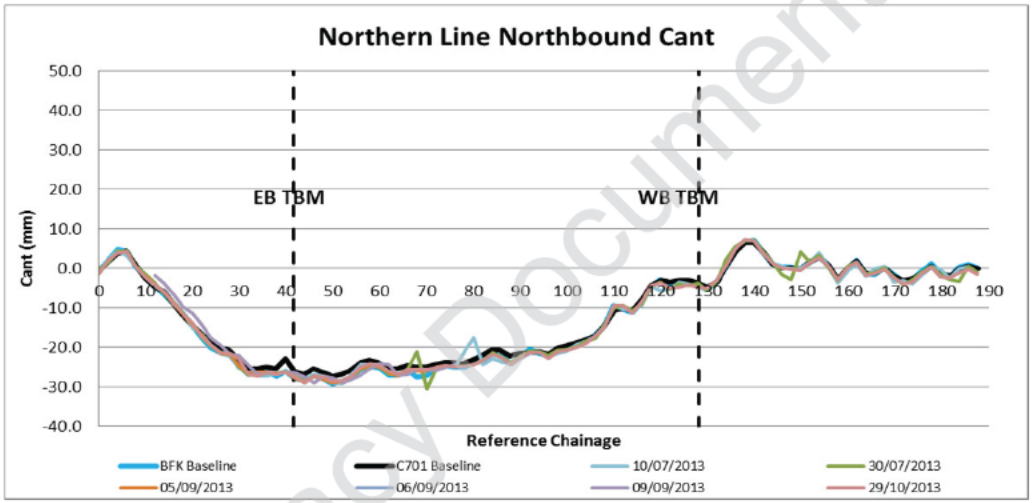


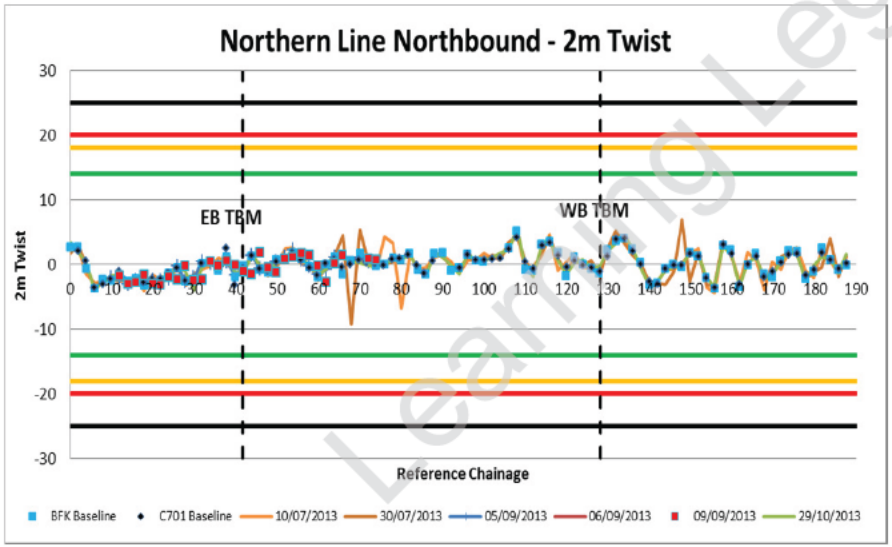


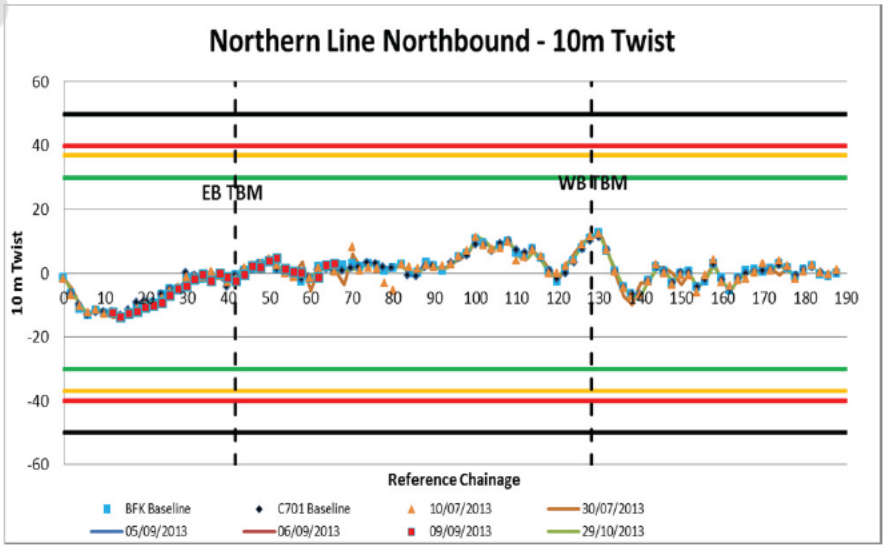
LU-TBMs Interfaces Manual Track Readings decommissioning



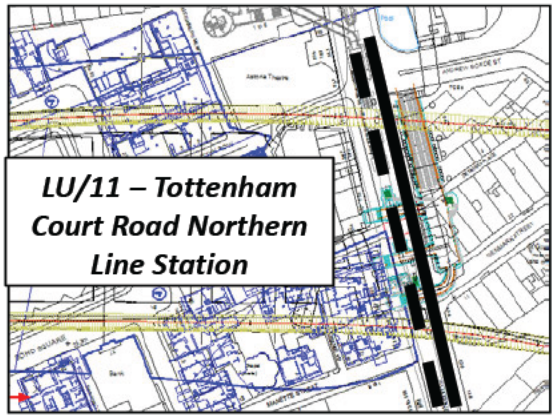


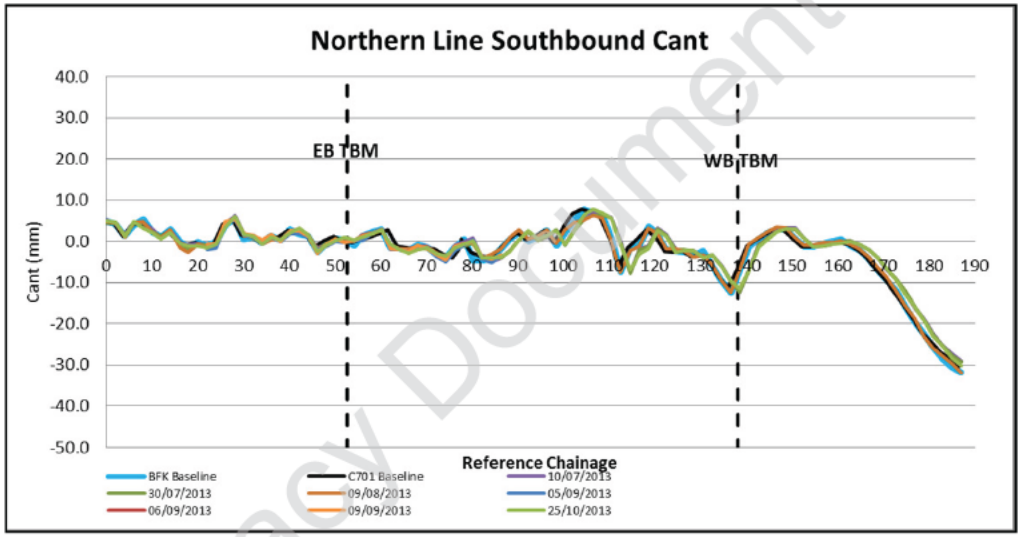
2. Manual Survey results – Northbound



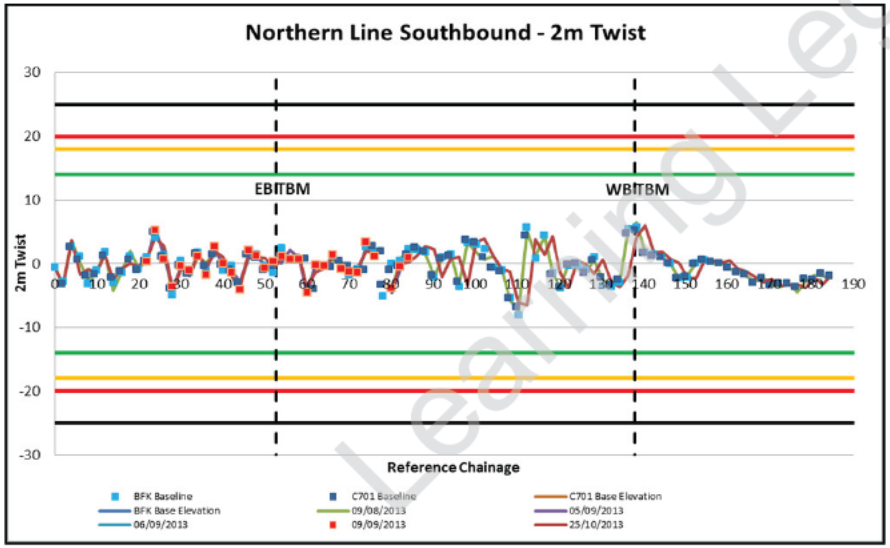


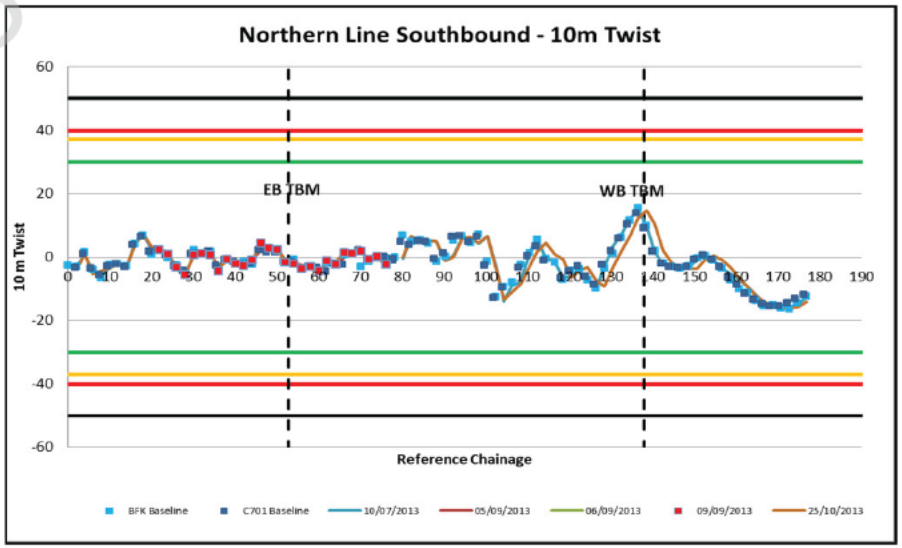
LU-TBMs Interfaces Manual Track Readings decommissioning



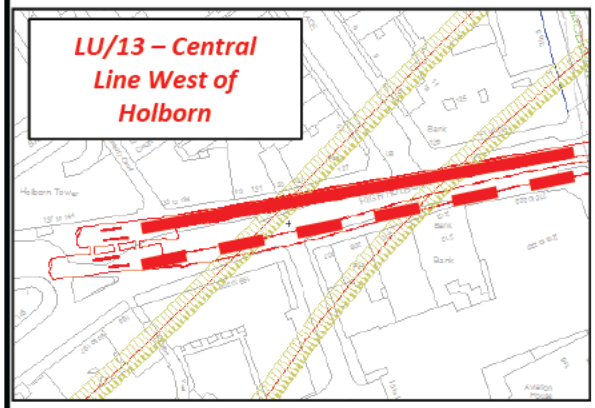


2. Manual Survey results – Southbound





LU-TBMs Interfaces Manual Track Readings decommissioning



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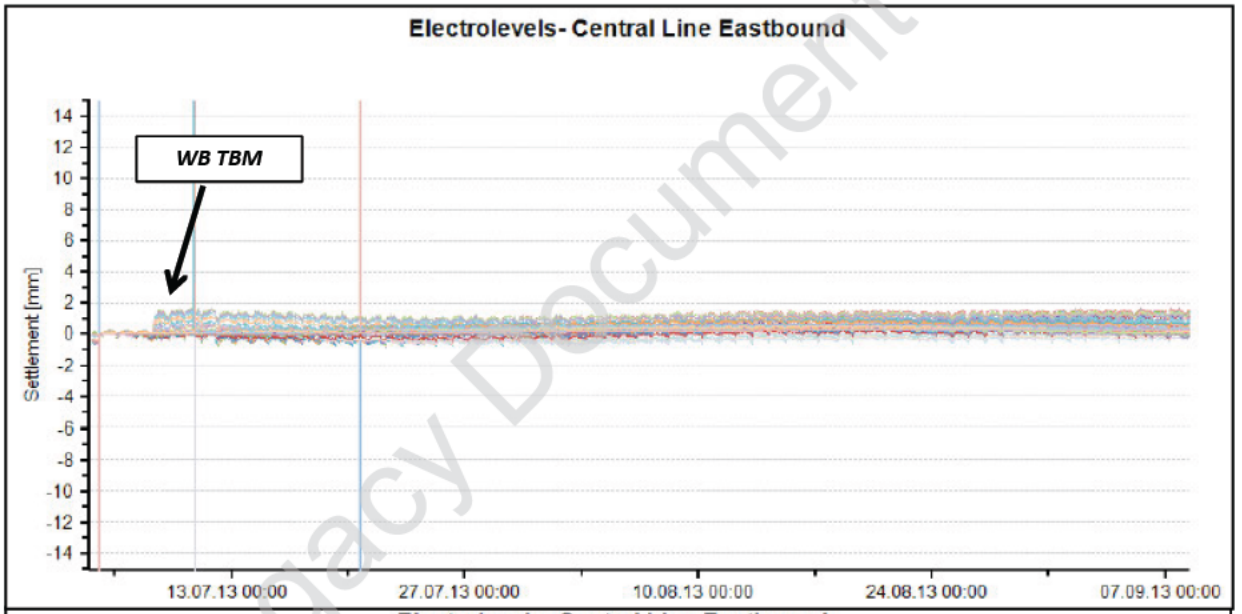
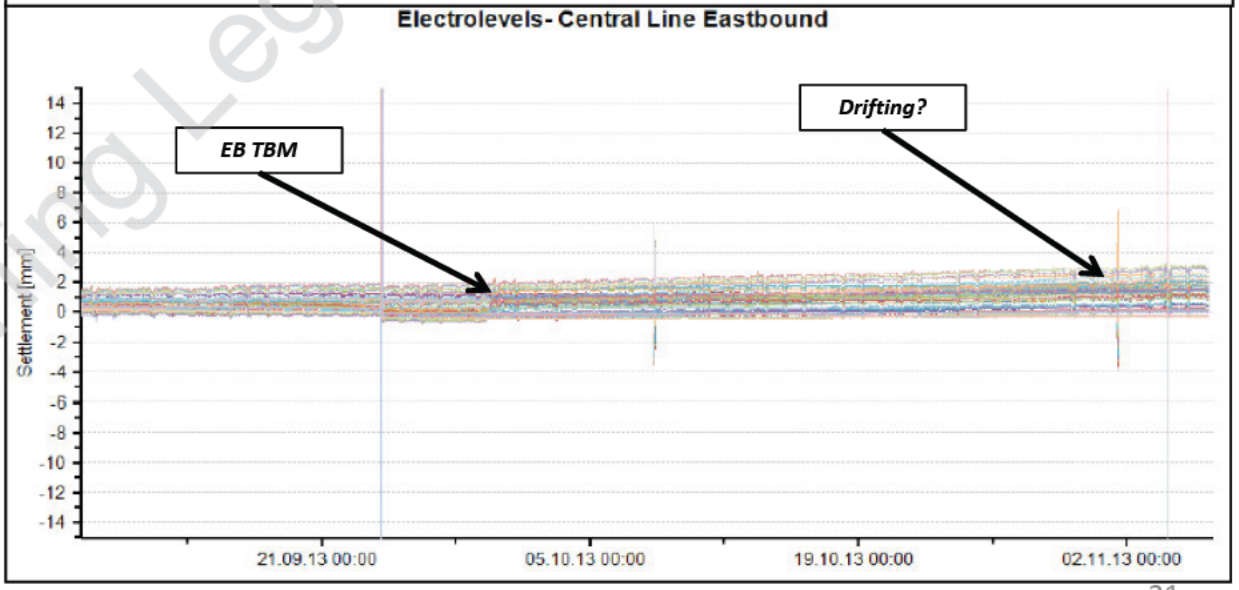
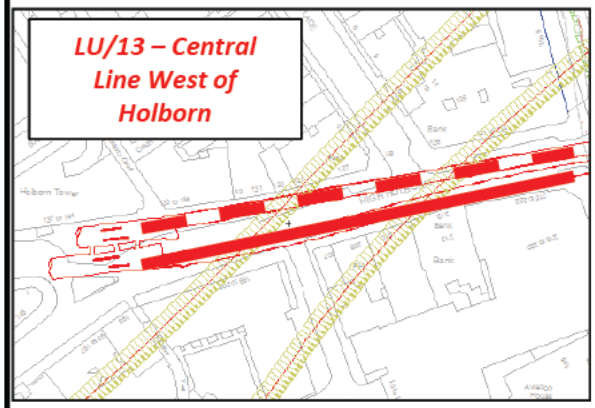
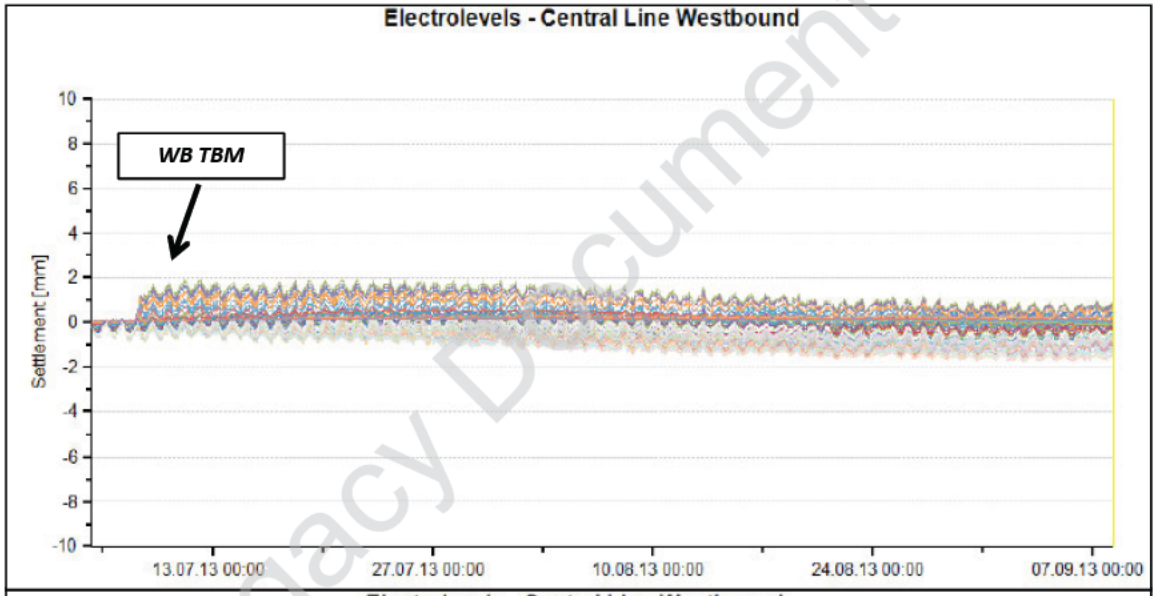


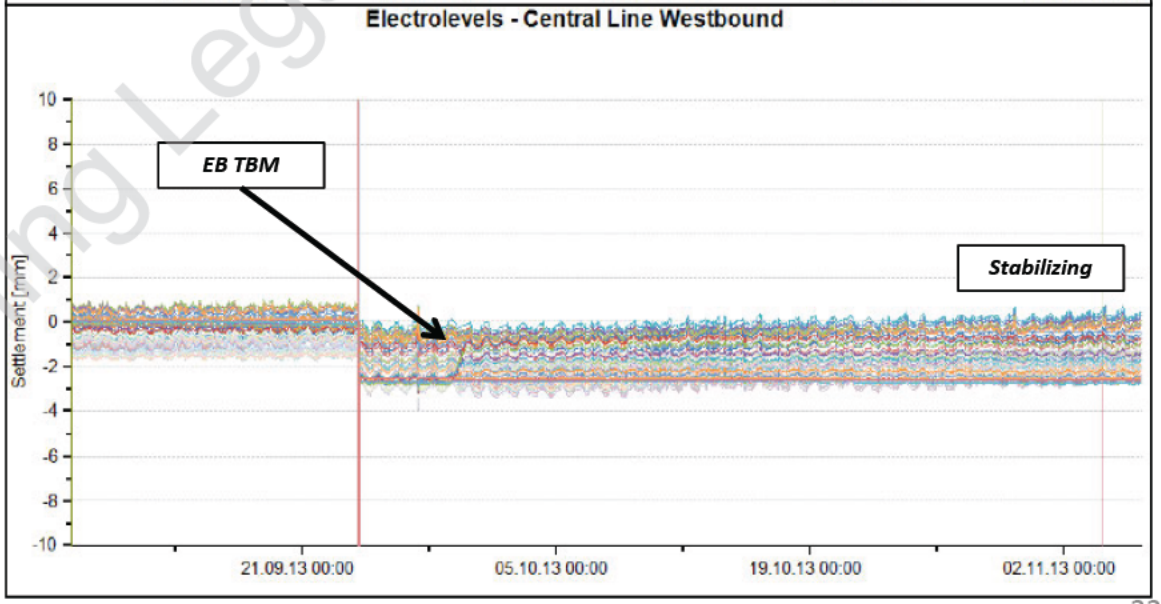


LU-TBMs Interfaces Manual Track Readings decommissioning

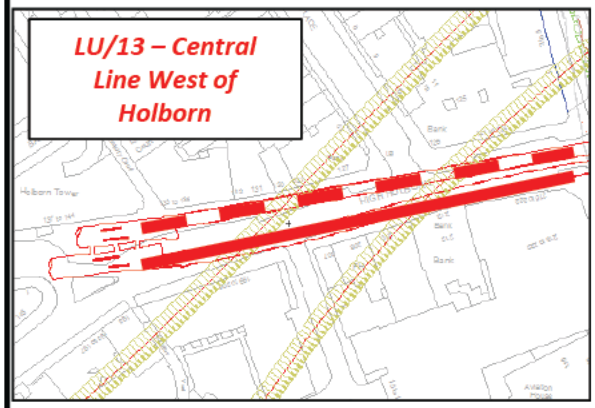


1.Electrolevels data

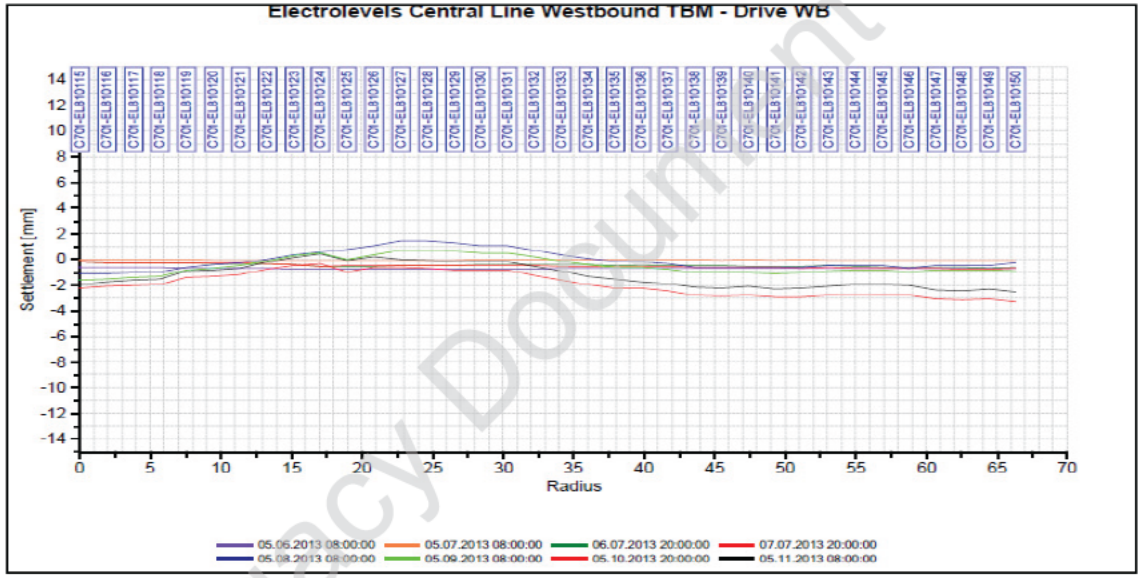


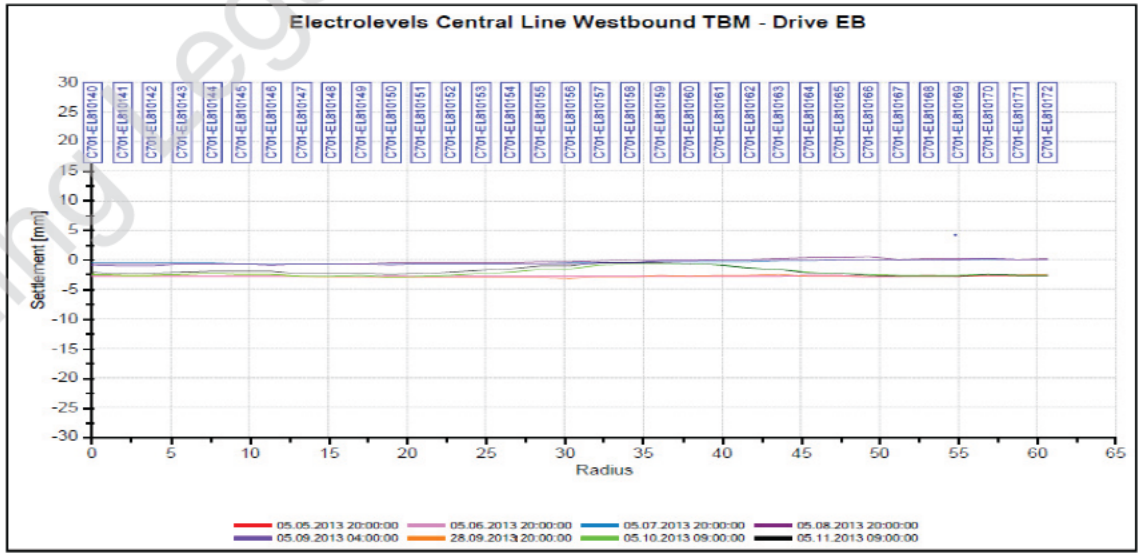


LU-TBMs Interfaces Manual Track Readings decommissioning

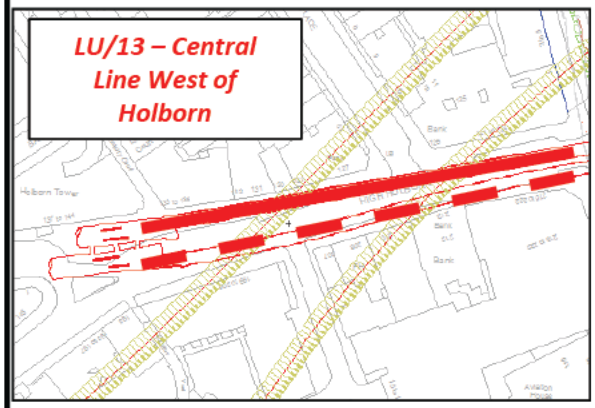


1.Electrolevels data

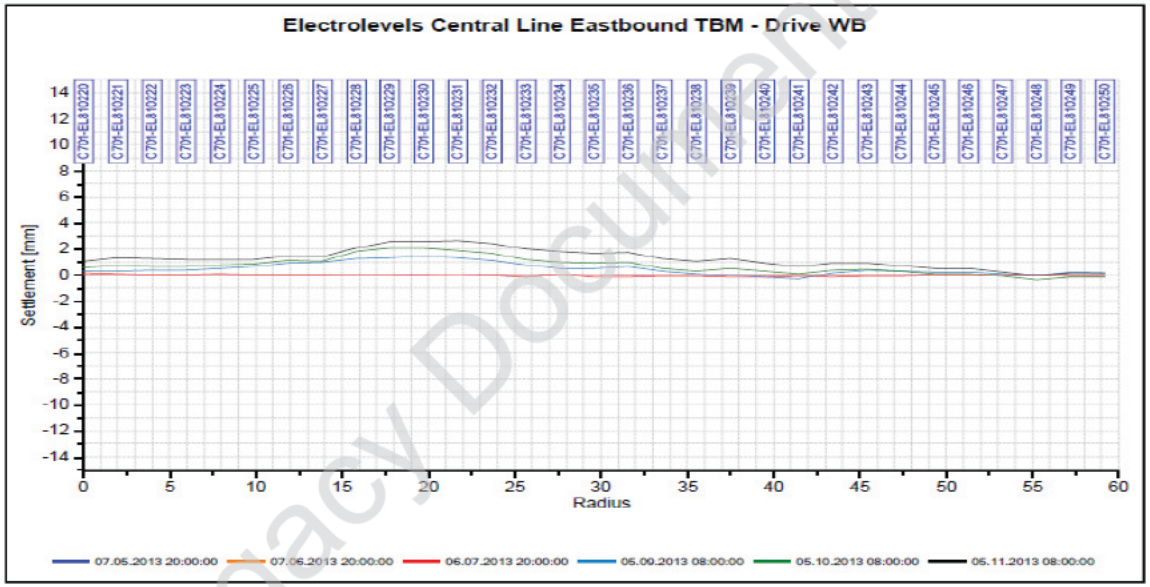


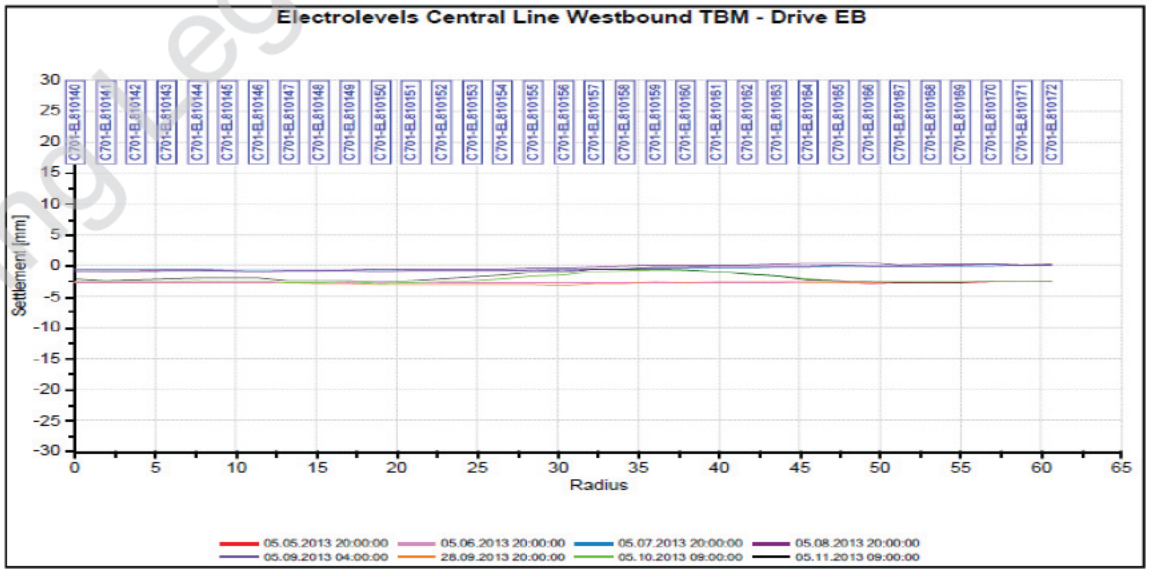


LU-TBMs Interfaces Manual Track Readings decommissioning

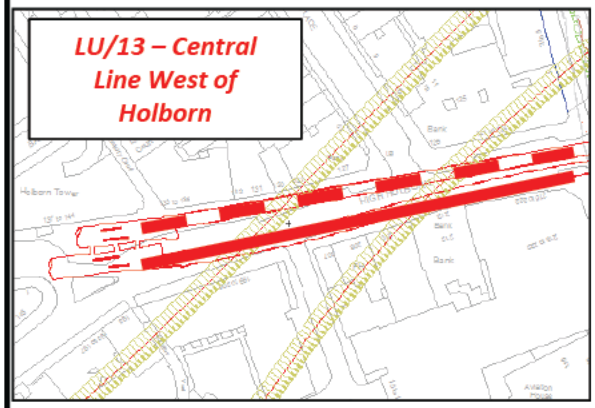


1.Electrolevels data

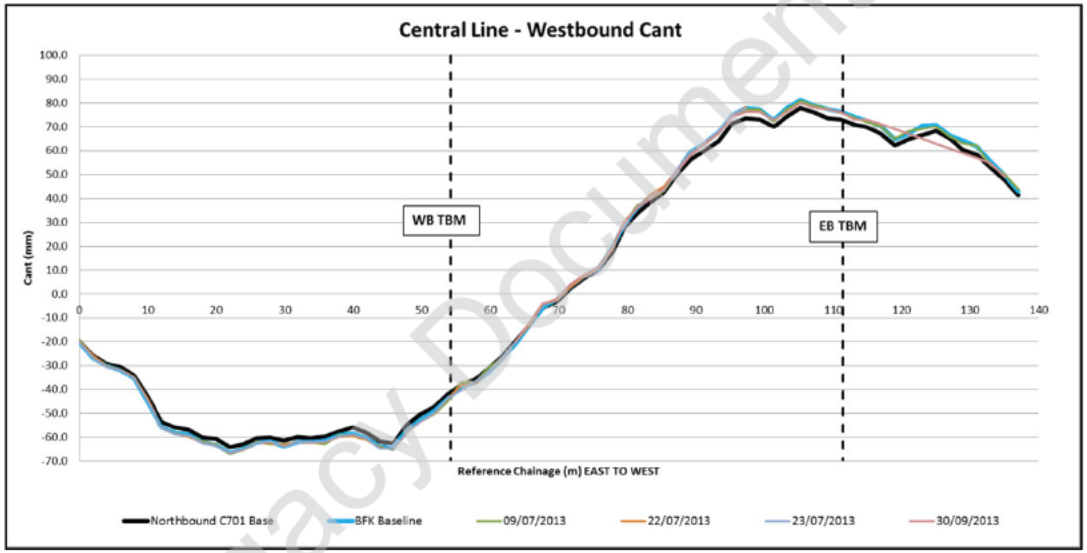


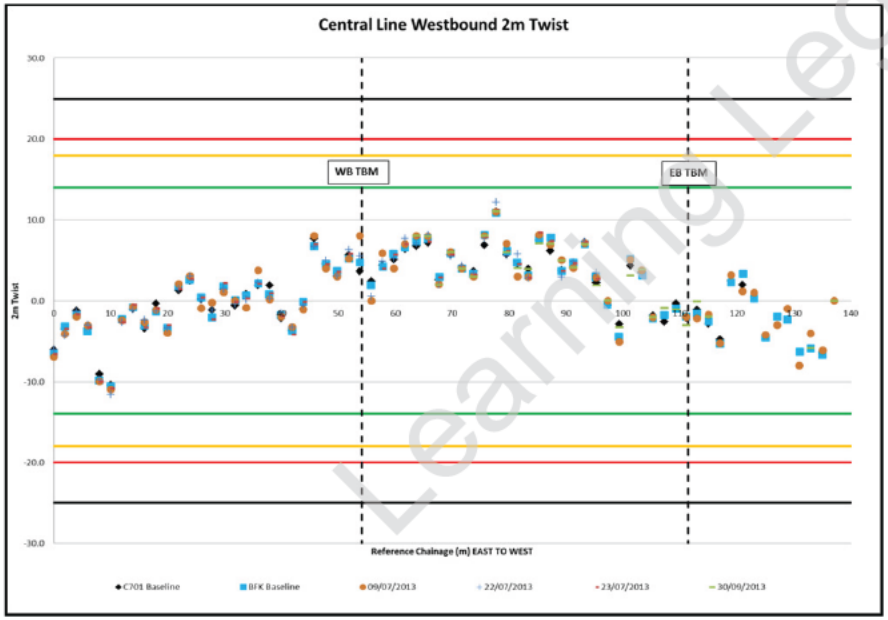


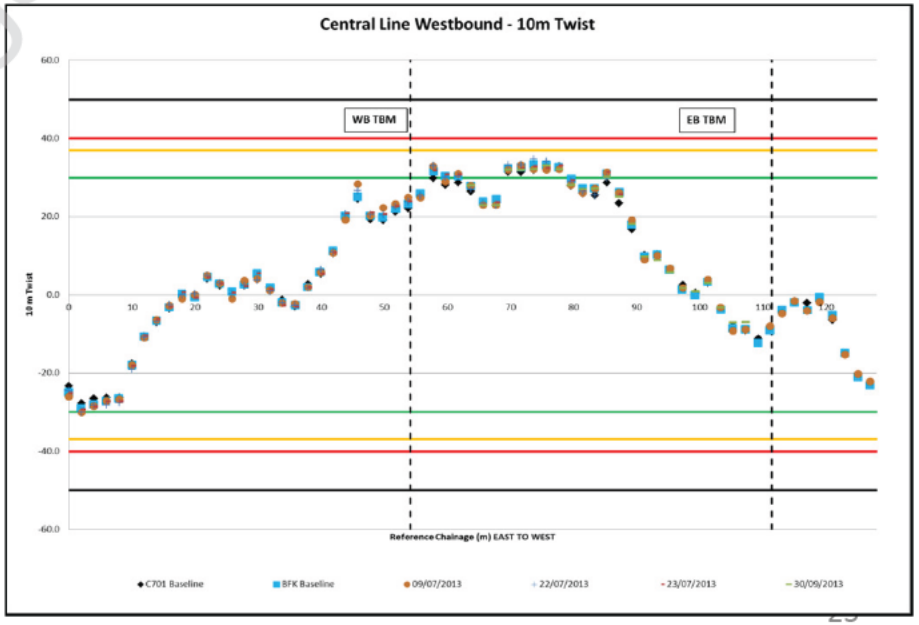
LU-TBMs Interfaces Manual Track Readings decommissioning



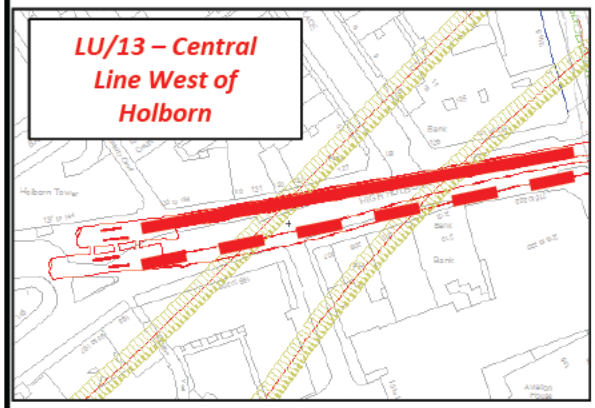
2. Manual Survey results – Westbound

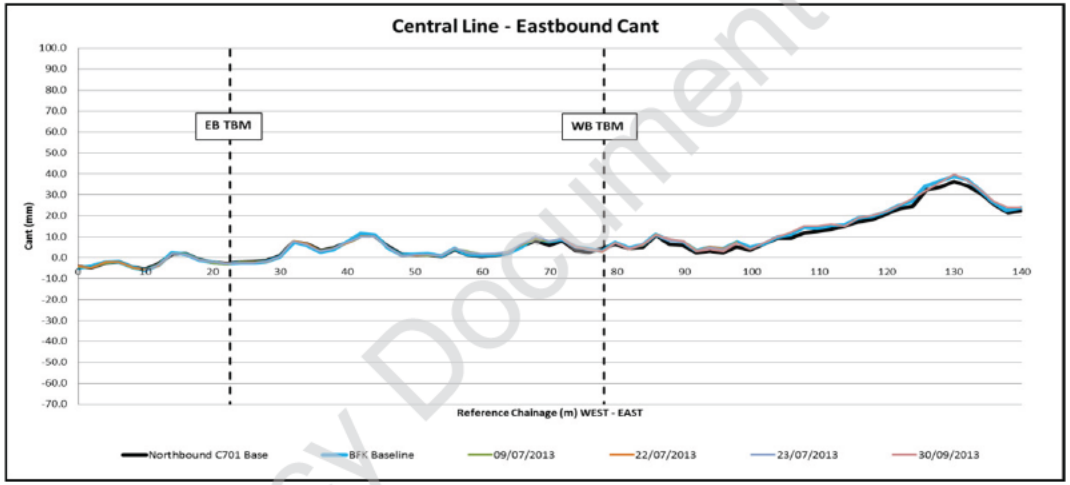




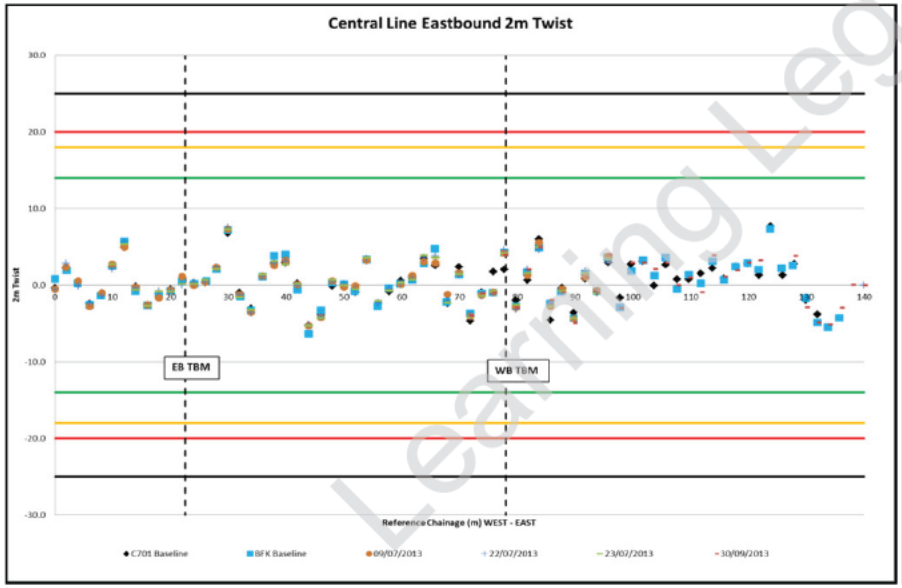


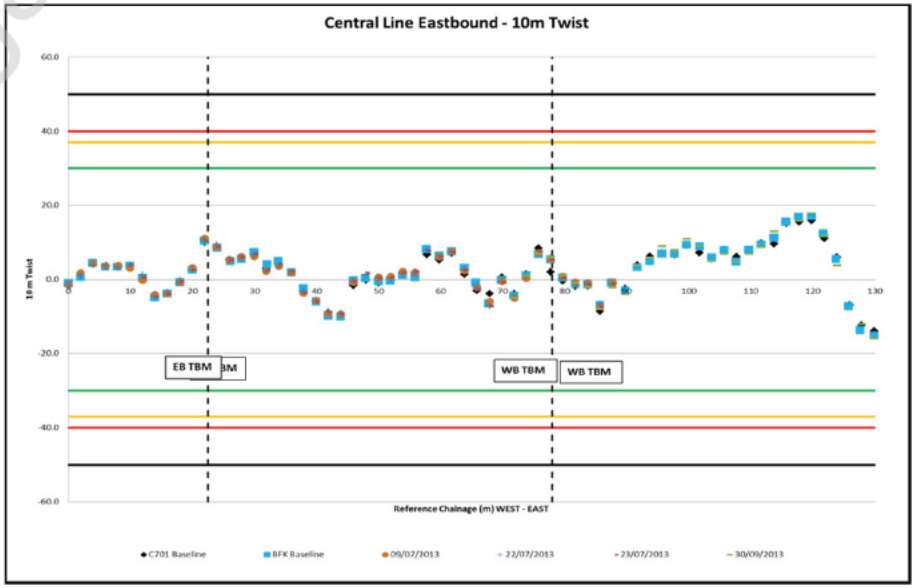
LU-TBMs Interfaces Manual Track Readings decommissioning





2. Manual Survey results – Eastbound





LU-TBMs Interfaces Manual Track Readings decommissioning

LU/05 – Central Line East of Lancaster Gate	EB Electrolevels: stabilized, max. settlement = approx. 20mm WB Electrolevels: quite stable, max. settlement = approx. 20mm
LU/08 – Victoria Line South of Oxford Circus	NB Electrolevels: stabilized, max. settlement = approx. 15-20mm (drifting) SB Electrolevels: stabilized, max. settlement = approx. 10mm
LU/09 – Bakerloo Line South of Oxford Circus	NB Electrolevels: quite stable (after drifting?) max. settlement = approx. 10mm SB Electrolevels: quite stable , max. settlement = approx. 10mm
LU/11 – Tottenham Court Road Northern Line Station	NB Electrolevels: quite stable (drift ng?), max. heave = approx. 3mm SB Electrolevels: quite stable , max. heave = approx. 4mm
LU/13 – Central Line West of Holborn	EB Electrole els: Drifting?, max. heave = approx. 4mm WB Electrolevels: quite stable (drifting?), max. heave = approx.3mm

Almost no effect on LU assets rails geometry (cant, 2m base twist, 10m base twist)

LU-TBMs Interfaces Manual Track Readings decommissioning