



C300/410



### Western Tunnels & Caverns Project

# Final Monitoring Report

## Bond Street Station – Manual Monitoring

CRL Document No. **C300-BFK-C4-RGN-CRT00\_ST005-53005**

Contract MDL reference: C14.022

### 1. Contractor Document Submittal History

Revision	Date	Prepared by	Checked by	Approved by	Reason for Issue
4.0	16/01/17	[Redacted]	[Redacted]	[Redacted]	For CRL Acceptance

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

Stakeholder submission required: LU  NR  DLR  RfL  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: \_\_\_\_\_ Name: \_\_\_\_\_ Role: \_\_\_\_\_ Date: \_\_\_\_\_  
 Sign: \_\_\_\_\_ Name: \_\_\_\_\_ Role: \_\_\_\_\_ Date: \_\_\_\_\_

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

Stakeholder Organisation	Job Title	Name	Signature	Date	Acceptance
					<input type="checkbox"/>
					<input type="checkbox"/>

### 3. Acceptance by Crossrail:

	<b>Crossrail Review and Acceptance Decal</b> This decal is to be used for submitted documents requiring acceptance by Crossrail	
<input checked="" type="checkbox"/>	Code 1. Accepted. Work May Proceed	
<input type="checkbox"/>	Code 2. Not Accepted. Revise and resubmit. Work may proceed subject to incorporation of changes indicated	
<input type="checkbox"/>	Code 3. Not Accepted. Revise and resubmit. Work may not proceed	
<input type="checkbox"/>	Code 4. Not Accepted. For information only. Receipt is confirmed	
Reviewed/Approved by: (signature)	Print Name: [Redacted]	Position: [Redacted] Date: 23/1/17
Acceptance by Crossrail does not relieve the designer/supplier from their compliance with their contract. This does not constitute Crossrail approval of design, details, calculations, analyses, test methods or materials developed or selected by the designer/supplier.		

<b>CONTENTS</b>		
<b>1.</b>	<b>Purpose and Scope</b>	<b>4</b>
<b>2.</b>	<b>Observed settlements: West Area BRE</b>	<b>7</b>
2.1.	Duke Street East	8
2.2.	Duke's Yard North	9
2.3.	Binney Street West	10
2.4.	Binney Street East	11
2.5.	Gilbert Street West	12
2.6.	Gilbert Street East (North)	13
2.7.	Gilbert Street East (South)	14
2.8.	Brook Street North	15
2.9.	Weighhouse Street South	15
2.10.	Weighhouse Street North	16
2.11.	Oxford Street South (West)	17
<b>3.</b>	<b>Observed Settlement: West Area PLP</b>	<b>18</b>
3.1.	Duke Street East	19
3.2.	Duke's Yard North	20
3.3.	Binney Street West	21
3.4.	Gilbert Street West	22
3.5.	Weighhouse Street North	24
3.6.	Oxford Street South	26
<b>4.</b>	<b>Observed Settlement: South area BRE</b>	<b>27</b>
4.1.	New Bond Street West (South)	28
4.2.	New Bond Street East (South)	29
4.3.	Brook Street South (West)	30
4.4.	Lancashire Court	31
4.5.	Brook Street North (Central)	31
<b>5.</b>	<b>Observed Settlement: South area PLP</b>	<b>32</b>
5.1.	New Bond Street West (South)	33
5.2.	New Bond Street East (South)	34
5.3.	Brook Street South (West)	35
5.4.	Lancashire Court	36
<b>6.</b>	<b>Observed Settlement: East area BRE</b>	<b>37</b>
6.1.	St. George Street West	38
6.2.	St. George Street East	38

<b>6.3.</b>	<b>Hanover Square South</b>	<b>39</b>
<b>6.4.</b>	<b>Hanover Square East</b>	<b>39</b>
<b>6.5.</b>	<b>Hanover Square North</b>	<b>40</b>
<b>6.6.</b>	<b>Harewood Place West</b>	<b>40</b>
<b>6.7.</b>	<b>Harewood Place East</b>	<b>41</b>
<b>6.8.</b>	<b>Princes Street South</b>	<b>41</b>
<b>6.9.</b>	<b>Oxford Street South (East)</b>	<b>42</b>
<b>7.</b>	<b>Observed Settlement: East Area PLP</b>	<b>43</b>
<b>7.1.</b>	<b>St. George Street West</b>	<b>44</b>
<b>7.2.</b>	<b>St. George Street Centre</b>	<b>44</b>
<b>7.3.</b>	<b>Hanover Square East</b>	<b>45</b>
<b>7.4.</b>	<b>Hanover Square North</b>	<b>46</b>
<b>7.5.</b>	<b>Hanover Square Gardens</b>	<b>47</b>
<b>7.6.</b>	<b>Hanover Square Footpath</b>	<b>47</b>
<b>7.7.</b>	<b>Hanover Square Inner East</b>	<b>48</b>
<b>7.8.</b>	<b>Hanover Square Inner South</b>	<b>49</b>
<b>7.9.</b>	<b>Harewood Place West</b>	<b>50</b>
<b>7.10.</b>	<b>Oxford Street South</b>	<b>50</b>
<b>8.</b>	<b>Reference Documents</b>	<b>51</b>
<b>Appendix 1.</b>	<b>Final Settlement Distribution</b>	<b>52</b>

## 1. Purpose and Scope

The purpose of this report is to supplement the Grout Shaft final reports produced for the Bond Street Station area, as listed in Table 1.1. These reports provide a summary of the observed movements relative to the works at Bond Street Station in accordance with the requirements of the Instrumentation and Monitoring Specification (KX10 C122-OVE-Z4-RSP-CR001-00007), Clauses KX10.2113 and KX10.2114. They include all manual survey data up to the termination of monitoring. However, there is additional instrumentation within the overall area of BOS station which is outside the extent of the compensation grouting arrays, as illustrated in Figure 1.1. This report presents the monitoring data from BRE and PLP not covered in the other reports.

### 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.

Report title:	Report Number:
Final and Close Out Monitoring Report:	C300-BFK-C4-RGN-CRT00_ST005-
Grouting Summary and I&M Final Report – BOS GS1	51211
Grouting Summary and I&M Final Report – BOS GS2	51179
Grouting Summary and I&M Final Report – BOS GS3	51214
Grouting Summary and I&M Final Report – BOS GS4	51215
Grouting Summary and I&M Final Report – BOS GS5	51178

**Table 1.1** List of Final / Close Out Reports for BOS Station.

There are three areas not covered in the Grout Shaft Close Out reports as shown on Figure 1.1. These comprise:

1. West – Duke Street to Gilbert Street, plus Weighhouse Street, Oxford Street and Brook Street east of Gilbert Street
2. South – Area to the west of New Bond Street from Brook Street to the south
3. East – Soho Square (excluding west façade)

All of these areas are primarily affected by works for the Ticket Halls and the only significant impact from C300 works is from the two TBM drives and the link to Bond Street London Underground station (AP1). The Greenfield 1mm settlement contour for all excavations and tunnels (provided by C122) is shown on Figure 1.1. The approximate extent of the 1mm contour due to BFK works is also shown (in blue) for AP1 and separately for the rest of the tunnels.

A plot of the monitoring data with time is provided, with the influence of the C300 works identified. If there was a significant impact (>10mm settlement), a profile plot is provided. The rate of post-construction settlement is compared to the specified limit of 2mm/year. If significant differential settlement occurred, slopes are compared to the trigger values given in the C122 I&M plan,

The monitoring points from which data is presented are shown on Figure 1.1. A figure showing the location of each point is included in the relevant section. A summary of the final settlements recorded on all BRE and PLP is given on the figures in Appendix 1. It should be noted that the data from all instruments is available on the UCIMS platform.

Since C411 works at the WTH preceded the commencement of monitoring by BFK, adjustments have been made to the monitoring data as described in report “Adjustment of BRE, PLP and Prisms in BOS area” C300-BFK-C4-RGN-CRT00\_ST005-50758. The adjustments are evident in the time-settlement plots where the initial settlement at the start of the data is non-zero.

A list of reference documents is given in Section 8.

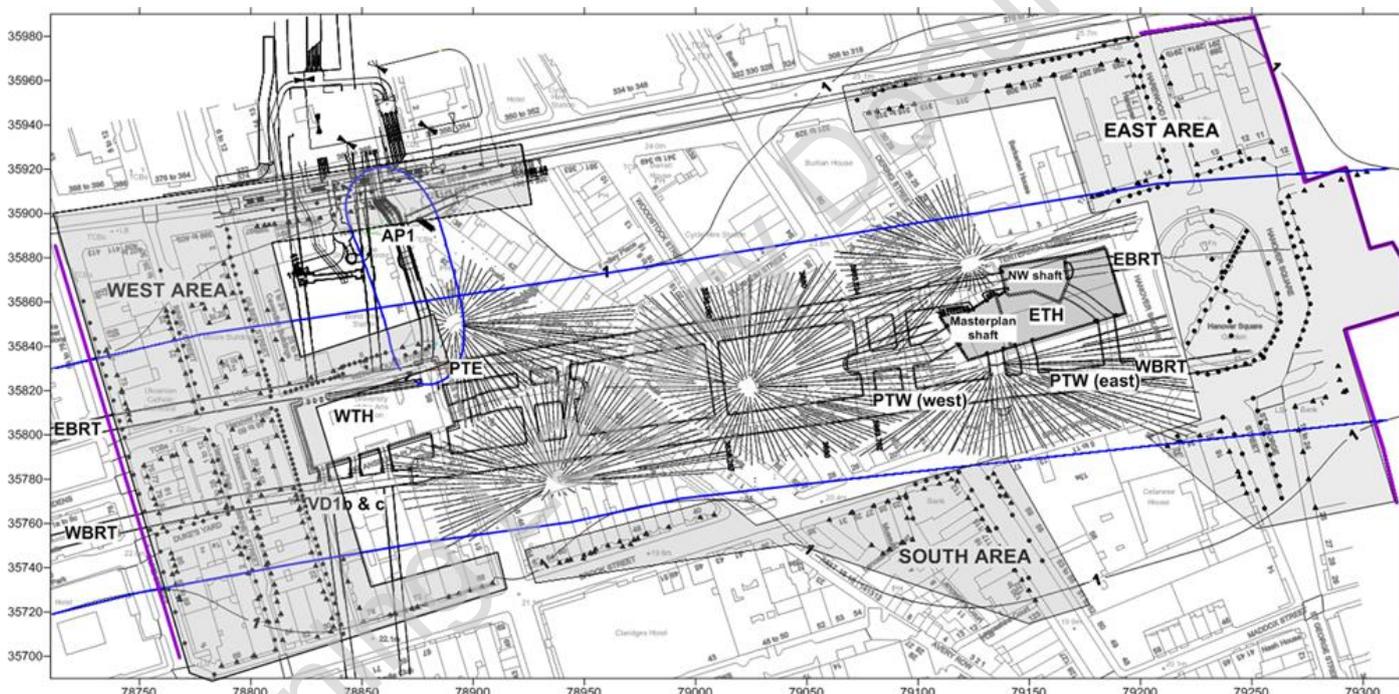


Figure 1.1 Areas from which data is presented

Construction Activity	Abbreviation	Start Date	End Date
WTH d-walls	WTH	pre C300 data	Oct-12
WTH Excavation	WTH	Nov-12	Nov-14
Westbound Running Tunnel	WBRT	14/03/13	20/03/13
Eastbound Running Tunnel	EBRT	21/04/13	26/04/13
Ventilation Duct 1b	VD1b	26/04/14	05/05/14
Ventilation Duct 1c	VD1c	13/05/14	22/05/14
Platform Tunnel Eastbound (west end)	PTE	11/06/14	18/06/14
WTH de-watering	WTH	Jan-13	Sep-13
LU Link Tunnel (Access Passage 1)	AP1	06/12/14	27/02/15

Table 1.2 Construction Activities – West Area



C300/410

Western Tunnels & Caverns Project



Final Monitoring Report: C300-BFK-C4-RGN-CRT00\_ST005-  
53005 Rev 4.0

Bond Street Station – Page 6 of 54  
Manual Monitoring

Construction Activity	Abbreviation	Start Date	End Date
ETH Masterplan Shaft Excavation	ETH_MP	Apr-12	Oct-12
ETH North West Shaft Excavation	ETH_NW	Nov-11	Oct-12
ETH Excavation	ETH	Jan-14	Jan-16
Westbound Running Tunnel	WBRT	03/04/13	04/05/13
Eastbound Running Tunnel	EBRT	29/06/13	02/07/13
Platform Tunnel Westbound (west)	PTW	10/11/13	21/01/14
Platform Tunnel Westbound (east)	PTW	19/04/14	15/08/14

Table 1.3 Construction Activities – South and East Area

Learning Legacy Document

## 2. Observed settlements: West Area BRE

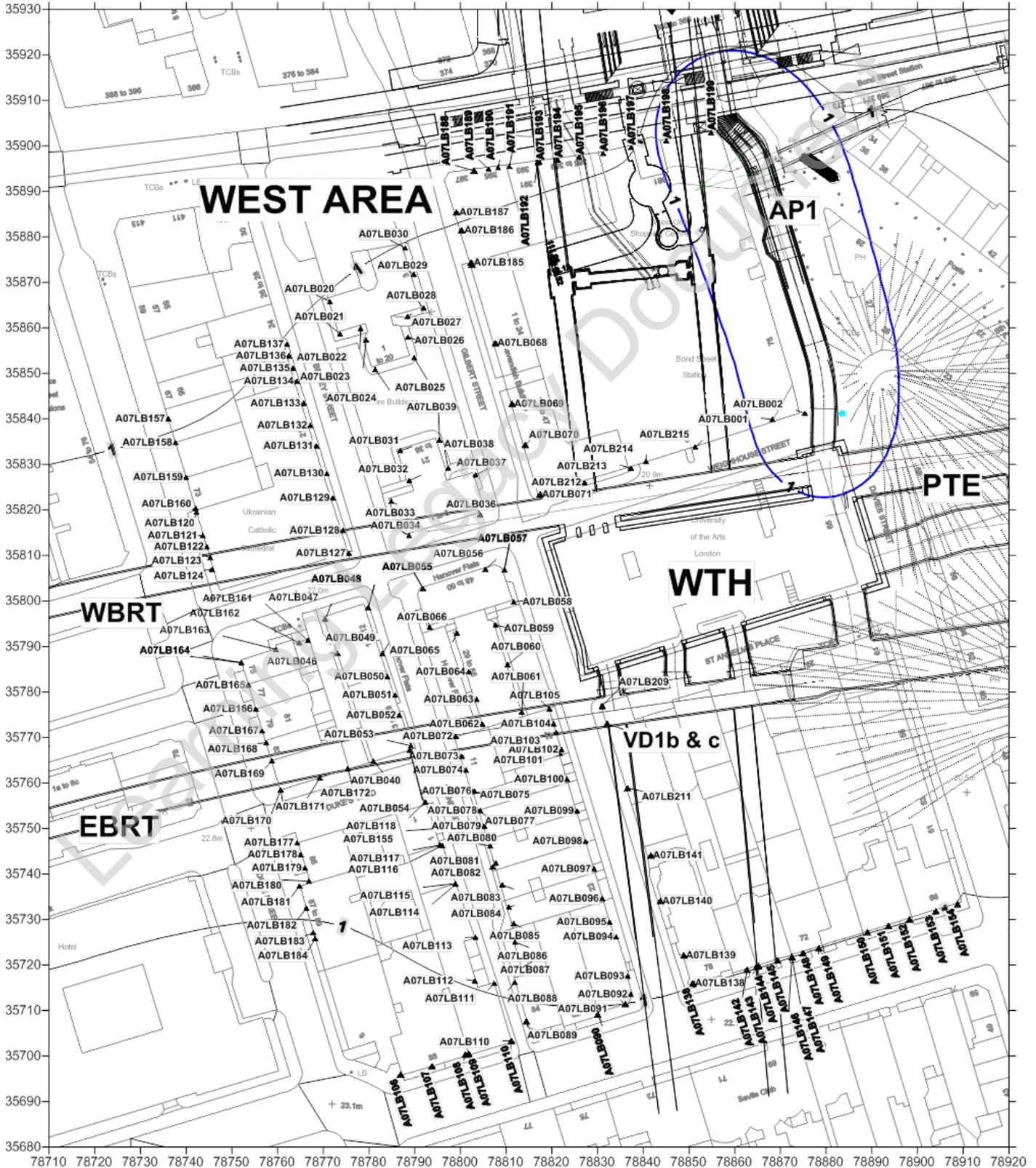


Figure 2.1: Location of BRE – west area

## 2.1. Duke Street East

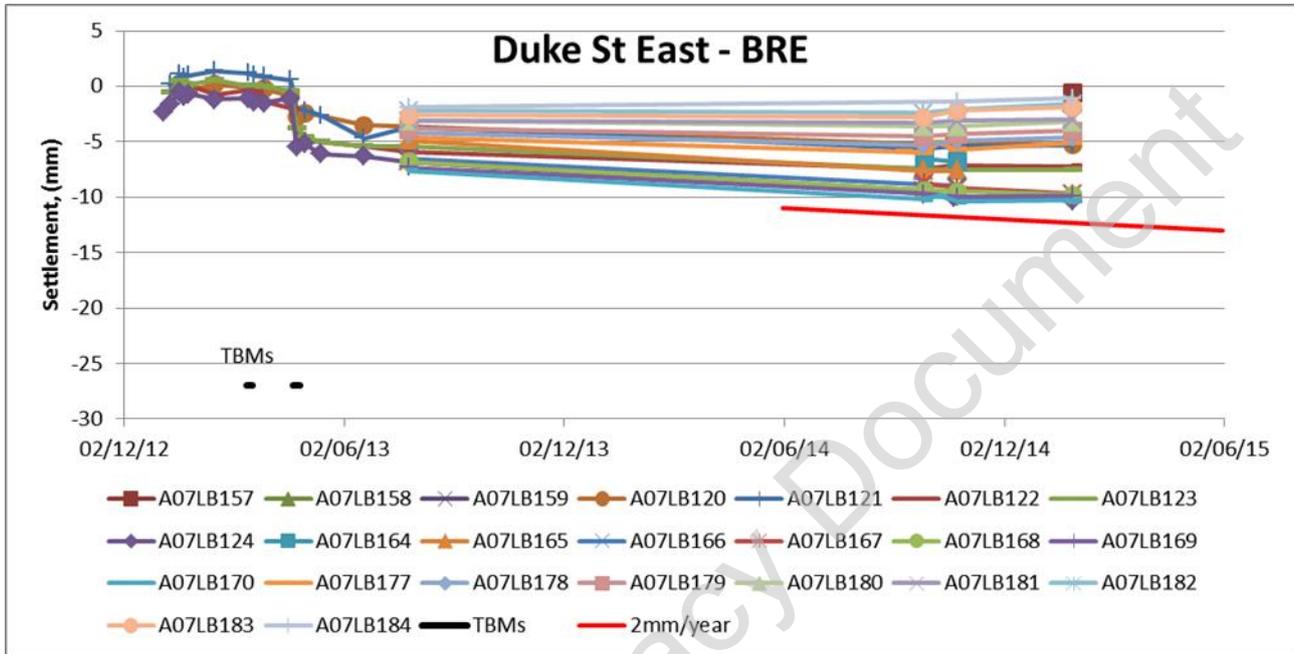


Figure 2.2: Data time-plot: comparison against 2mm/year settlement rate (long-term)

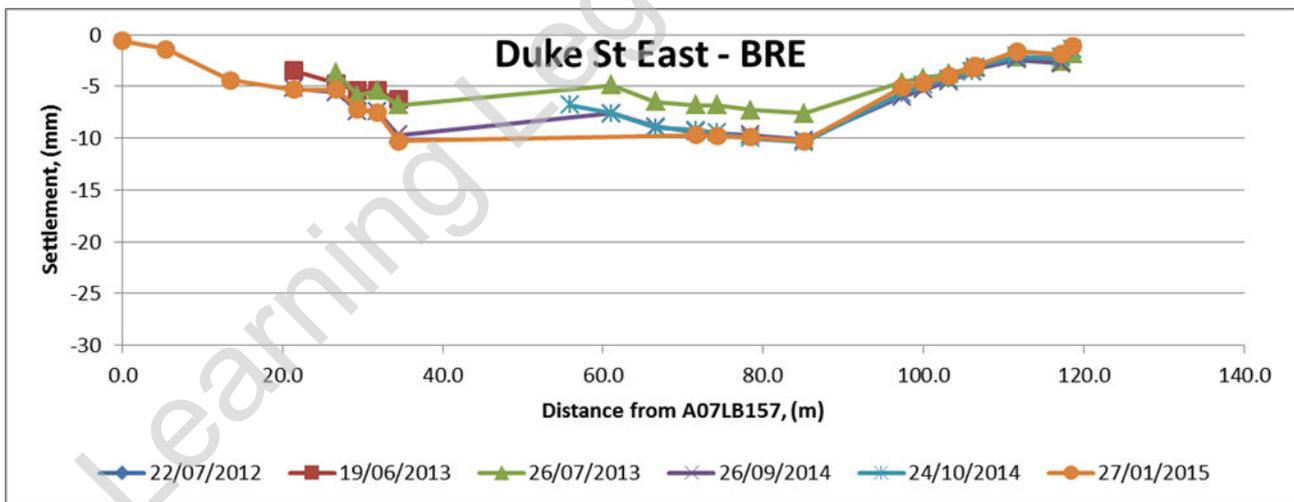


Figure 2.3: Profile plot: Duke Street East facade

The points on the east façade of Duke Street had settled by ~5mm at the end of C300 Works. Small effects associated with the two TBM drives are visible from the settlement time-plot. Long term settlement with a potential contribution from the WTH works (C411) increased the maximum movement to 10mm.

The overall long term behaviour gives a settlement rate of less than 2mm/year. By inspection of the profile plot, no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

## 2.2. Duke's Yard North

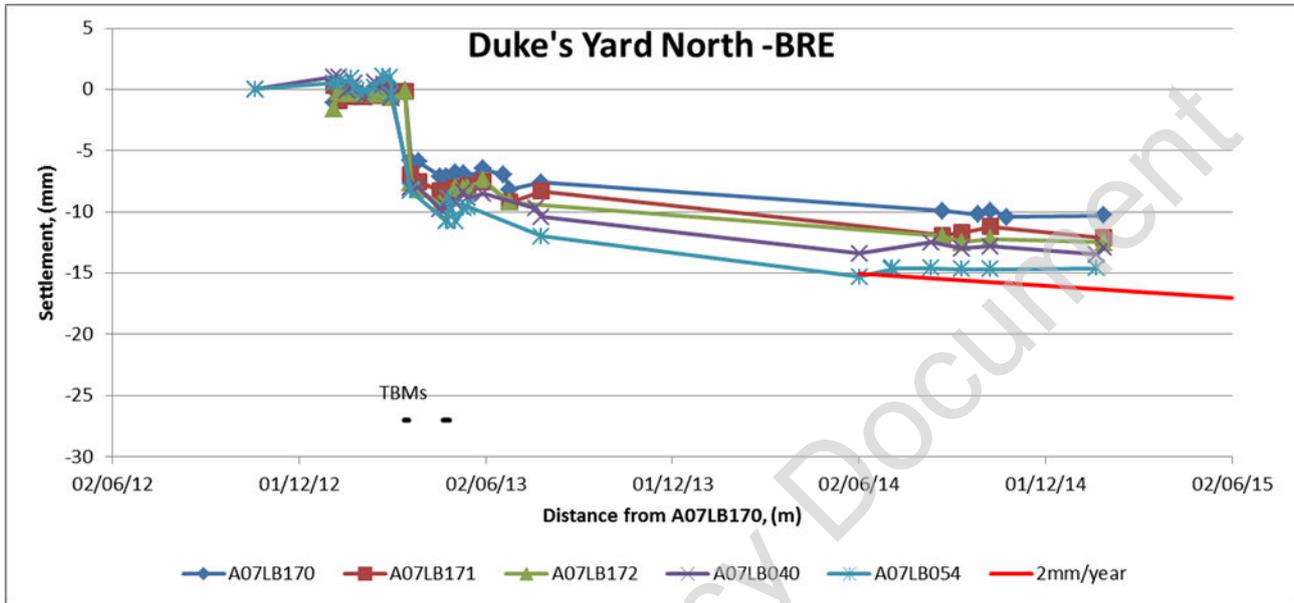


Figure 2.4: Data time-plot: comparison against 2mm/year settlement rate (long-term)

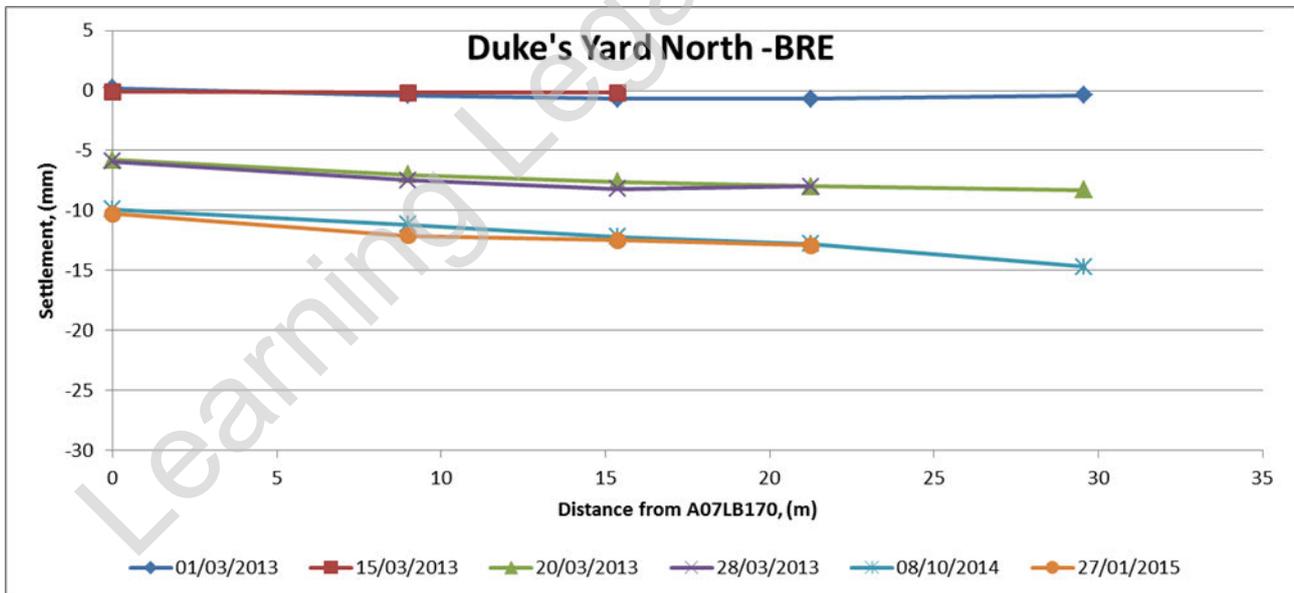


Figure 2.5: Profile plot: Duke's Yard North facade

The points on the north façade of Duke's Yard had settled by ~10mm at the end of C300 Works. Small effects associated with the two TBM drives are visible from the settlement time-plot. Long term settlement with a potential contribution from the WTH works (C411) increased the maximum movement to 15mm.

The overall long term behaviour gives a settlement rate of less than 2mm/year. By inspection of the profile plot, no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

### 2.3. Binney Street West

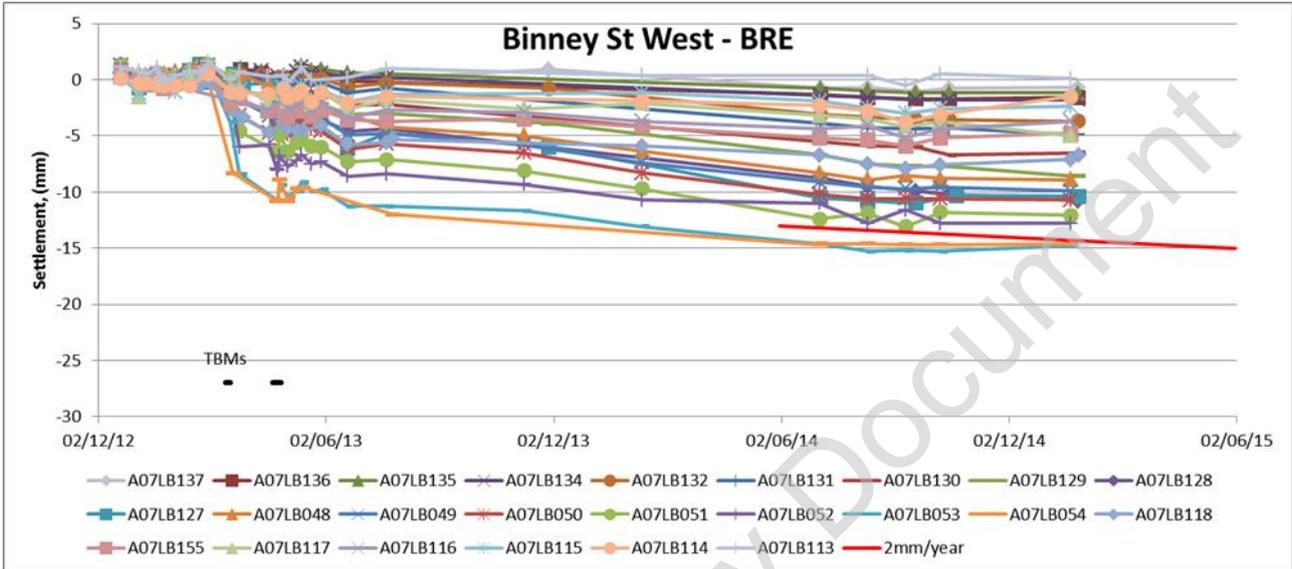


Figure 2.6: Data time-plot - comparison against 2mm/year settlement rate (long-term)

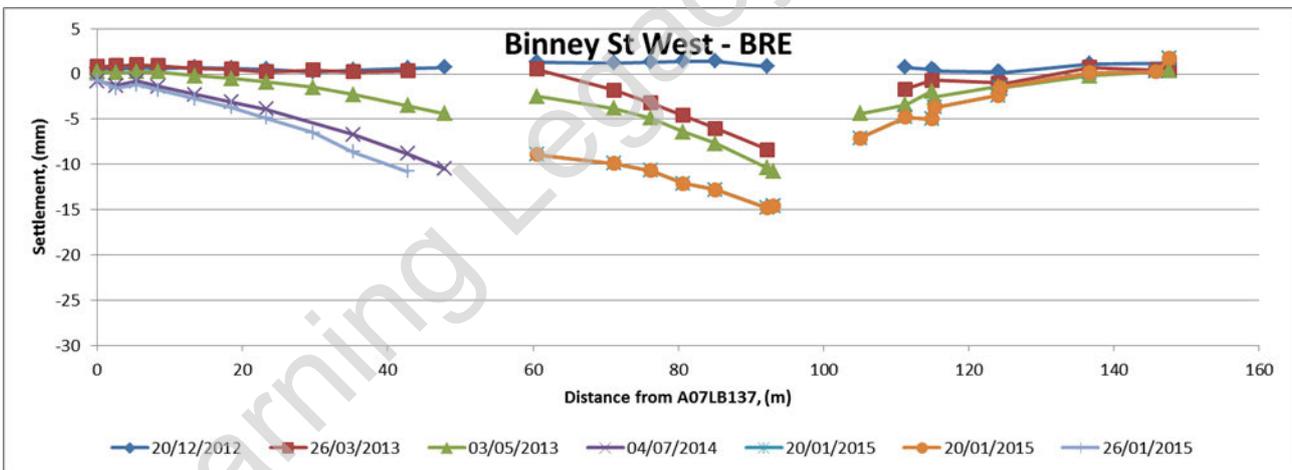


Figure 2.7: Profile plot: Binney Street West facade

The points on the west façade of Binney Street had settled by ~10mm at the end of C300 Works. Small effects associated with the two TBM drives are visible from the settlement time-plot. Long term settlement with a potential contribution from the WTH works (C411) increased the maximum movement to 15mm.

The overall long term behaviour gives a settlement rate of 2mm/year. By inspection of the profile plot, no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

## 2.4. Binney Street East

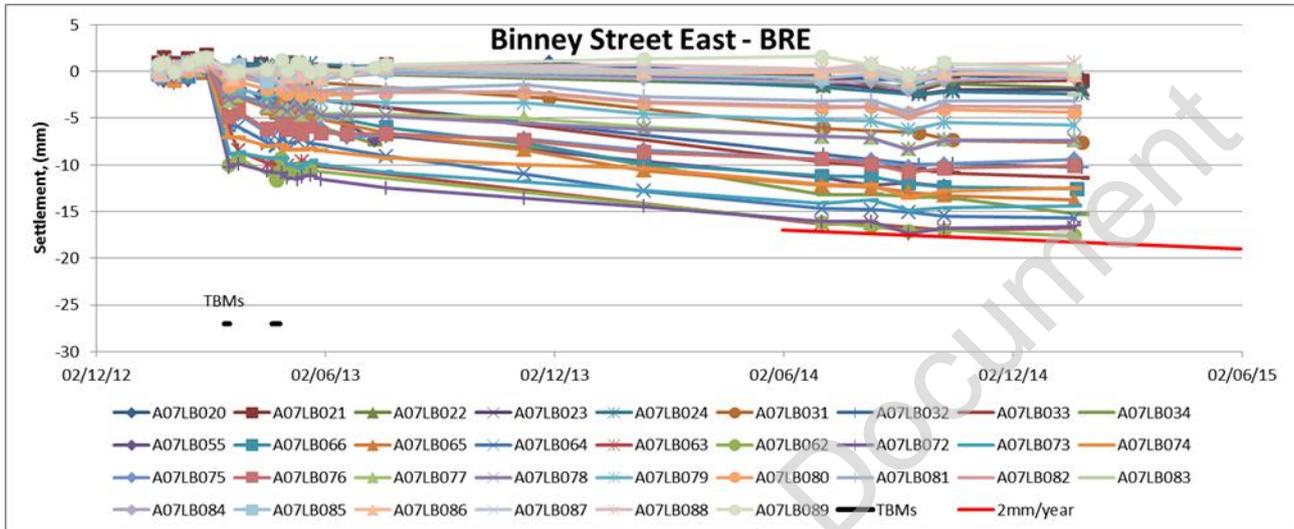


Figure 2.8: Data time-plot - comparison against 2mm/year settlement rate (long-term)

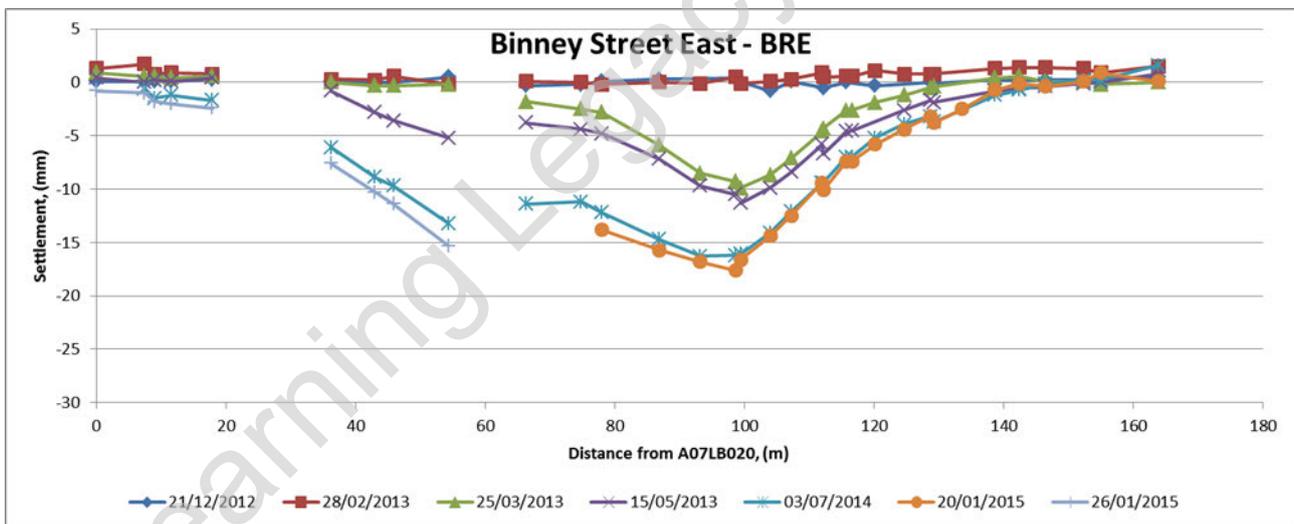


Figure 2.9: Profile plot: Binney Street East façade

The points on the east façade of Binney Street had settled by ~12mm at the end of C300 Works. Small effects associated with the two TBM drives are visible from the settlement time-plot. Long term settlement with a potential contribution from the WTH works (C411) increased the maximum movement to 17mm.

The overall long term behaviour gives a settlement rate of 2mm/year. By inspection of the profile plot, no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

## 2.5. Gilbert Street West

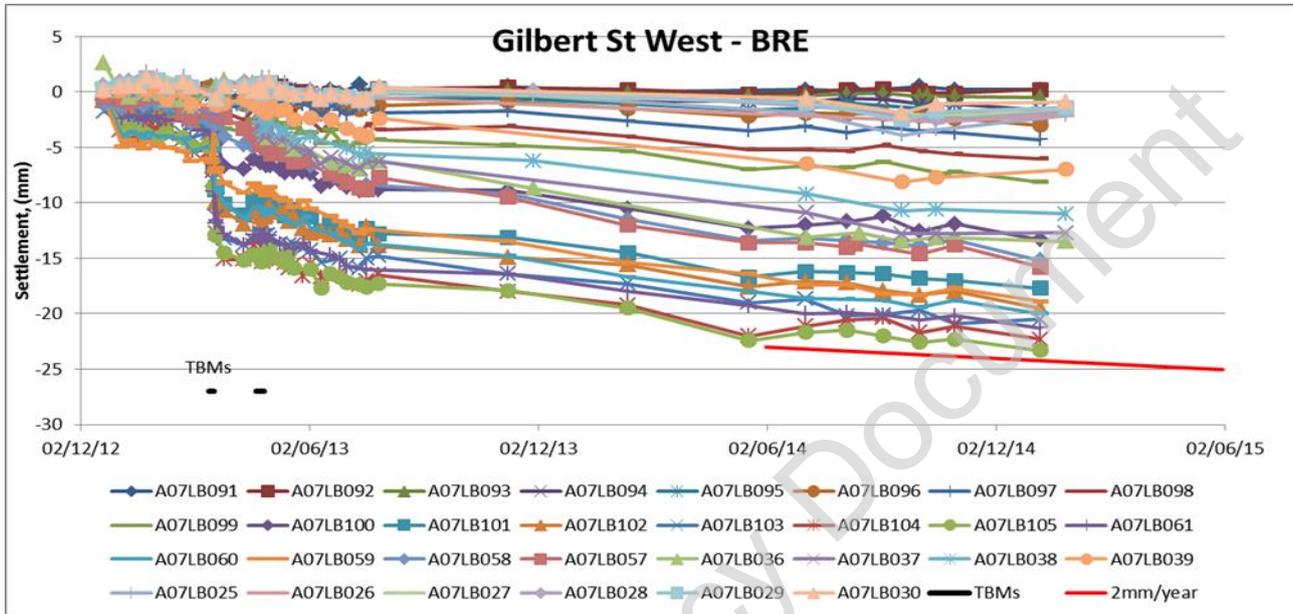


Figure 2.10: Data time-plot - comparison against 2mm/year settlement rate (long-term)

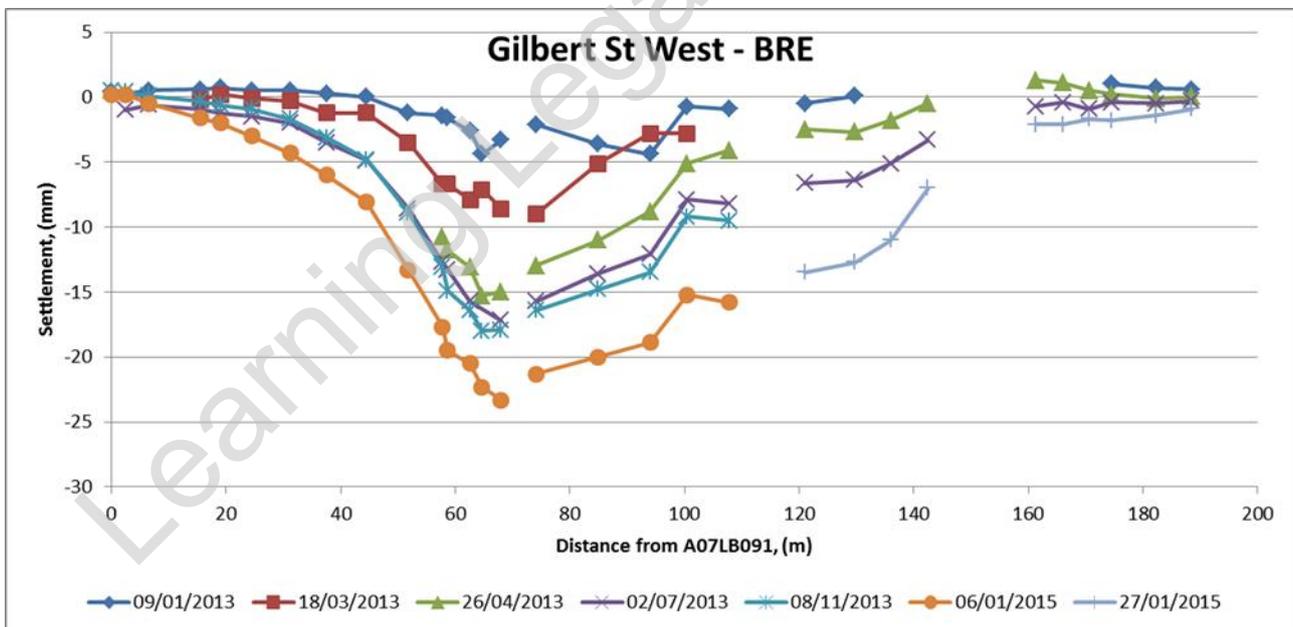


Figure 2.11: Profile Plot: Gilbert Street West façade

The points on the west façade of Gilbert Street had settled by up to 5mm prior to BFK works. Settlement increased by ~10mm due to the TBM drives. Small effects associated with the two TBM drives are visible from the settlement time-plot. Long term settlement with a potential contribution from the WTH works (C411) increased the maximum movement to 24mm.

The overall long term behaviour gives a settlement rate of 2mm/year. The maximum slope recorded is less than 0.8mm/m: no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

## 2.6. Gilbert Street East (North)

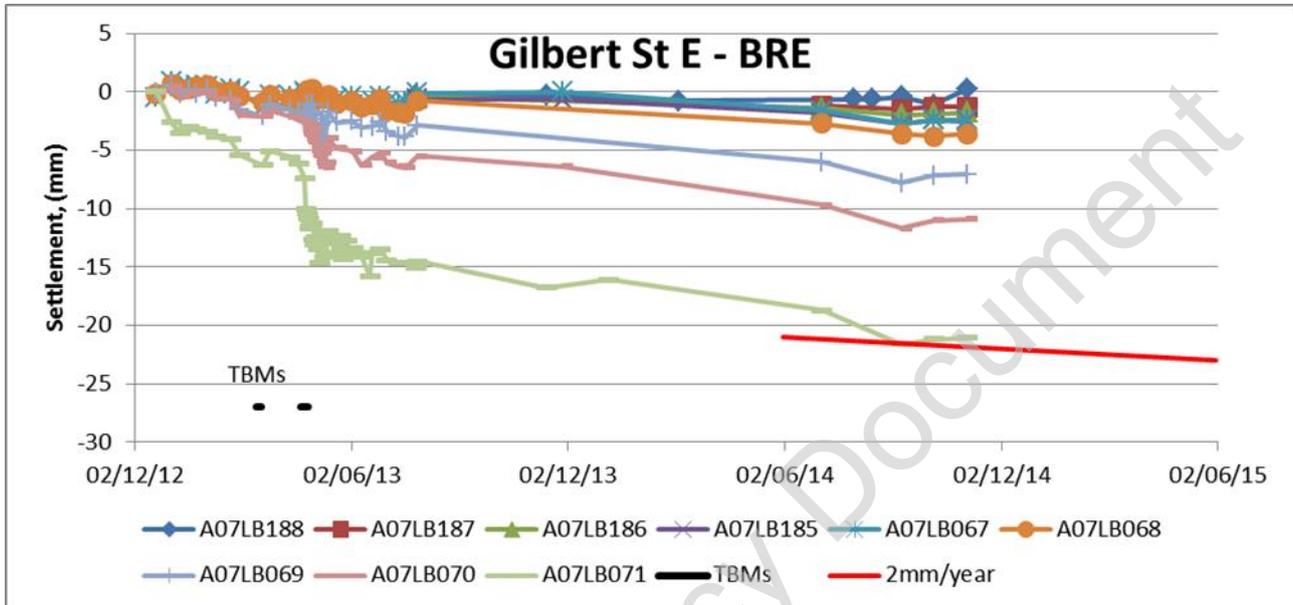


Figure 2.12: Data time-plot - comparison against 2mm/year settlement rate (long-term)

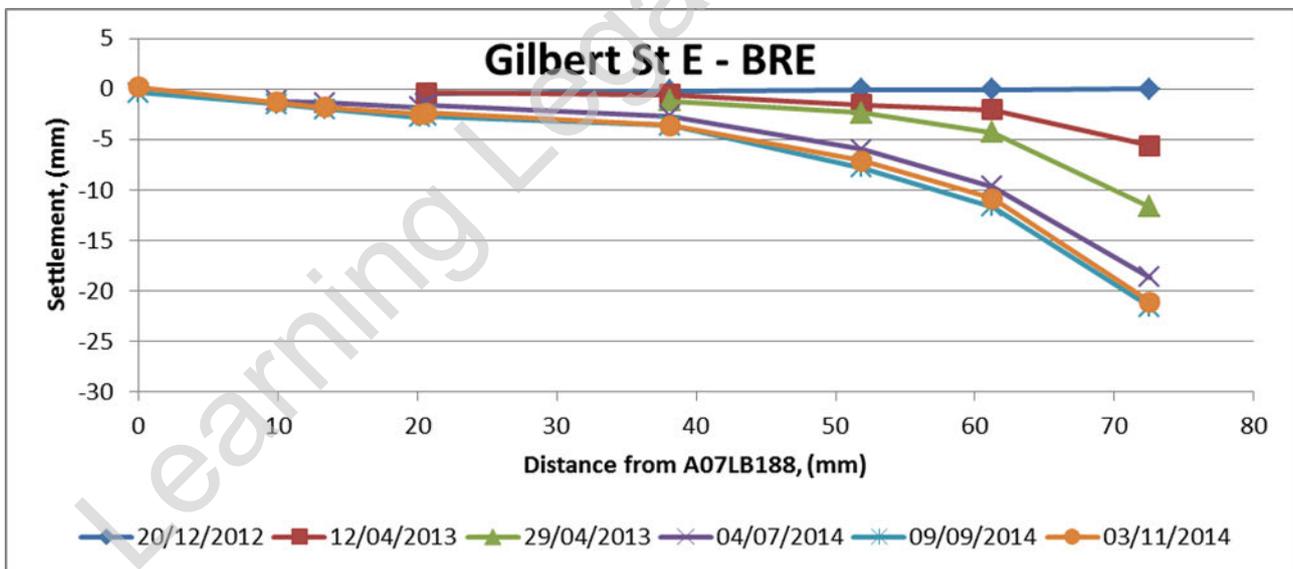


Figure 2.13 Profile Plot: Gilbert Street East façade (north)

The points on the east façade of Gilbert Street (north of Weighhouse Street) had settled by up to 5mm prior to BFK works. Settlement increased by ~10mm due to the EBRT TBM drive. Long term settlement with a potential contribution from the WTH works (C411) increased the maximum movement to 22mm.

The overall long term behaviour gives a settlement rate of 2mm/year. The maximum slope recorded is 0.9mm/m: no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

### 2.7. Gilbert Street East (South)

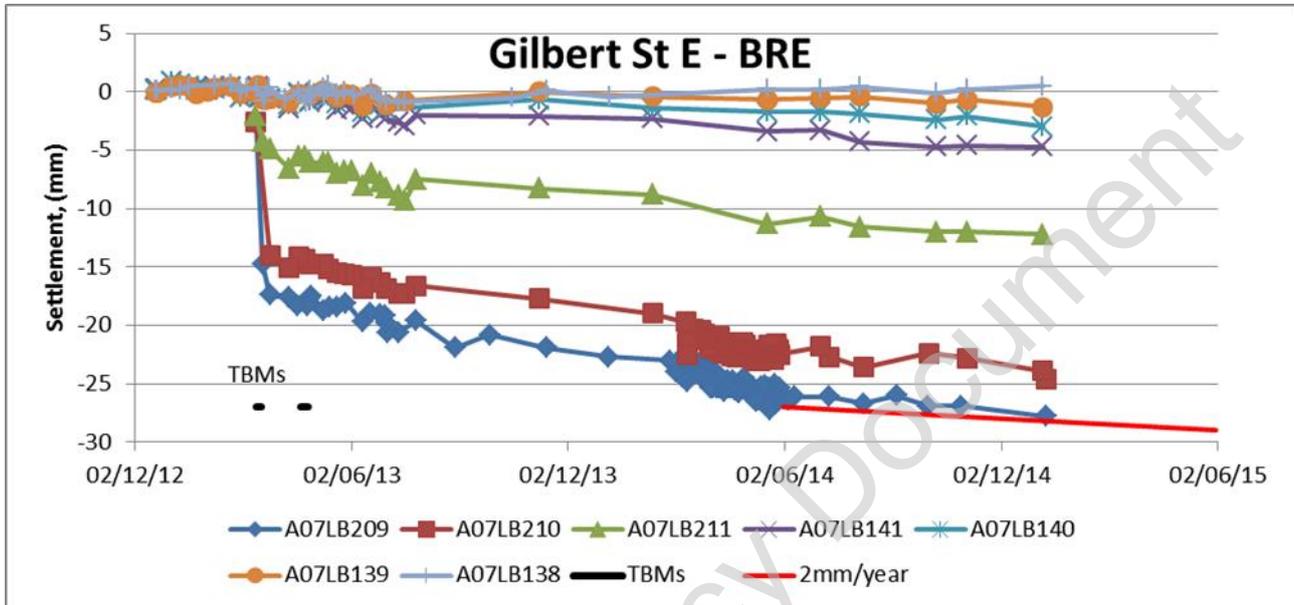


Figure 2.14 Data time-plot - comparison against 2mm/year settlement rate (long-term)

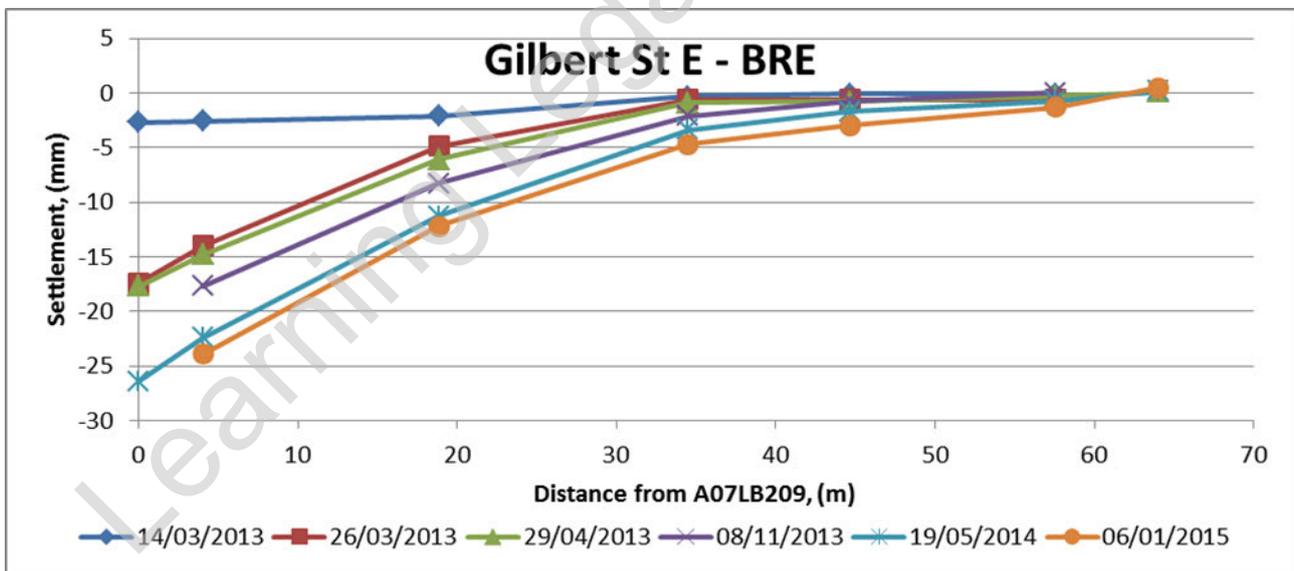


Figure 2.15: Profile Plot: Gilbert Street East façade (south)

The points on the east façade of Gilbert Street (south of St. Anselm’s Place) settled up to 18mm due to the first C300 WB running tunnel excavation. There is no visible effect from the second, EB, TBM on the settlement time-plot. A small impact (<5mm) from construction of vent tunnel VD1c is evident in May 2014.

Long term settlement with a potential contribution from the WTH works (C411) increased to 28mm at a rate of about 2mm/year. The maximum slope is around 0.9mm/m: no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

## 2.8. Brook Street North

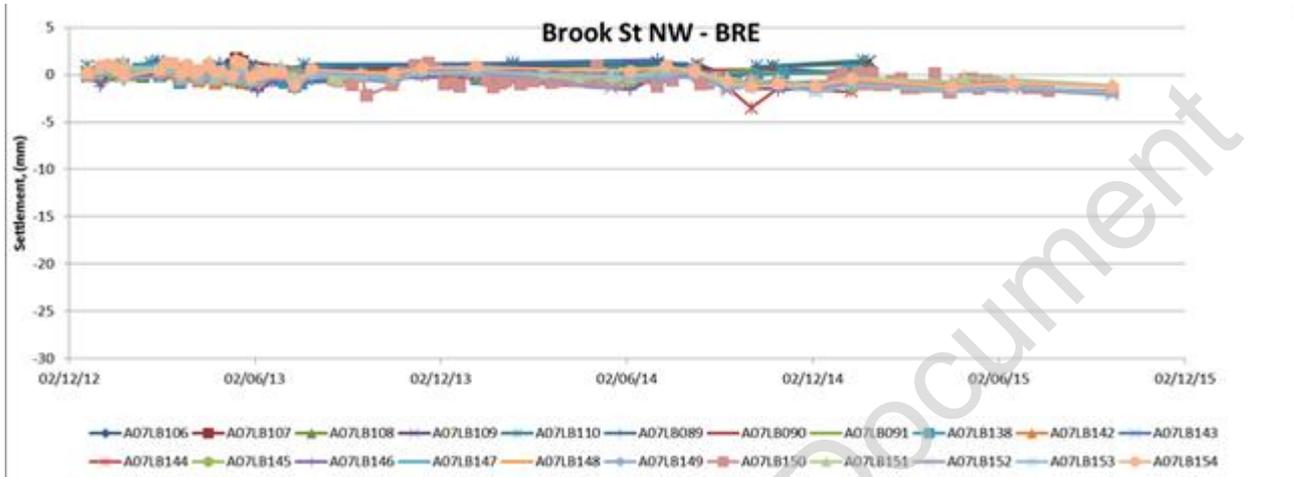


Figure 2.16: Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the façade on north side of Brook Street show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

## 2.9. Weighouse Street South

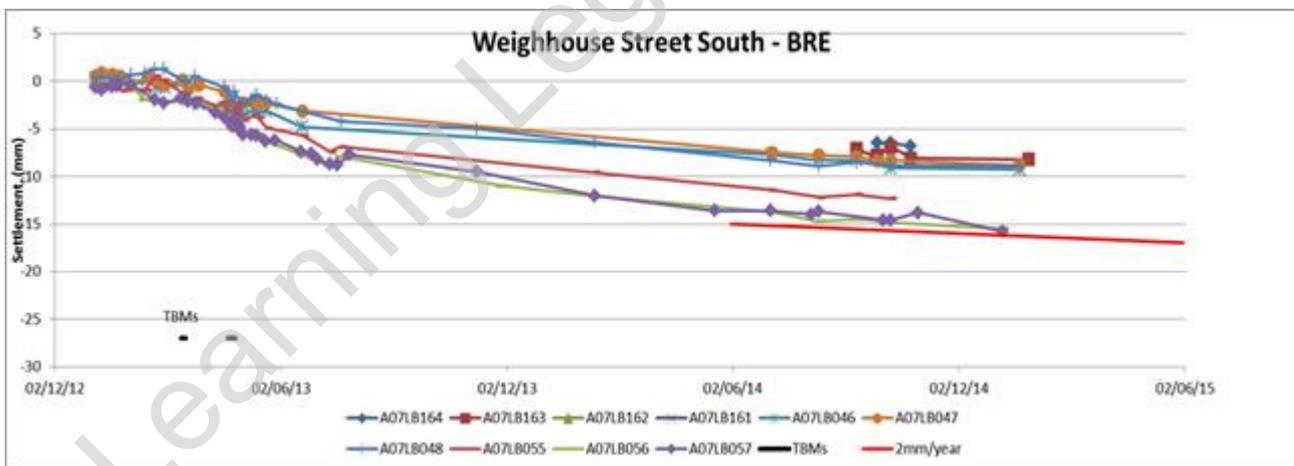


Figure 2.17: Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the south side of Weighouse Street (to the west of Gilbert Street) had minor settlement prior to C300 works. The maximum settlement following the two TBM drives was about 6mm. Long term settlement, with a potential contribution from the WTH works (C411), increased to a maximum of 16mm. The BRE are located on 3 separate structures and hence no profile plot is presented.

The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

## 2.10. Weighhouse Street North

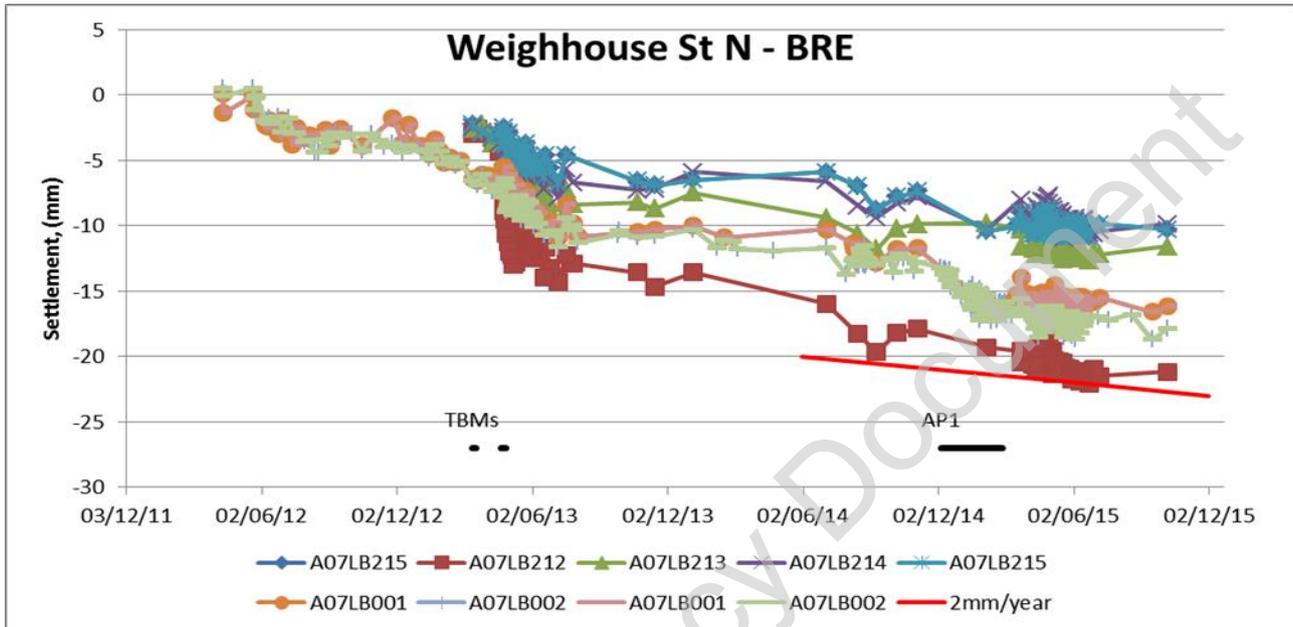


Figure 2.18: Data time-plot - comparison against 2mm/year settlement rate (long-term)

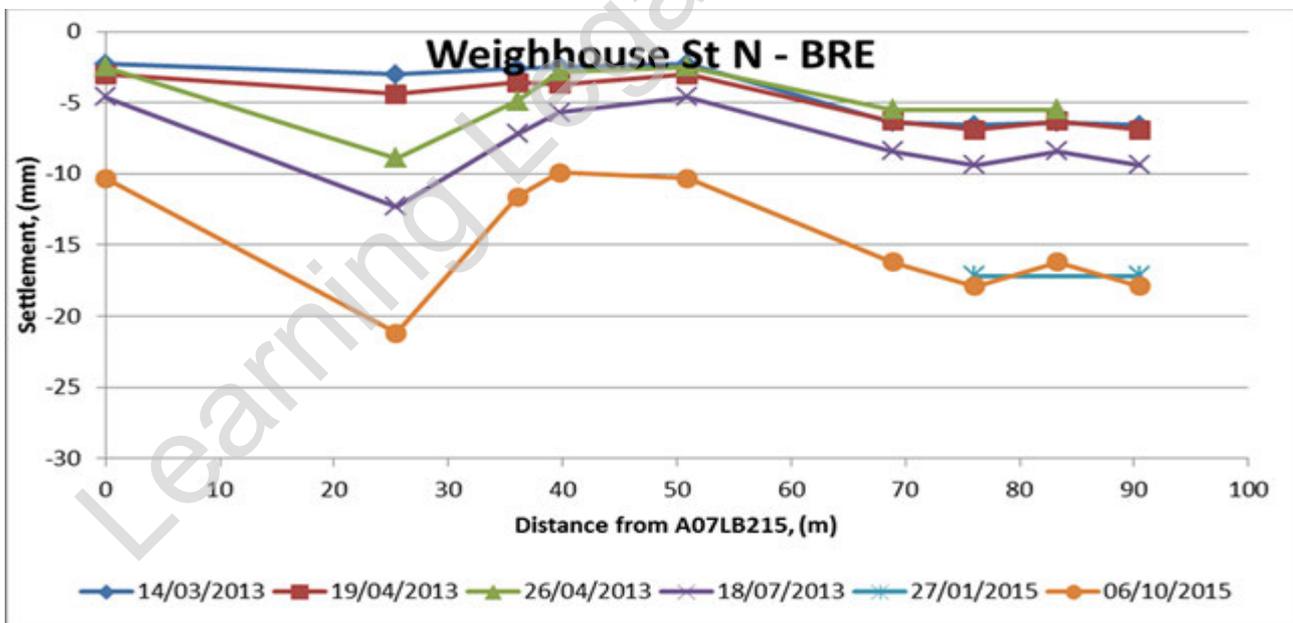


Figure 2.19: Profile Plot: Weighhouse Street North facade

The points on the north side of Weighhouse Street (to the east of Gilbert Street) had up to 6mm settlement prior to C300 works. The maximum settlement following the two TBM drives was about 13mm. Long term settlement, with a potential contribution from the WTH works (C411), increased to a maximum of 21mm. A small effect from AP1 is shown in December 2014.

The overall long term rate of settlement is about 2mm/year. The maximum slope is around 0.9mm/m: no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

### 2.11. Oxford Street South (West)

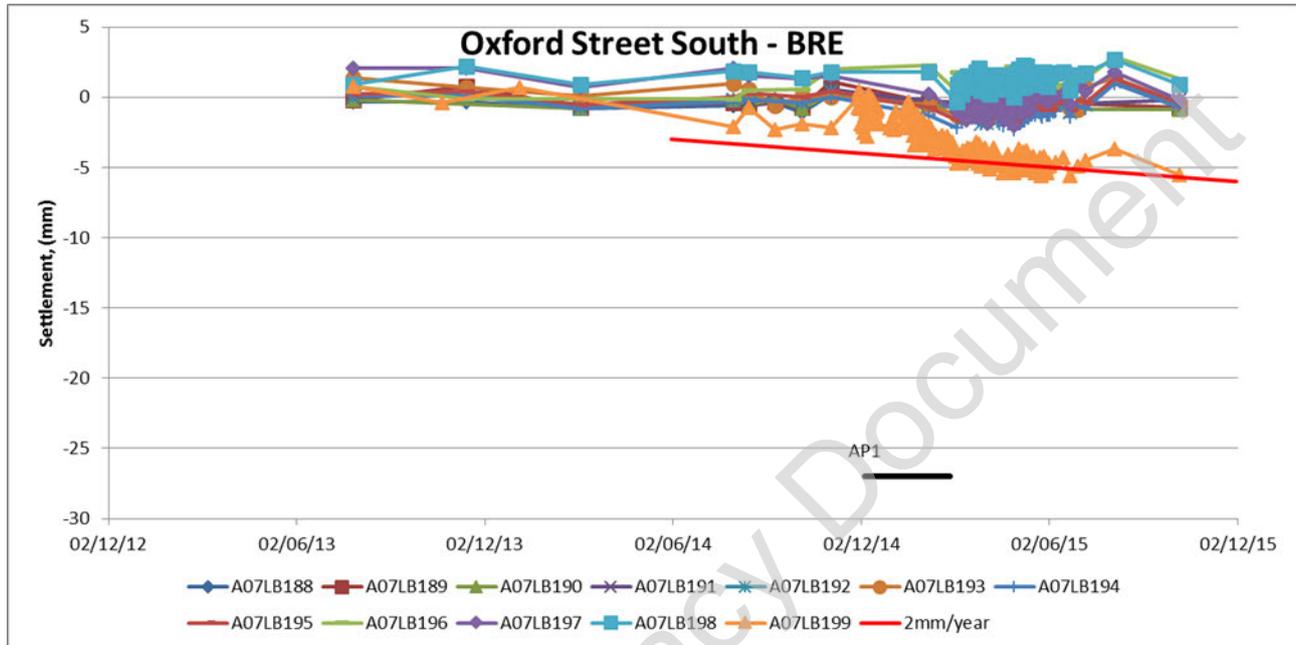


Figure 2.20: Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the south side of Oxford Street (to the east of Davies Street) showed settlement of up to 5mm due to construction of AP1 in January 2015.

The overall long term rate of settlement is less than 2mm/year. The maximum slope is around 0.6mm/m: no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

### 3. Observed Settlement: West Area PLP

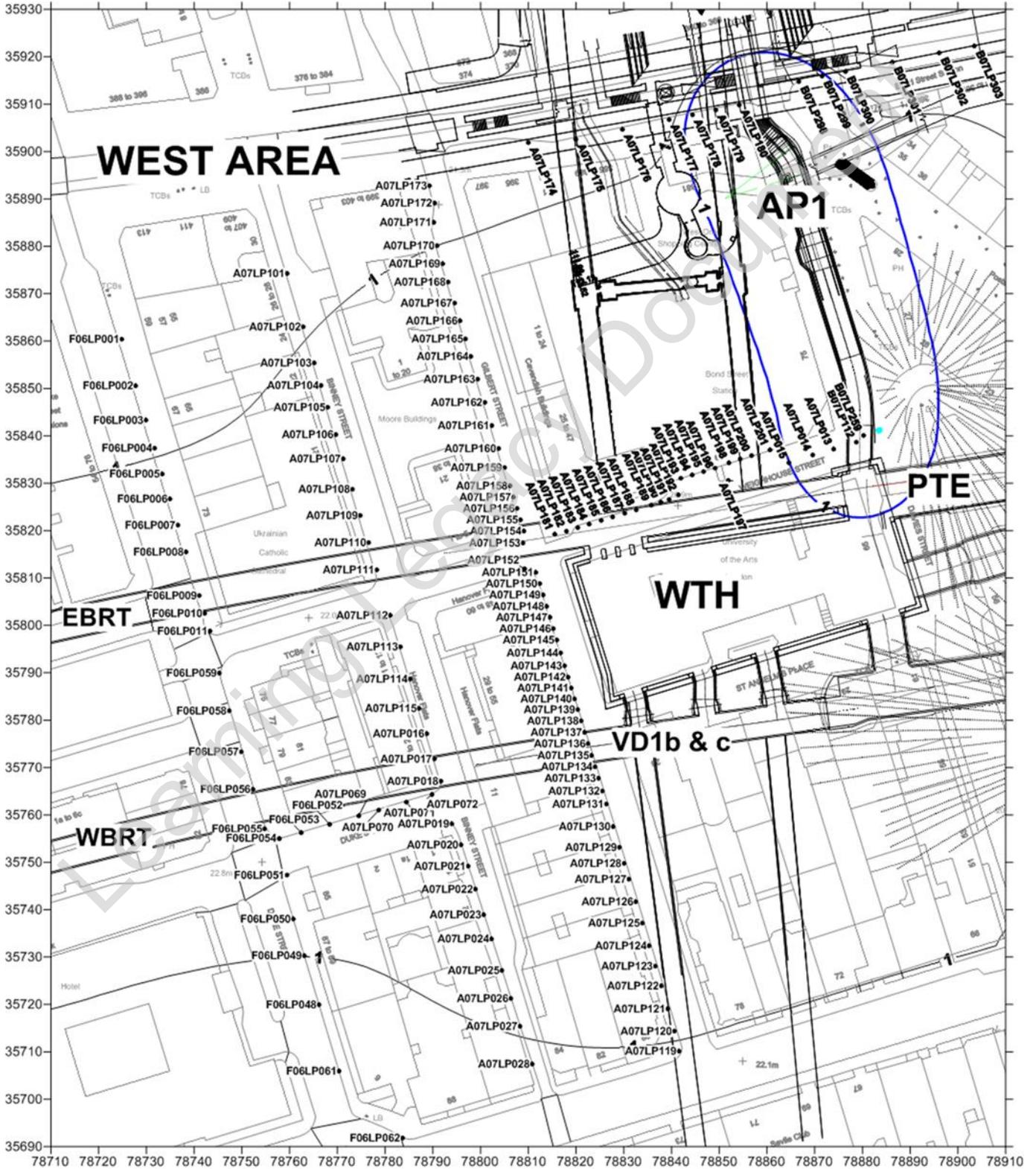


Figure 3.1 Location of PLP – west area

### 3.1. Duke Street East

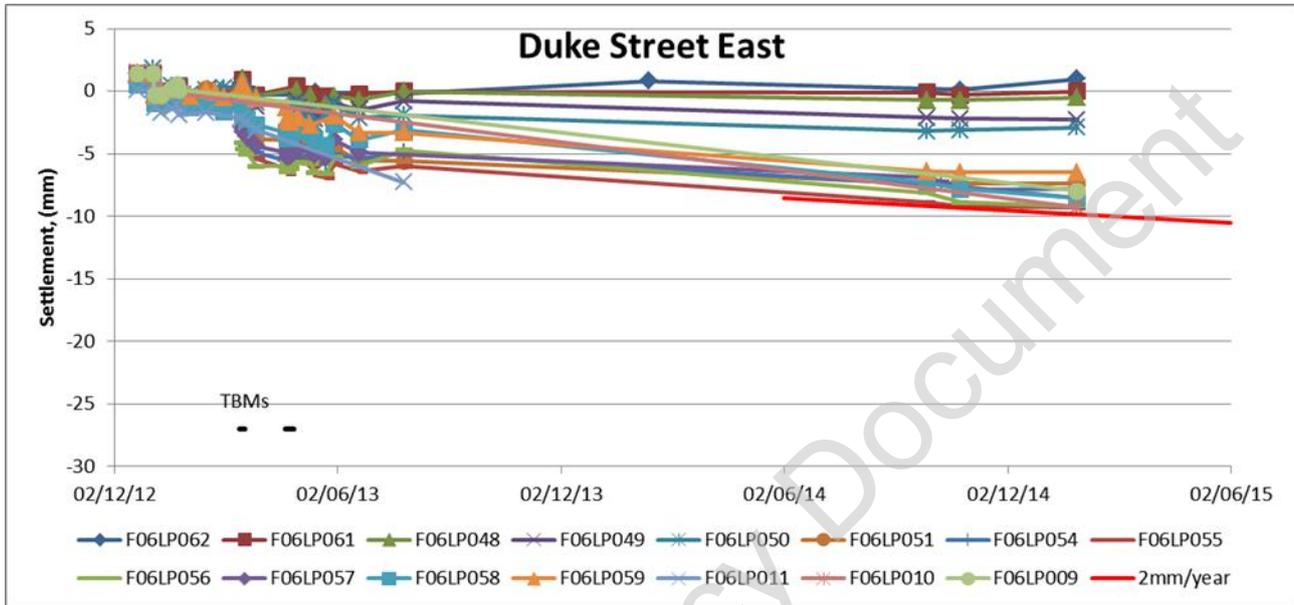


Figure 3.2: Data time-plot - comparison against 2mm/year settlement rate (long-term)

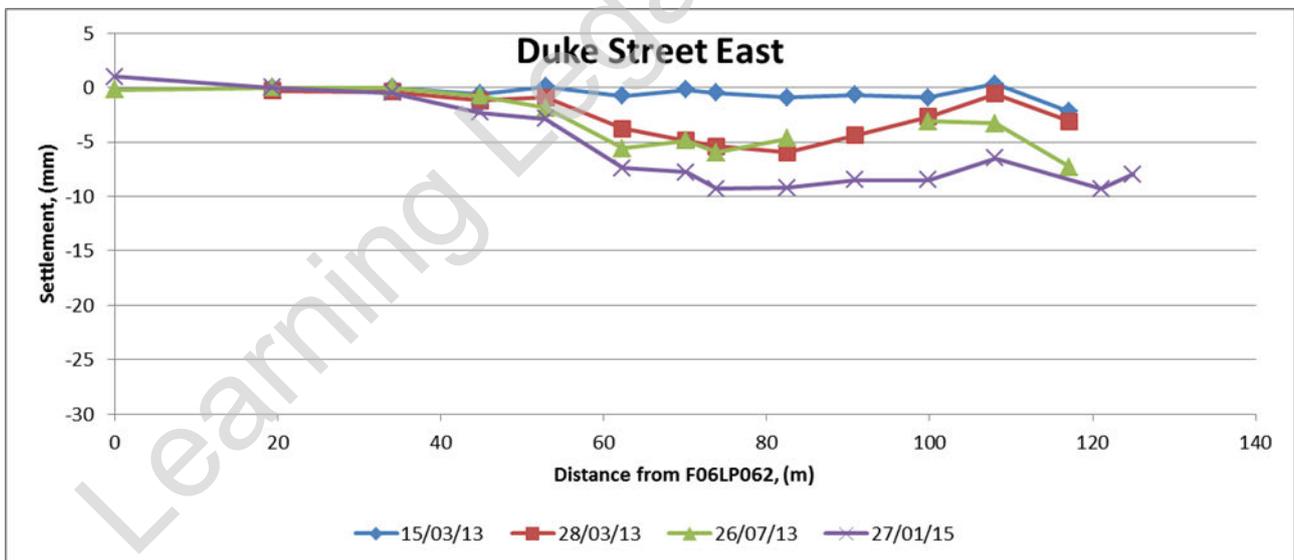


Figure 3.3: Profile Plot: Duke Street East kerbline

The points on the east kerbline of Duke Street had settled by ~7mm at the end of C300 Works. Small effects associated with the two TBM drives are visible from the settlement time-plot. Long term settlement with a potential contribution from the WTH works (C411) increased the maximum movement to 10mm.

The overall long term behaviour gives a settlement rate of around 2mm/year. By inspection of the profile plot, no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

### 3.2. Duke's Yard North

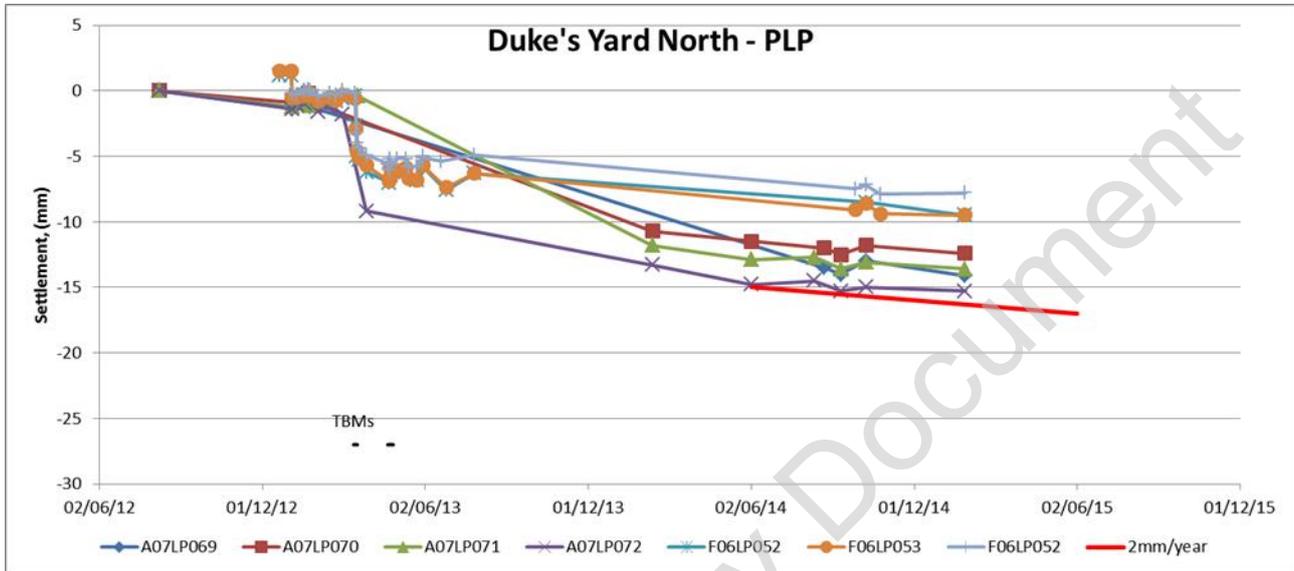


Figure 3.4: Data time-plot - comparison against 2mm/year settlement rate (long-term)

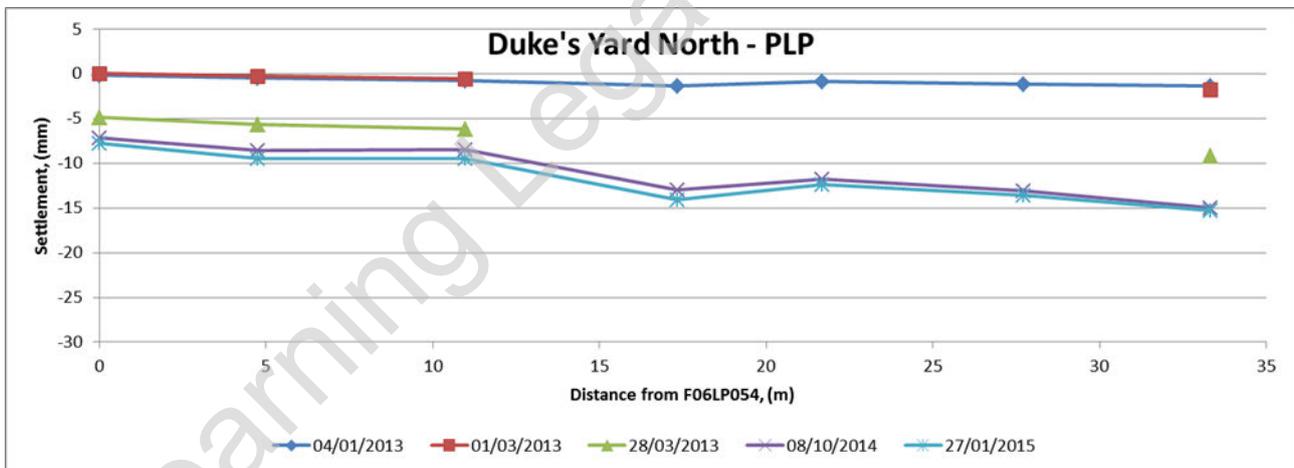


Figure 3.5: Profile Plot: Duke's Yard North kerbline

The points on the north kerbline of Duke's Yard had settled by ~10mm at the end of C300 Works. Small effects associated with the two TBM drives are visible from the settlement time-plot. Long term settlement with a potential contribution from the WTH works (C411) increased the maximum movement to 15mm.

The overall long term behaviour gives a settlement rate of less than 2mm/year. By inspection of the profile plot, no slope triggers have been exceeded. The residual risk associated with long-term settlements is considered to be negligible.

### 3.3. Binney Street West

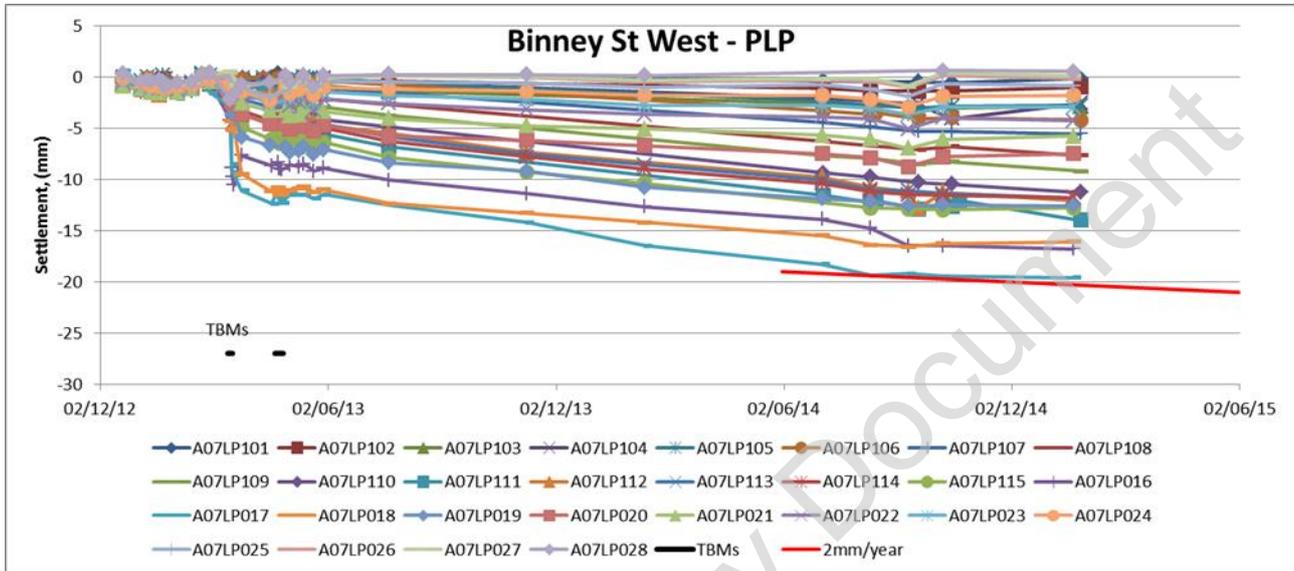


Figure 3.6: Data time-plot - comparison against 2mm/year settlement rate (long-term)

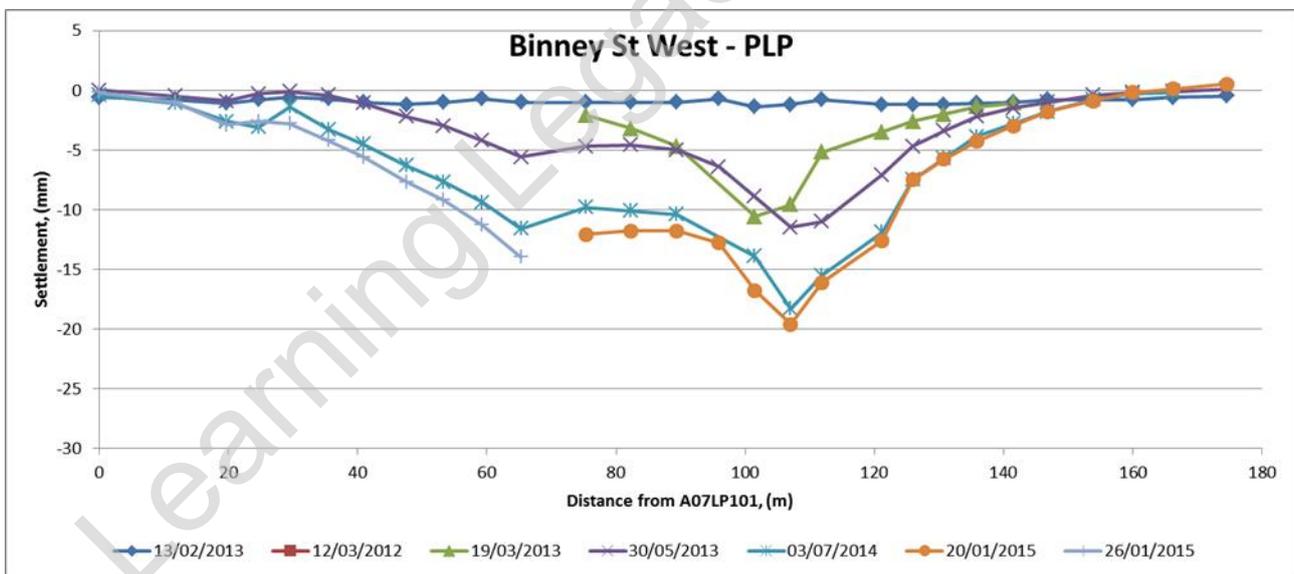


Figure 3.7 Profile Plot: Binney Street West kerbline

The points on the kerbline on west side of Binney Street settled by up to 12mm during the TBM drives. Long term settlement, with a potential contribution from the WTH works (C411), increased the maximum movement to 20mm. The maximum slope over ~10m was 0.7mm/m. No slope trigger levels have been exceeded

The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 3.4. Gilbert Street West

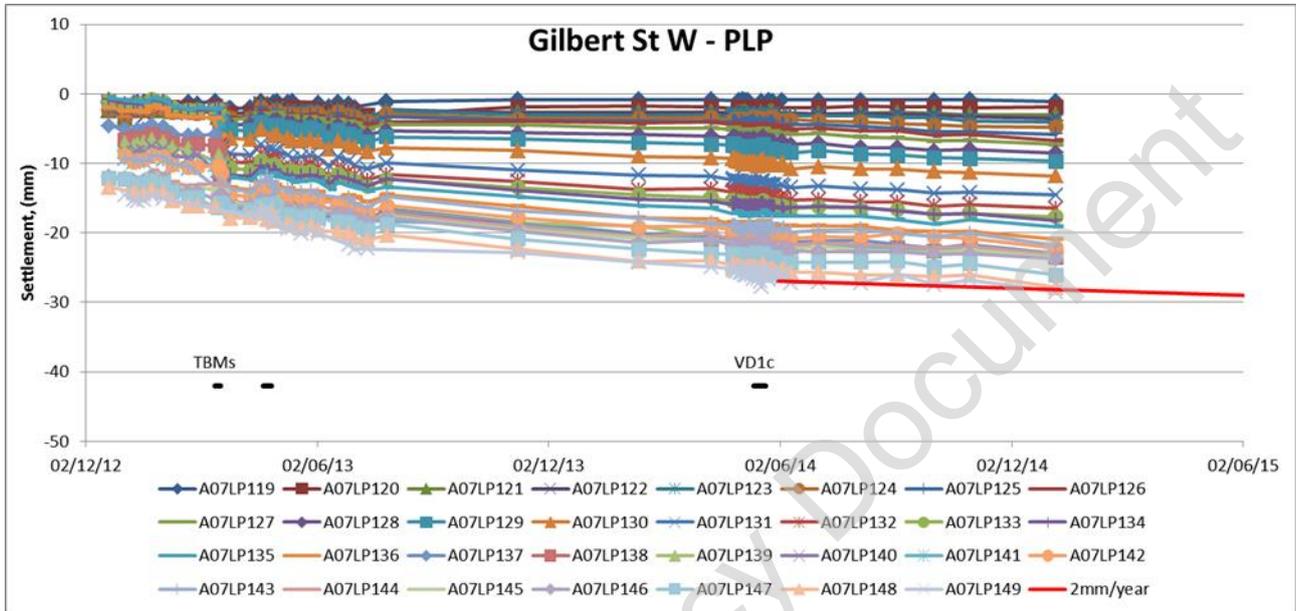


Figure 3.8 Data time-plot - comparison against 2mm/year settlement rate (long-term)

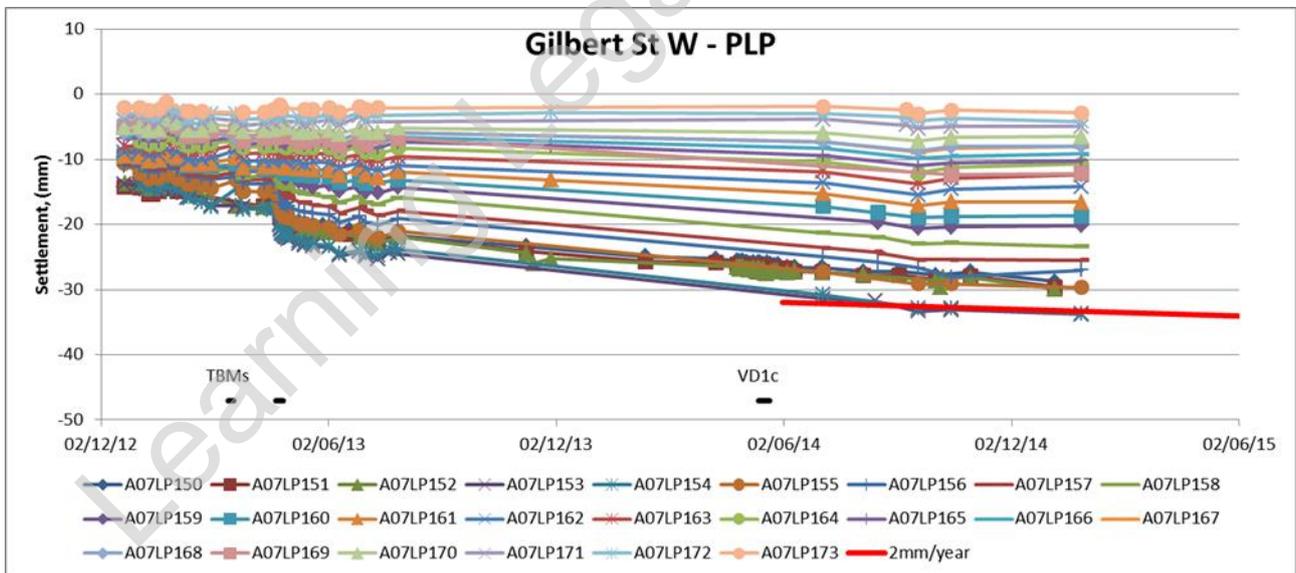


Figure 3.9 Data time-plot - comparison against 2mm/year settlement rate (long-term)

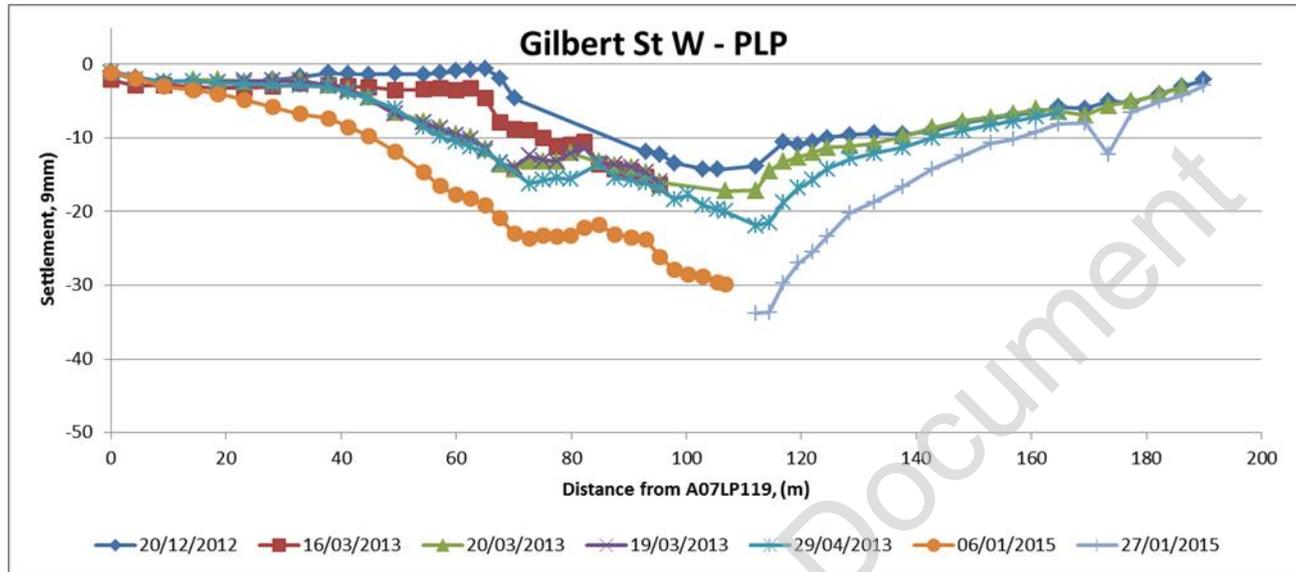


Figure 3.10 Profile Plot: Gilbert Street West kerbline

The points on the kerbline on west side of Gilbert Street settled by up to 15mm prior to the TBM drives. The maximum settlement immediately after the drives was 23mm. The excavation of VD1c in May 2014 had no noticeable effect. Long term settlement, with a potential contribution from the WTH works (C411), increased the maximum movement to 34mm. The maximum slope is 1.0mm/m at the Amber trigger level. By inspection of the profile plot, no deflection ratio triggers have been breached.

The final long term rate of settlement is about 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 3.5. Weighouse Street North

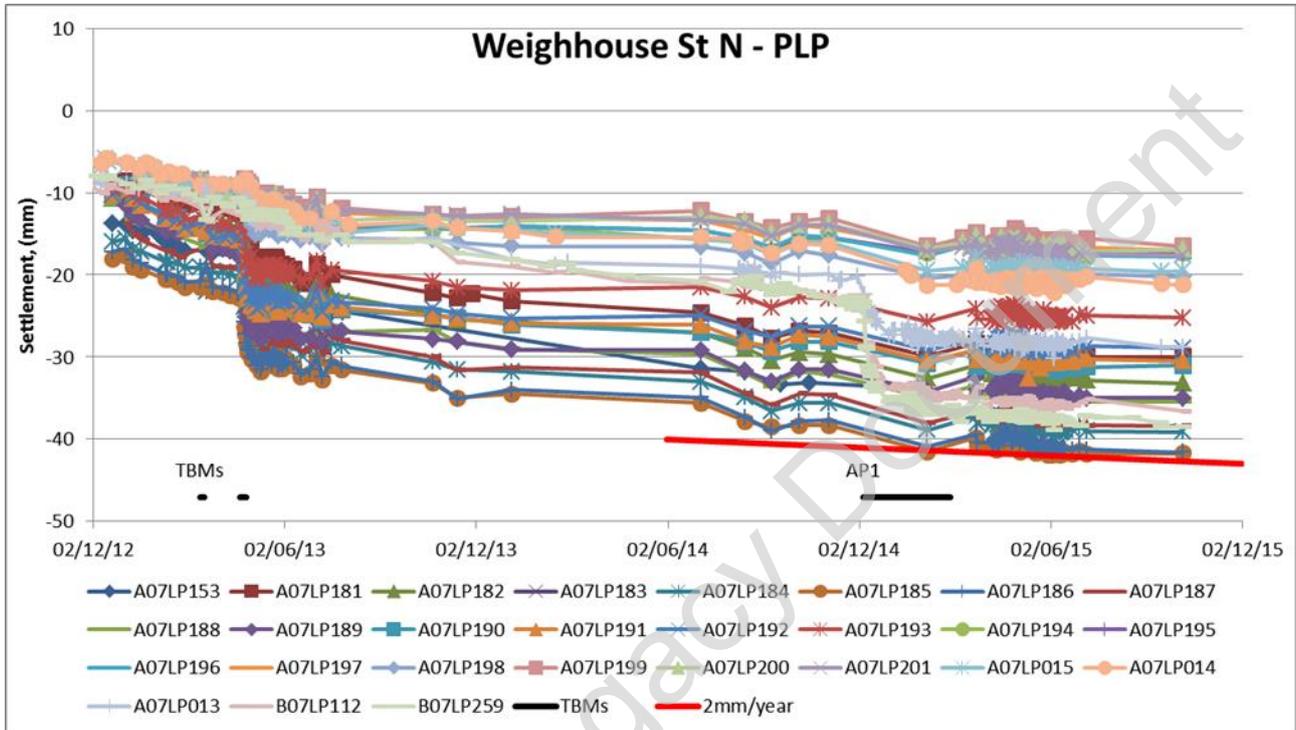


Figure 3.11 Data time-plot - comparison against 2mm/year settlement rate (long-term)

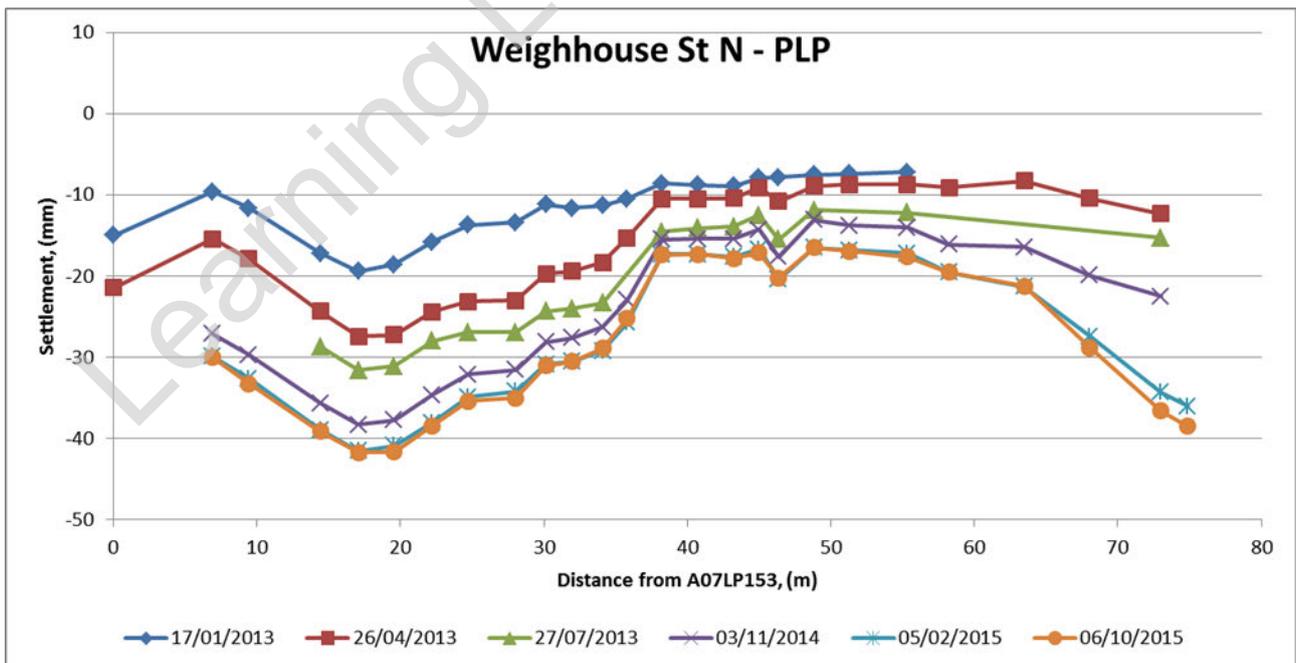


Figure 3.12 Profile Plot: Weighouse Street North kerbline

The points on the kerbline on north side of Weighouse Street settled by up to 20mm prior to the TBM drives. The maximum settlement immediately after the drives was 32mm. The excavation of AP1 in December 2014 / January 2015 increased the settlement on three points at the east end of the profile (A07LP013, B07LP112, B07LP259) by up to 15mm giving a maximum of ~36mm at this location. Slopes in excess of 1mm/m have



been recorded at the west and east ends of the profile, however the greatest slope is in the central section (distances 28m to 38m) where a value of  $\sim 1.5\text{mm/m}$  was recorded. It is noted that the location of the monitoring points changes from the kerbline to the building line at this location, which may contribute to the different responses measured.

Long term settlement, with a potential contribution from the WTH works (C411), increased the maximum movement on the profile to 41mm.

The final long term rate of settlement is about 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

Learning Legacy Document

### 3.6. Oxford Street South

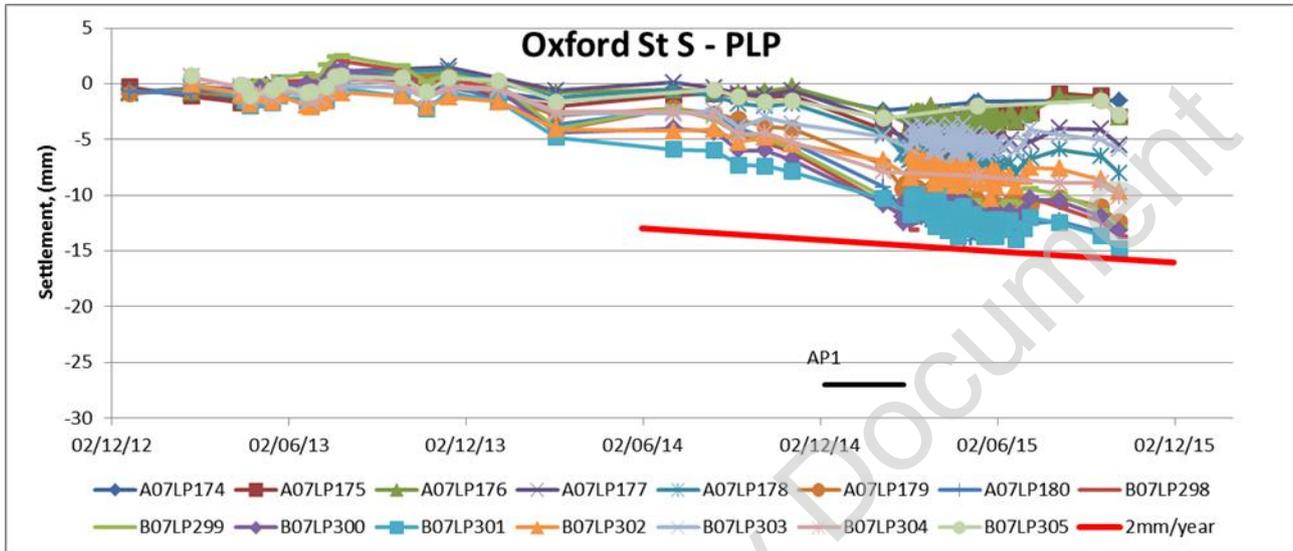


Figure 3.13 Data time-plot - comparison against 2mm/year settlement rate (long-term)

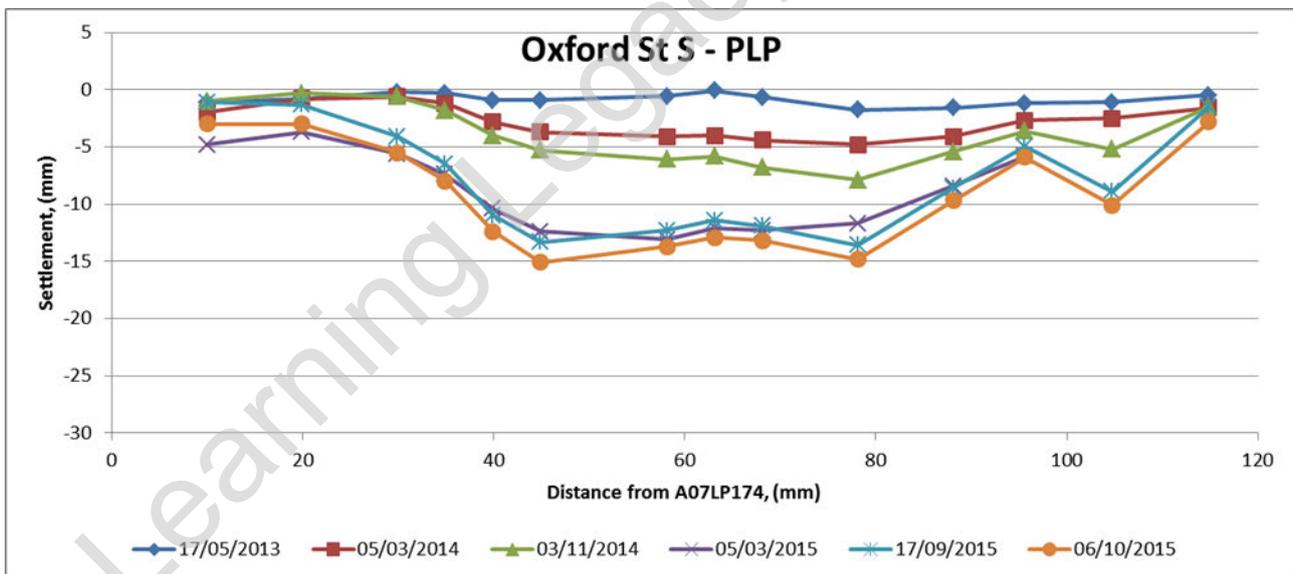


Figure 3.14 Profile Plot: Oxford Street South kerblines

The points on the kerblines on the south side of Oxford Street settled by up to 8mm prior to the construction of AP1. The excavation of AP1 in December 2014 / January 2015 increased settlement by up to 7mm, giving a maximum settlement of 13mm. A minor post-construction settlement occurred (to 15mm maximum), however, the rate of settlement appeared to be increasing at the termination of monitoring. It is assumed that this was associated with works by the LU Station Upgrade project.

#### 4. Observed Settlement: South area BRE

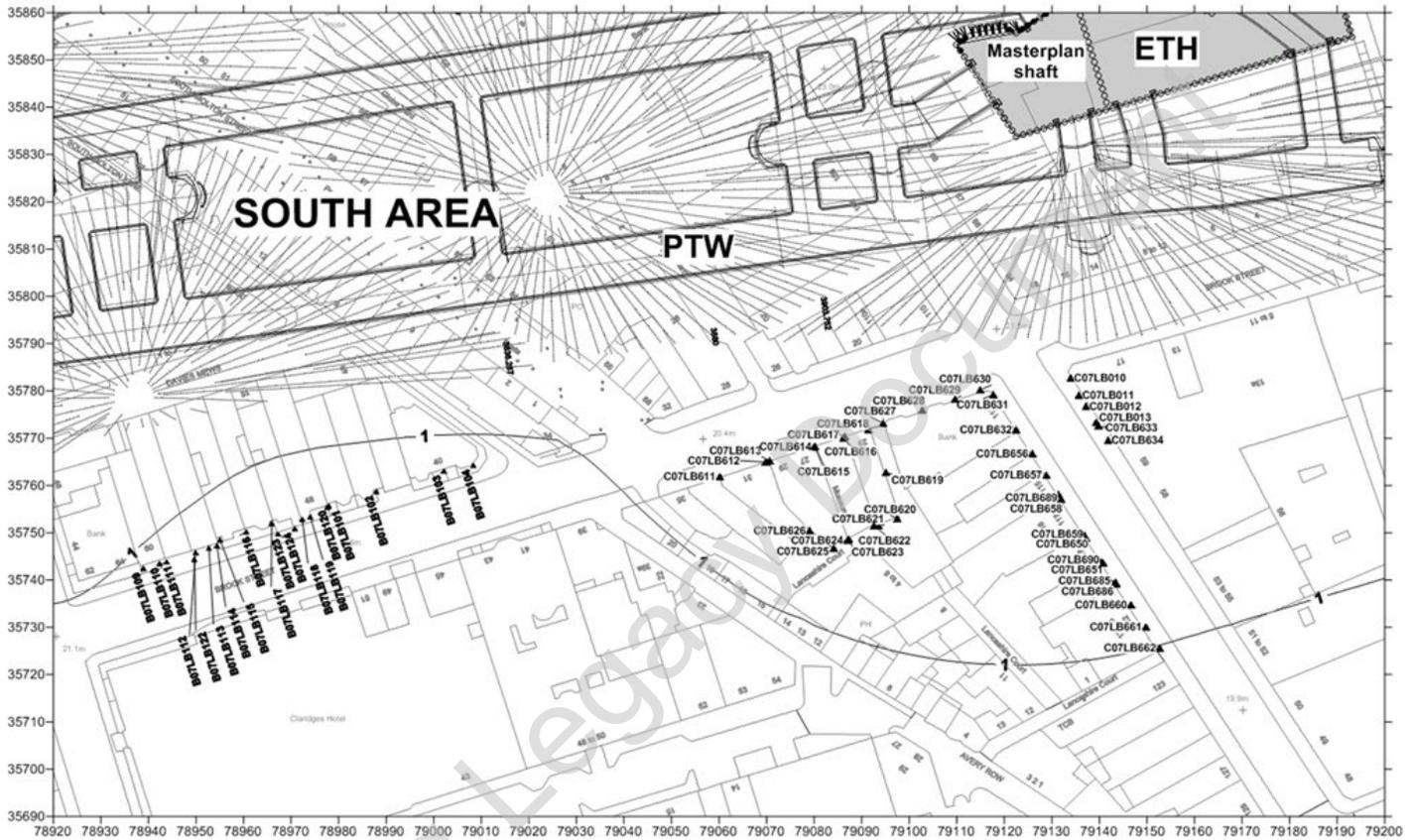


Figure 4.1 Location of BRE – South area

#### 4.1. New Bond Street West (South)

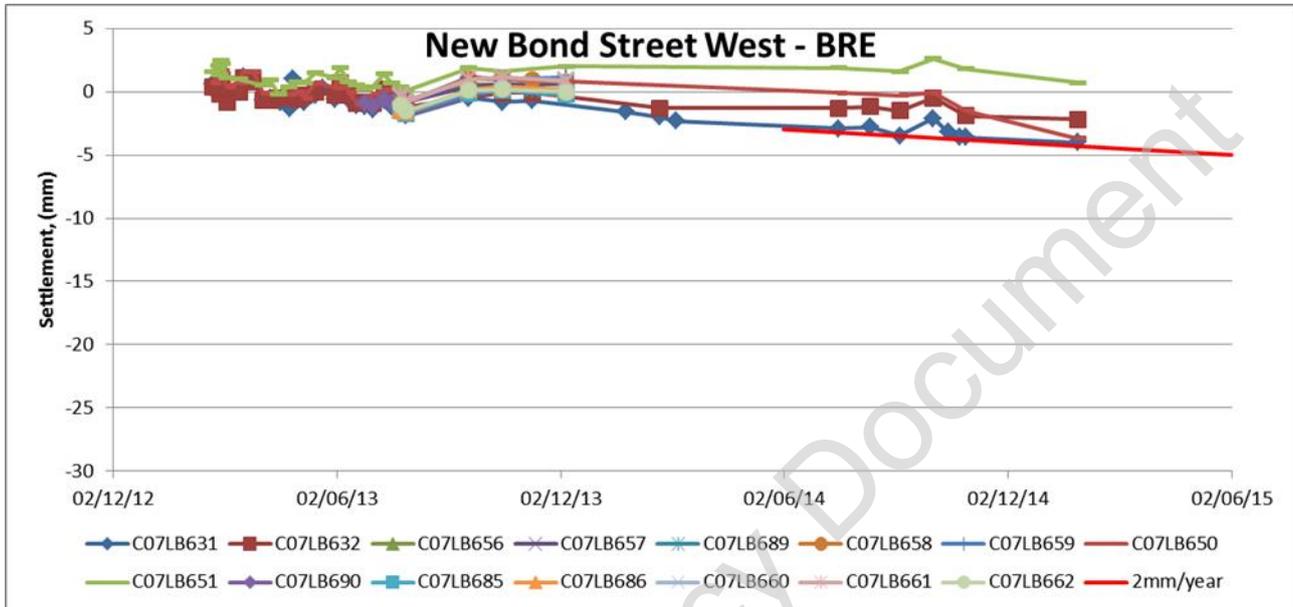


Figure 4.2 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the west façade of New Bond Street, south of Brook Street, had settled by less than 5mm at the end of C300 monitoring. These points are located outside the zone of influence of C300 works and it is concluded that the movements are due to C411 ETH works with a potential contribution from long term settlement following the construction of PTW in late 2013 / early 2014.

The overall long term behaviour gives a settlement rate of less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible, albeit the C411 ETH works were still in progress at the termination of monitoring by C300.

## 4.2. New Bond Street East (South)

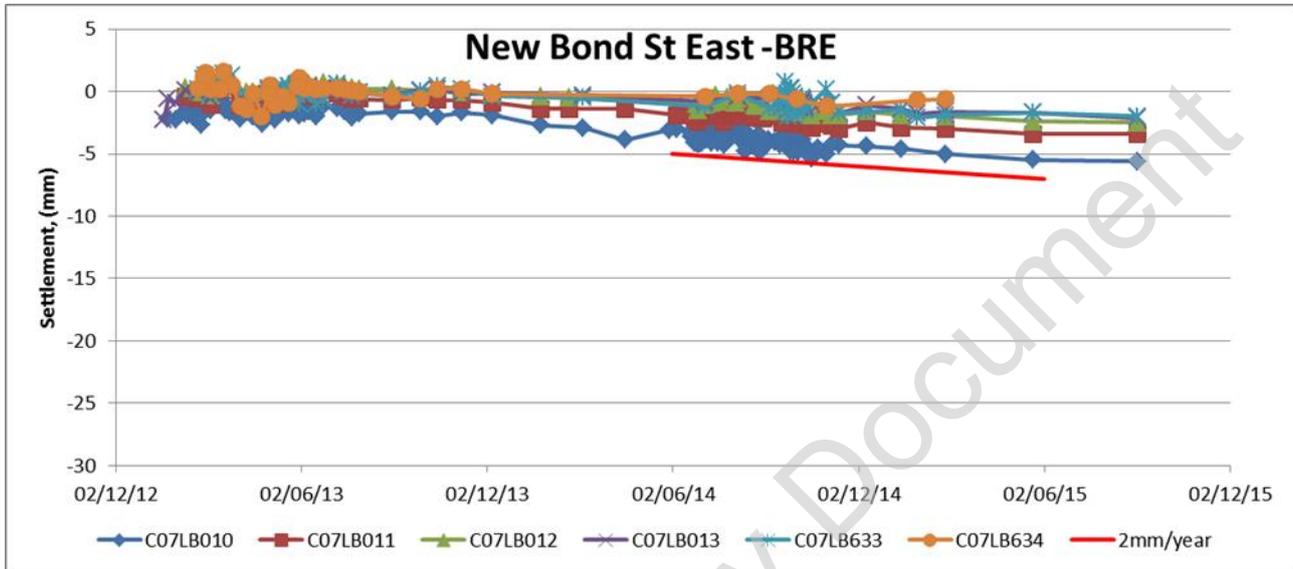


Figure 4.3 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the east façade of New Bond Street, south of Brook Street, had settled by less than 6mm at the end of C300 monitoring. These points are located outside the zone of influence of C300 works and it is concluded that the movements are due to C411 ETH works with a potential contribution from long term settlement following the construction of PTW in late 2013 / early 2014.

The overall long term behaviour gives a settlement rate of less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible, albeit the C411 ETH works were still in progress at the termination of monitoring by C300.

### 4.3. Brook Street South (West)

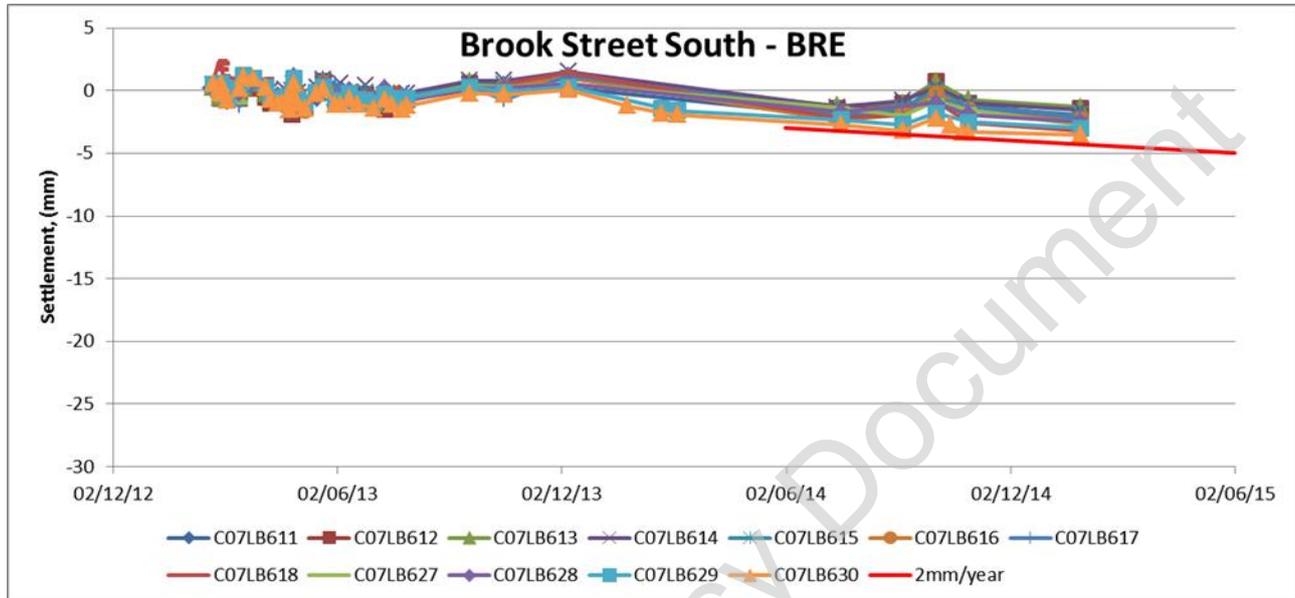


Figure 4.4 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the south façade of Brook Street, west of New Bond Street, had settled by less than 5mm at the end of C300 monitoring. These points are located outside the zone of influence of C300 works and it is concluded that the movements are due to C411 ETH works with a potential contribution from long term settlement following the construction of PTW in late 2013 / early 2014.

The overall long term behaviour gives a settlement rate of less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible, albeit the C411 ETH works were still in progress at the termination of monitoring by C300.

#### 4.4. Lancashire Court

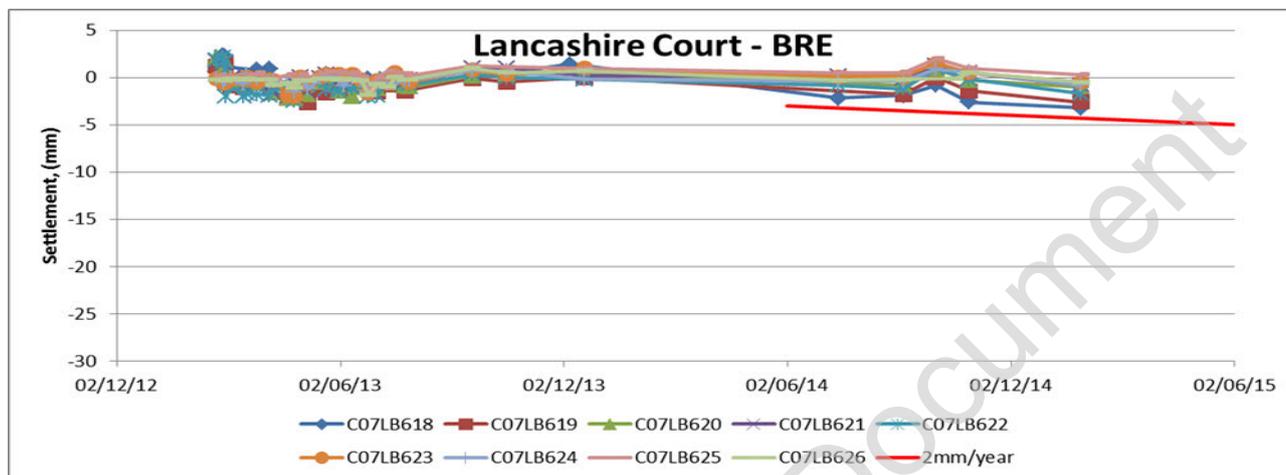
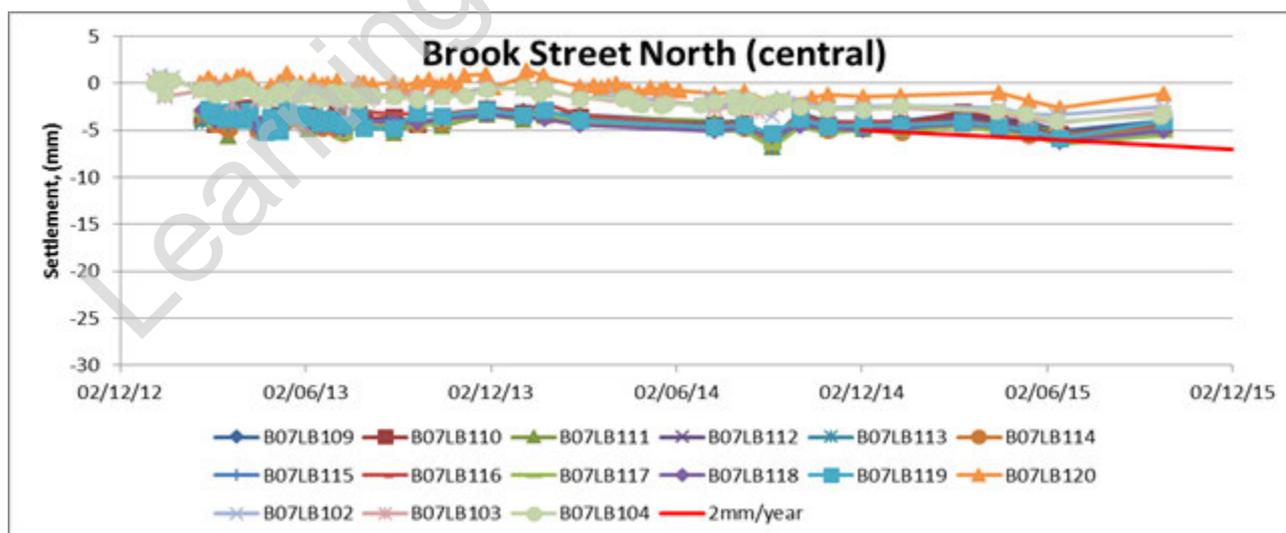


Figure 4.5 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the façades around Lancashire Court had settled by less than 5mm at the end of C300 monitoring. These points are located outside the zone of influence of C300 works and it is concluded that the movements are due to C411 ETH works with a potential contribution from long term settlement following the construction of PTW in late 2013 / early 2014.

The overall long term behaviour gives a settlement rate of less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible, albeit the C411 ETH works were still in progress at the termination of monitoring by C300.

#### 4.5. Brook Street North (Central)



The points on the façades along the north side of Brook Street between Davies Street and South Molton Lane had settled by about 5mm at the end of C300 monitoring. These points are located outside the 1mm greenfield settlement contour works and settlement has not significantly increased during or following C300 works.

The overall long term behaviour gives a settlement rate of less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 5. Observed Settlement: South area PLP

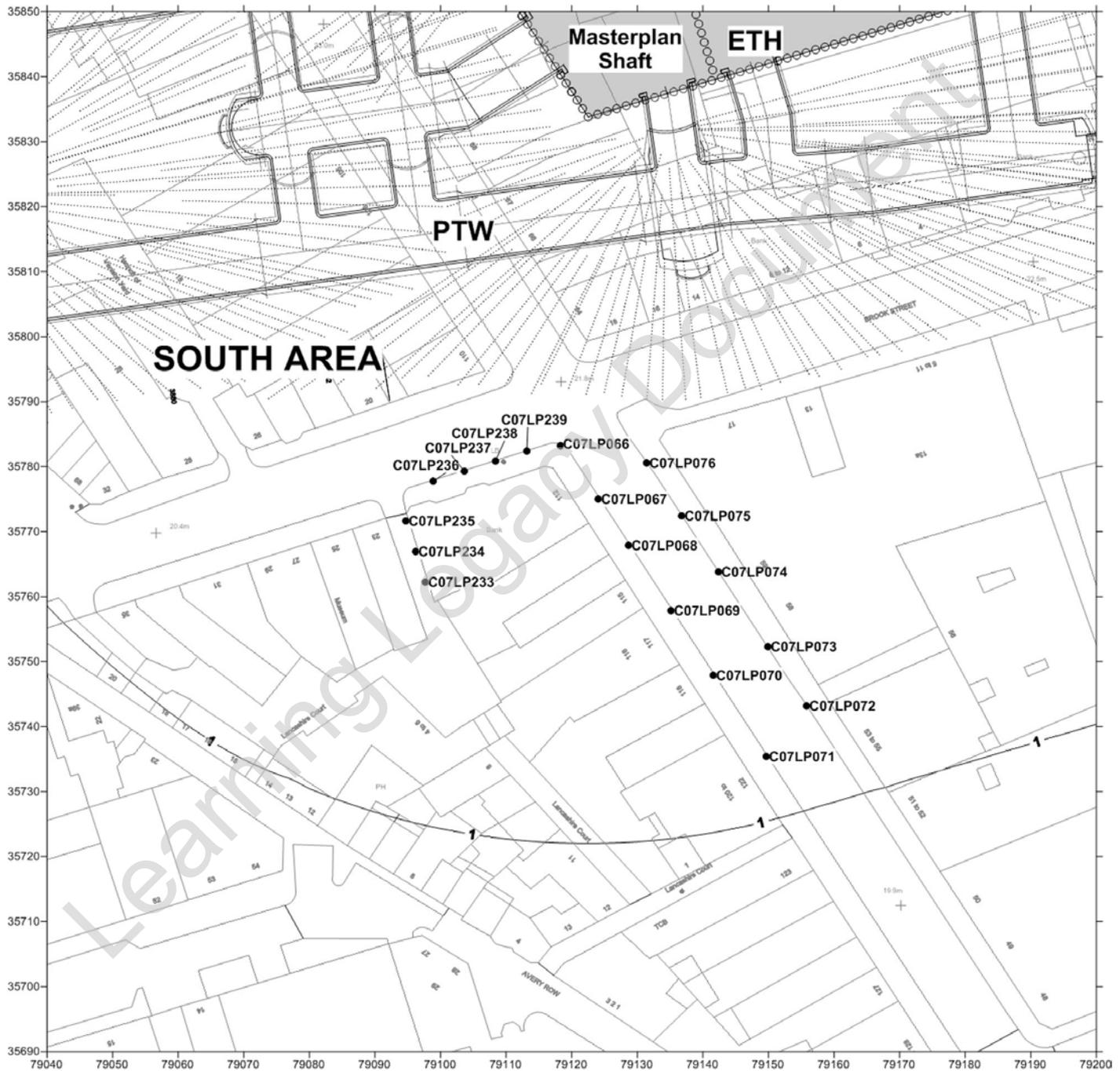


Figure 5.1 Location of PLP – South area

### 5.1. New Bond Street West (South)

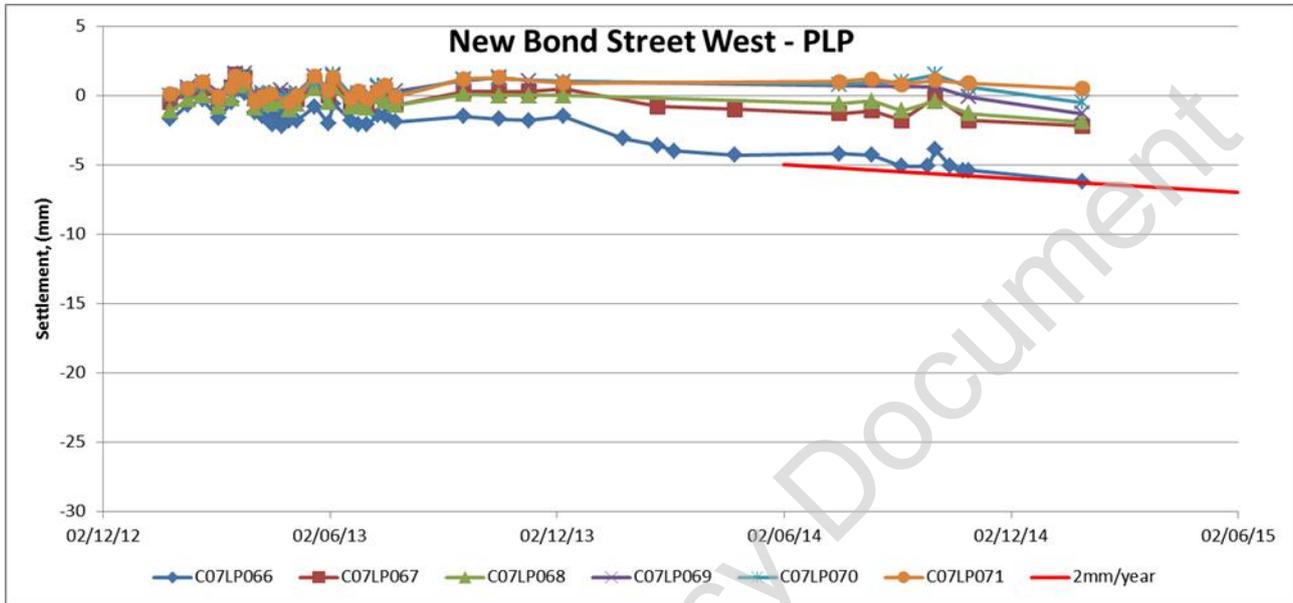


Figure 5.2 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the west kerbline of New Bond Street, south of Brook Street, had settled by less than 6mm at the end of C300 monitoring. These points are located outside the zone of influence of C300 works and it is concluded that the movements are due to C411 ETH works with a potential contribution from long term settlement following the construction of PTW in late 2013 / early 2014.

The overall long term behaviour gives a settlement rate of about 2mm/year. The residual risk associated with long-term settlements is considered to be negligible, albeit the C411 ETH works were still in progress at the termination of monitoring by C300.

## 5.2. New Bond Street East (South)

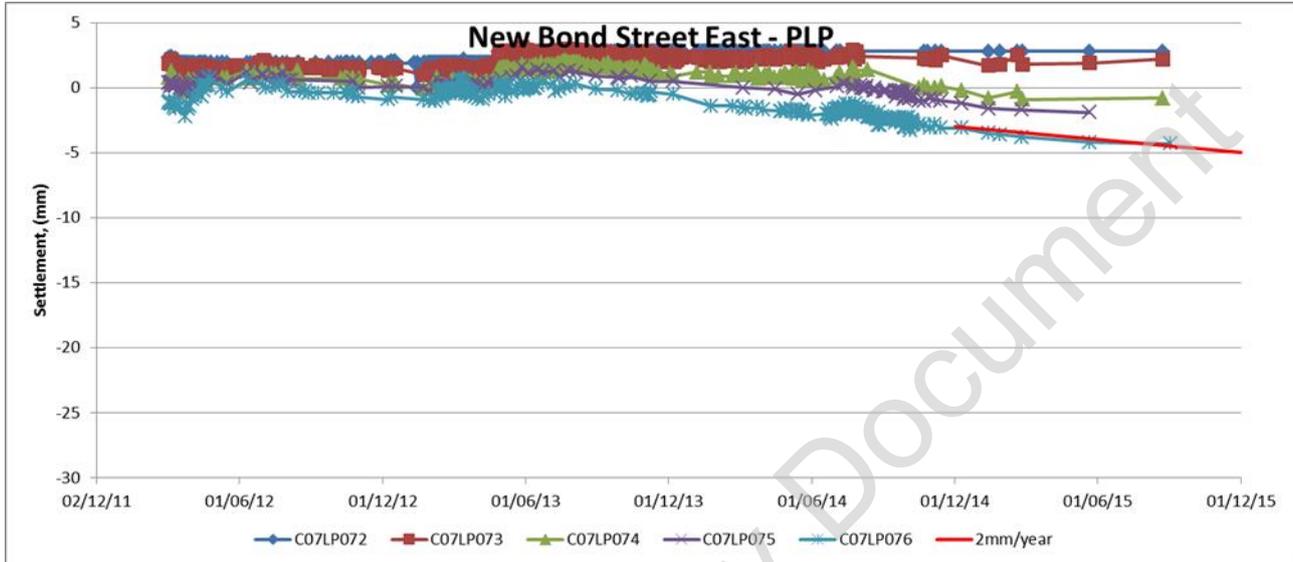


Figure 5.3 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the east kerbline of New Bond Street, south of Brook Street, had settled by less than 5mm at the end of C300 monitoring. These points are located outside the zone of influence of C300 works and it is concluded that the movements are due to C411 ETH works with a potential contribution from long term settlement following the construction of PTW in late 2013 / early 2014.

The overall long term behaviour gives a settlement rate of less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible, albeit the C411 ETH works were still in progress at the termination of monitoring by C300.

### 5.3. Brook Street South (West)

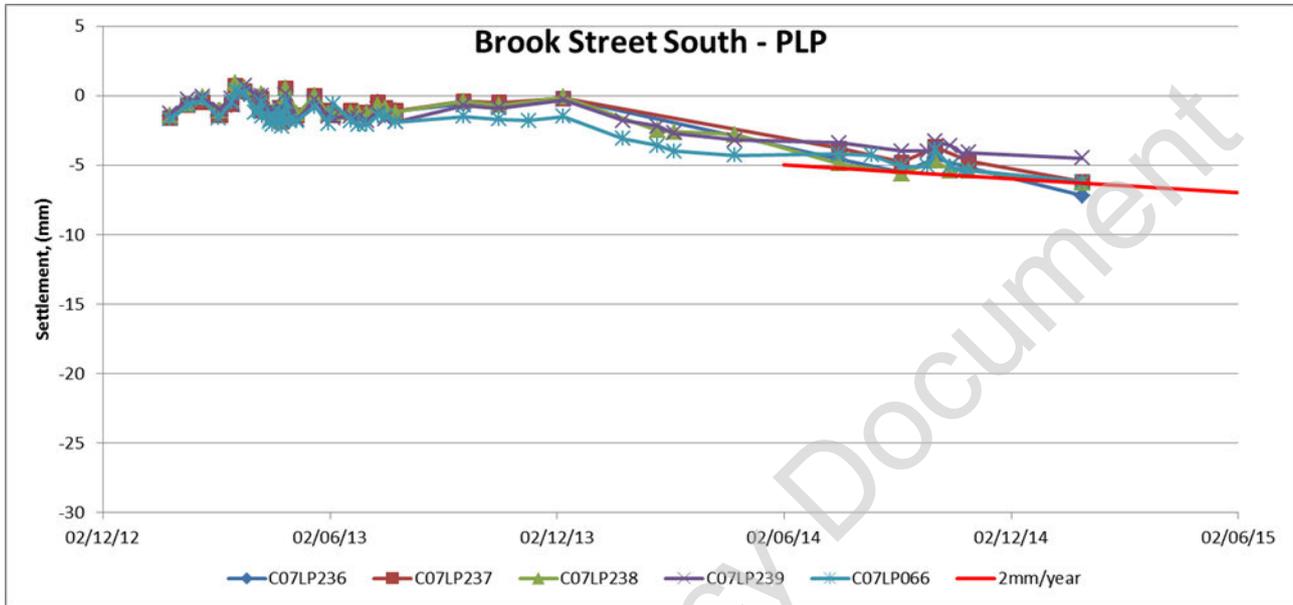


Figure 5.4 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the south kerbline of Brook Street, west of New Bond Street, had settled by less than 8mm at the end of C300 monitoring. These points are located outside the zone of influence of C300 works and it is concluded that the movements are due to C411 ETH works with a potential contribution from long term settlement following the construction of PTW in late 2013 / early 2014.

The overall long term behaviour gives a settlement rate of about 2mm/year. The residual risk associated with long-term settlements is considered to be negligible, albeit the C411 ETH works were still in progress at the termination of monitoring by C300.

### 5.4. Lancashire Court

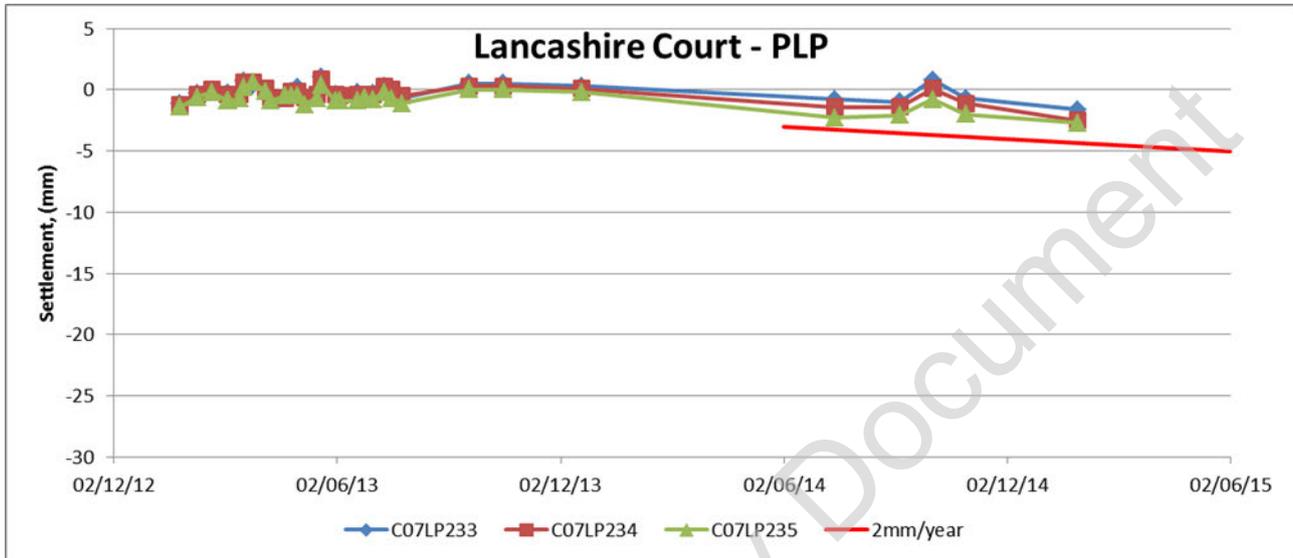


Figure 5.5 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the façades around Lancashire Court had settled by less than 5mm at the end of C300 monitoring. These points are located outside the zone of influence of C300 works and it is concluded that the movements are due to C411 ETH works with a potential contribution from long term settlement following the construction of PTW in late 2013 / early 2014.

The overall long term behaviour gives a settlement rate of less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6. Observed Settlement: East area BRE

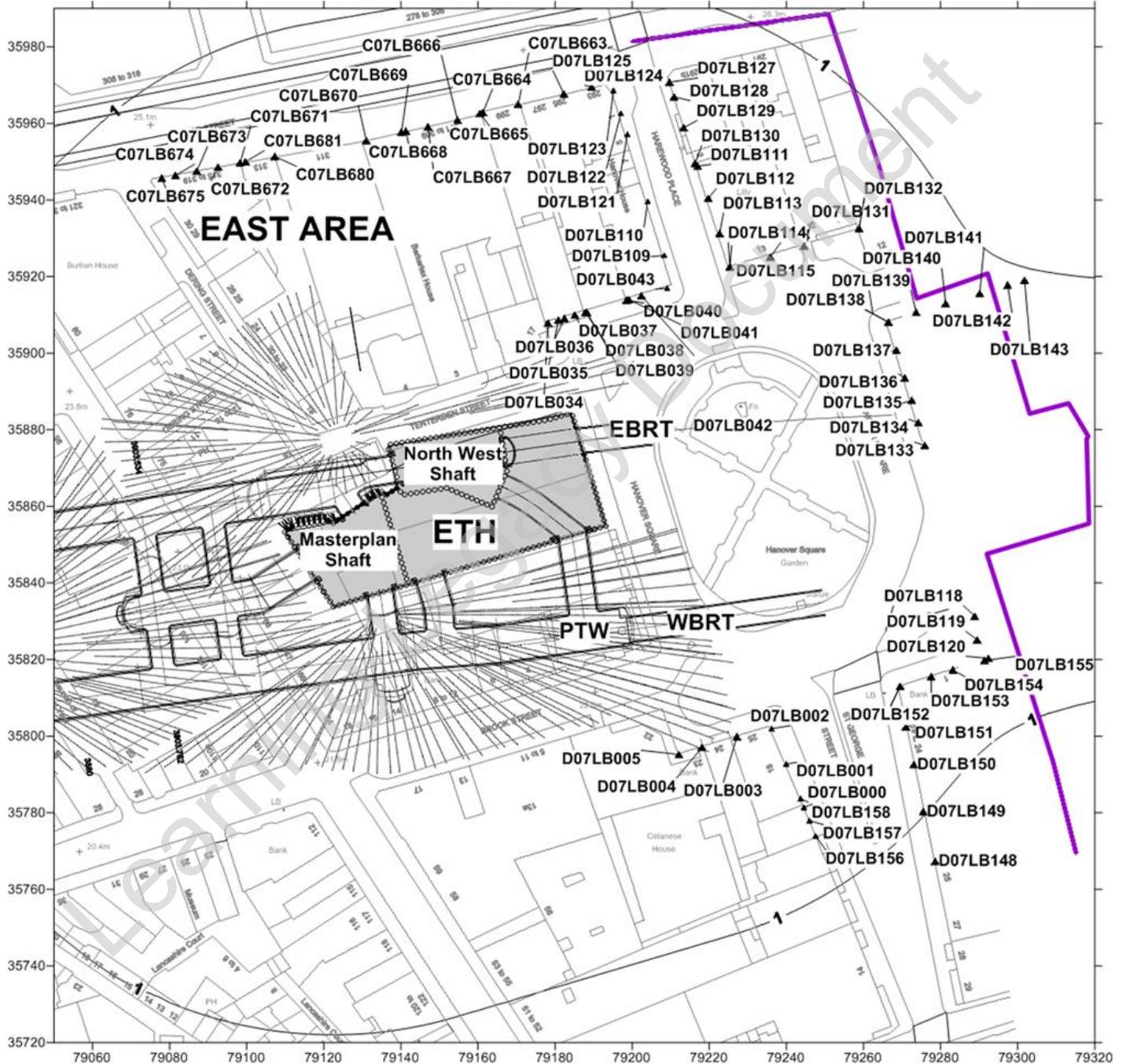


Figure 6.1 Location of BRE – East area

### 6.1. St. George Street West

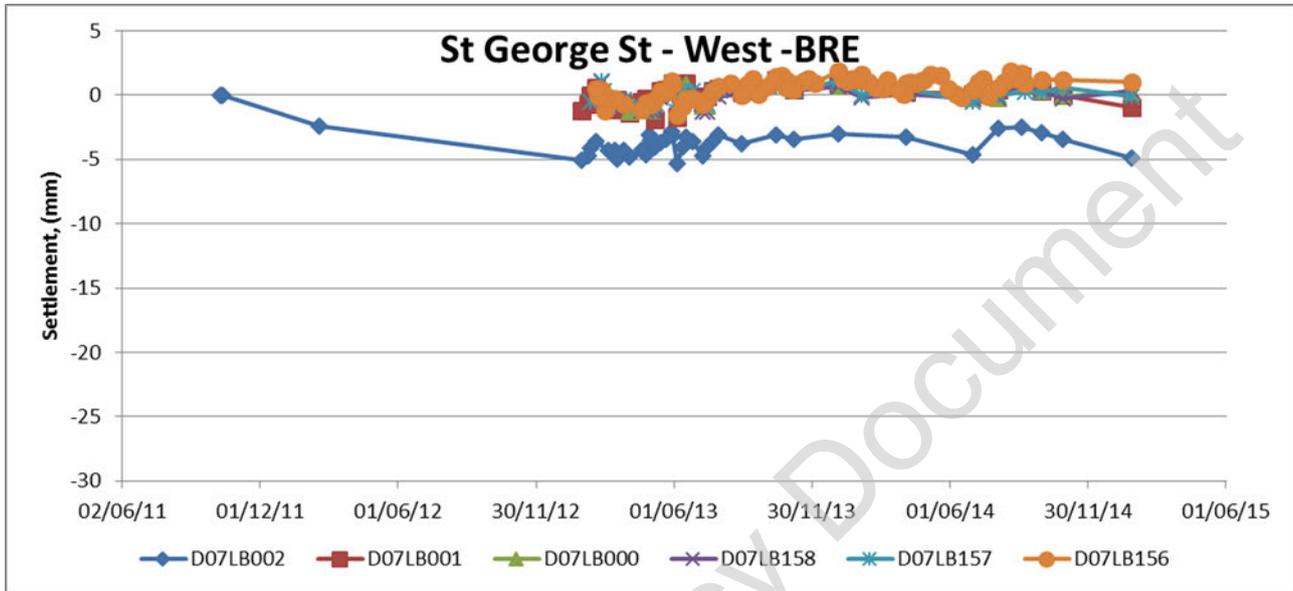


Figure 6.2: Data time-plot

The points on the façade on the west side of St. George Street show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6.2. St. George Street East

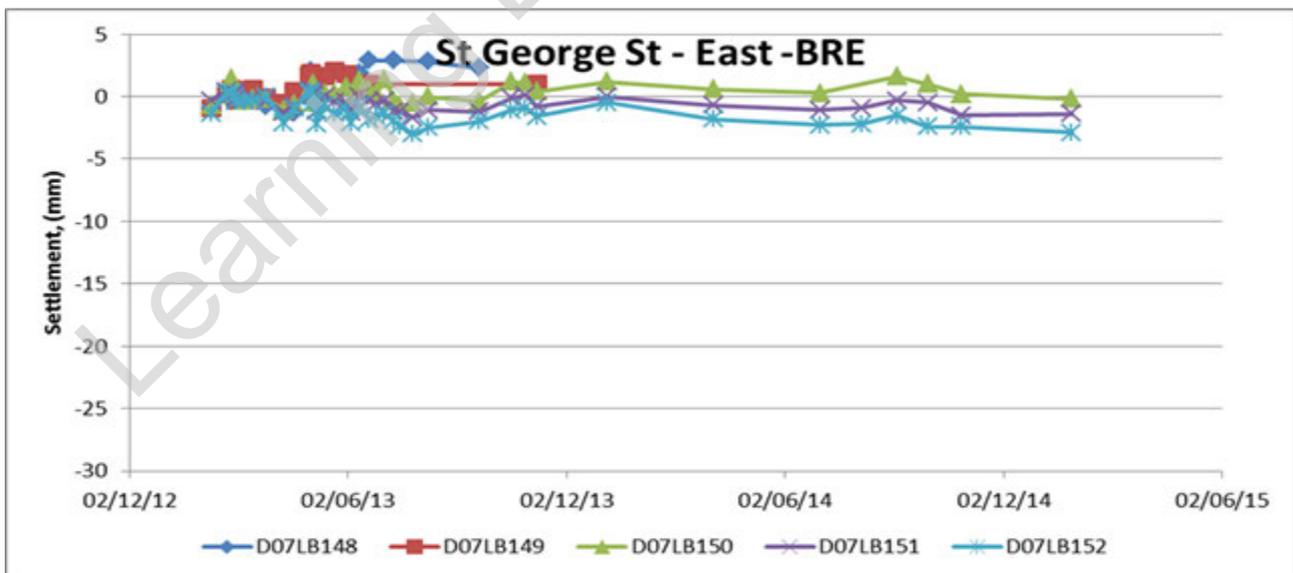


Figure 6.3: Data time

The points on the façade on the west side of St. George Street show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6.3. Hanover Square South

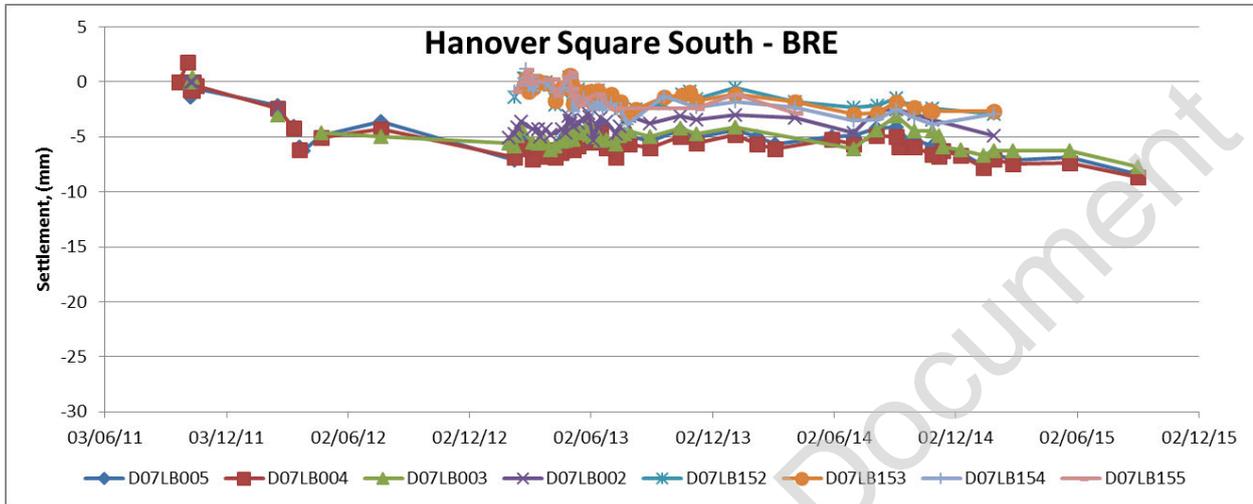


Figure 6.4 Data time-plot

The points on the façades on the south side of Hanover Square show low impact (<10mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6.4. Hanover Square East

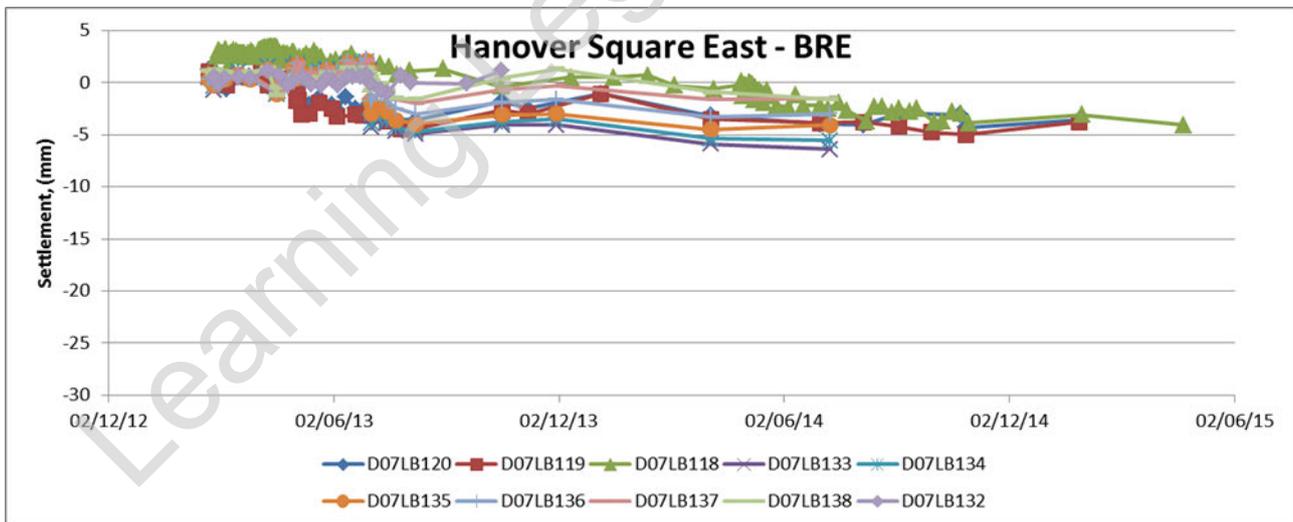


Figure 6.5 Data time-plot

The points on the façades on the east side of Hanover Square show low impact (<10mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6.5. Hanover Square North

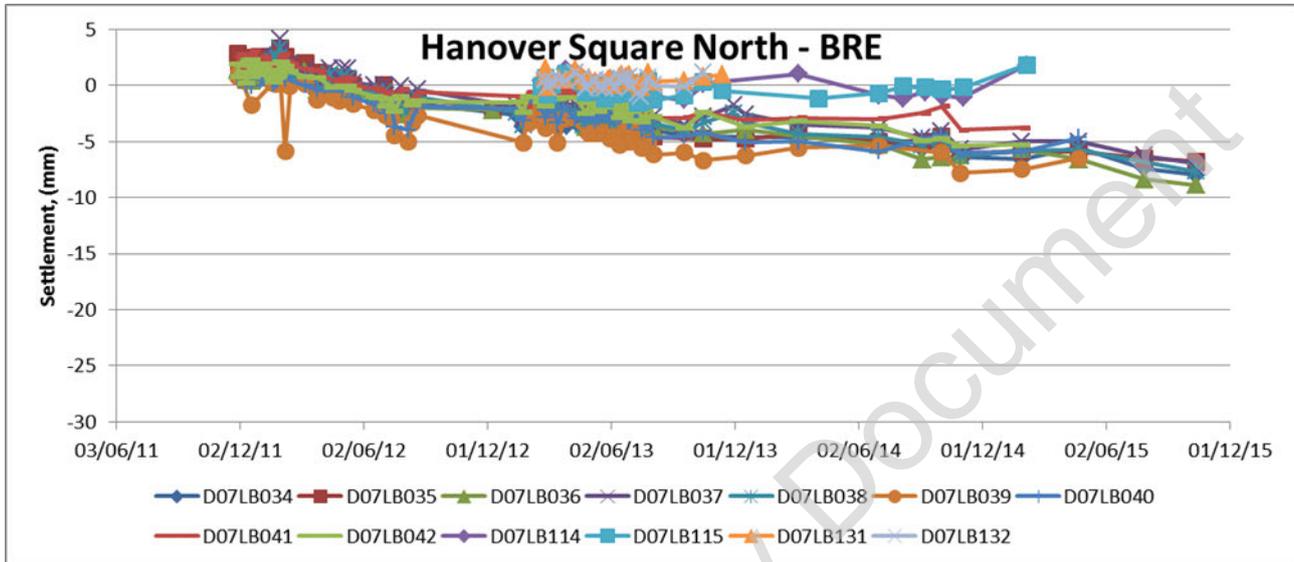


Figure 6.6 Data time-plot

The points on the façades on the north side of Hanover Square show low impact (<10mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6.6. Harewood Place West

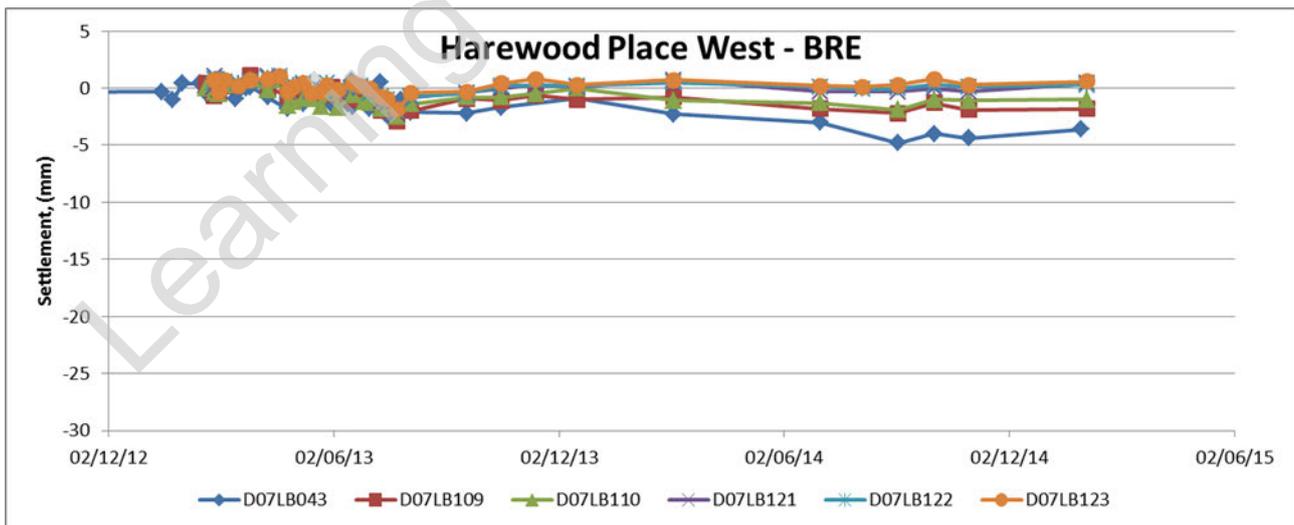


Figure 6.7 Data time-plot

The points on the façade on the west side of Harewood Place show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6.7. Harewood Place East

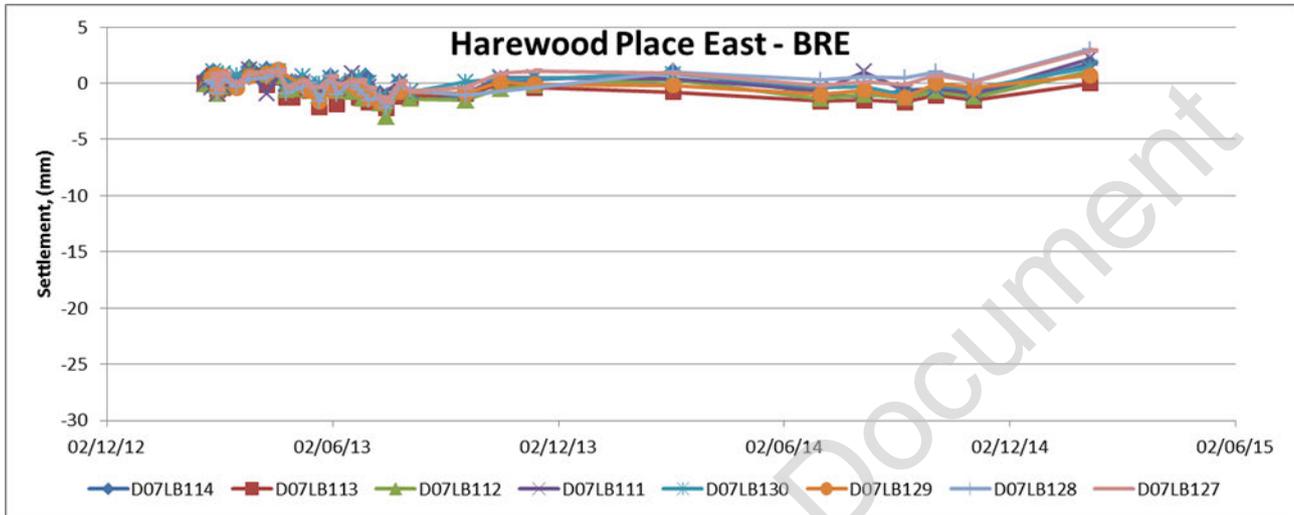


Figure 6.8 Data time-plot

The points on the façade on the east side of Harewood Place show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6.8. Princes Street South

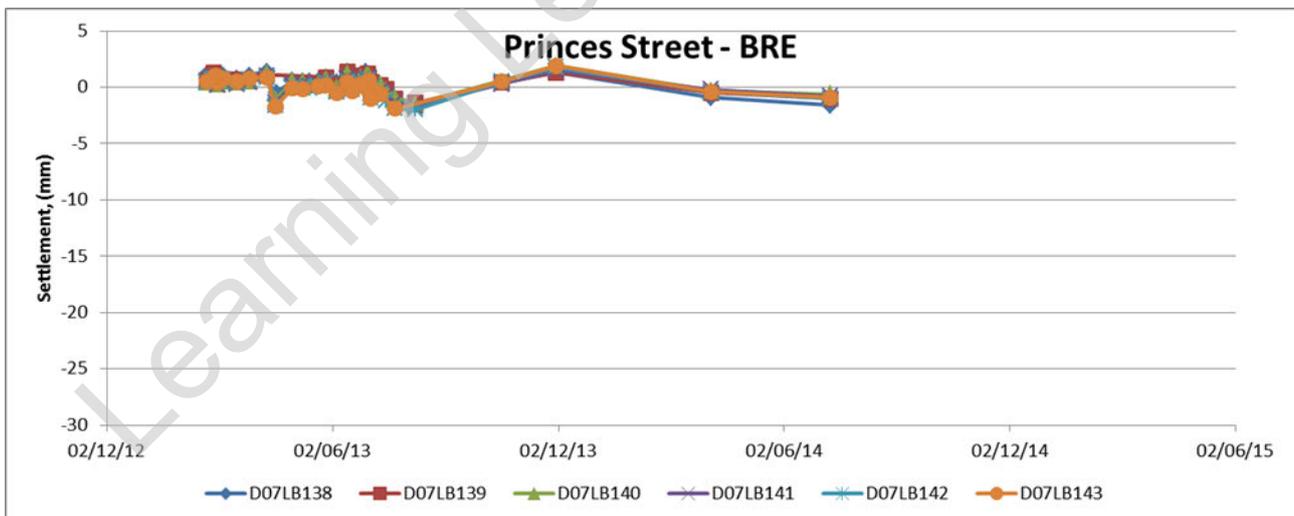


Figure 6.9 Data time-plot

The points on the façade on the south side of Princes Street show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 6.9. Oxford Street South (East)

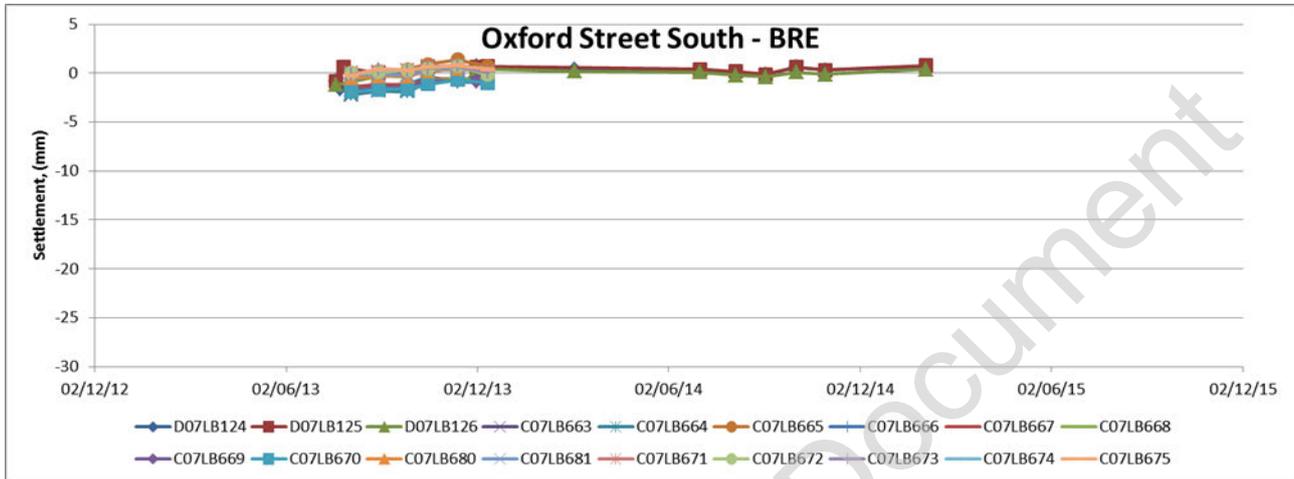


Figure 6.10 Data time-plot

The points on the façade on the south side of Oxford Street show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 7. Observed Settlement: East Area PLP

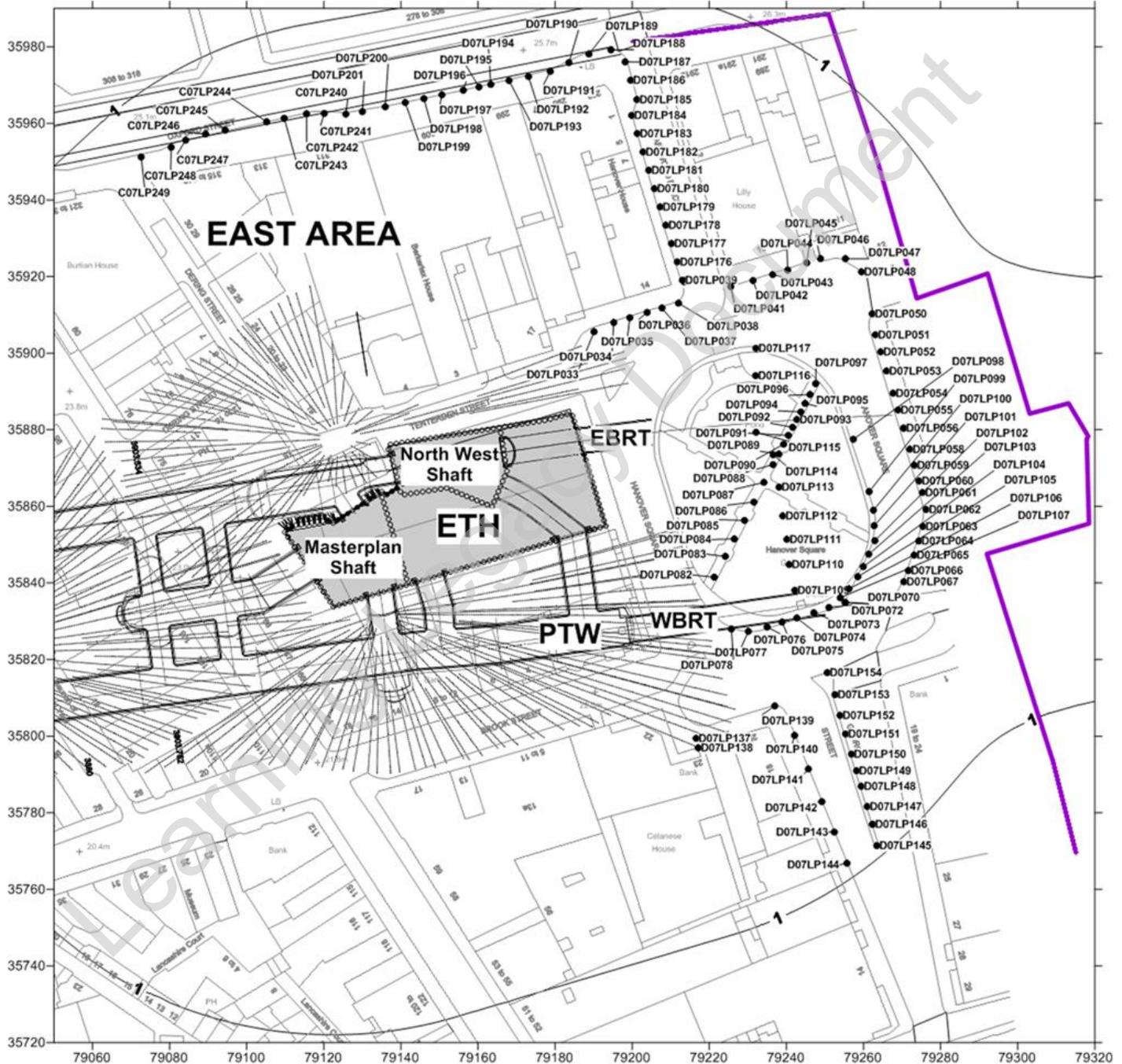


Figure 7.1 Location of PLP – East area

### 7.1. St. George Street West

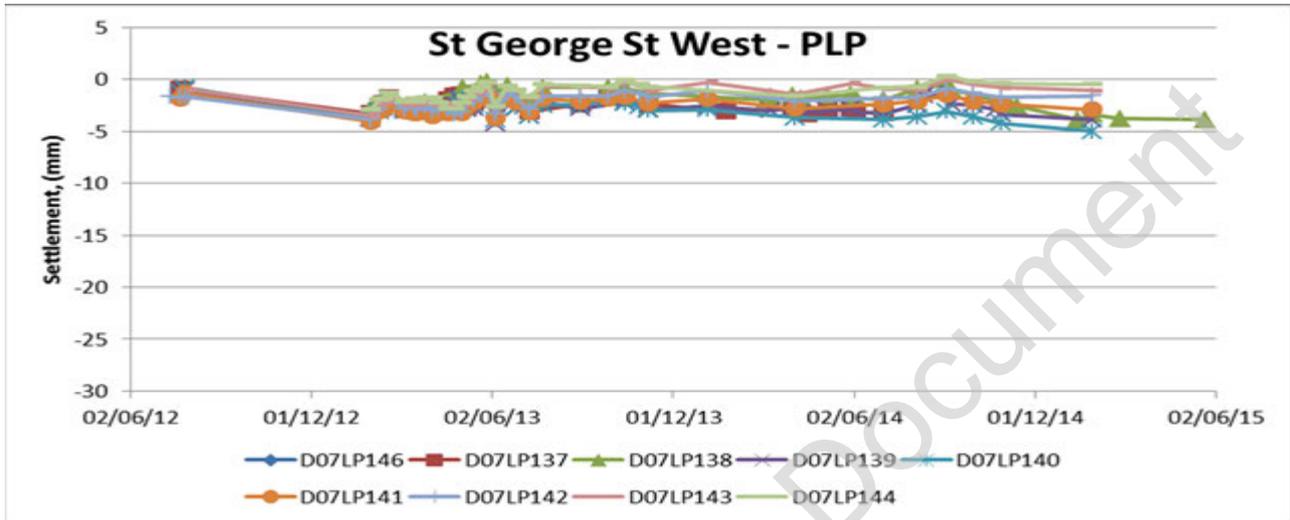


Figure 7.2 Data time-plot

The points on the west kerbline of St. George’s Street show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 7.2. St. George Street Centre

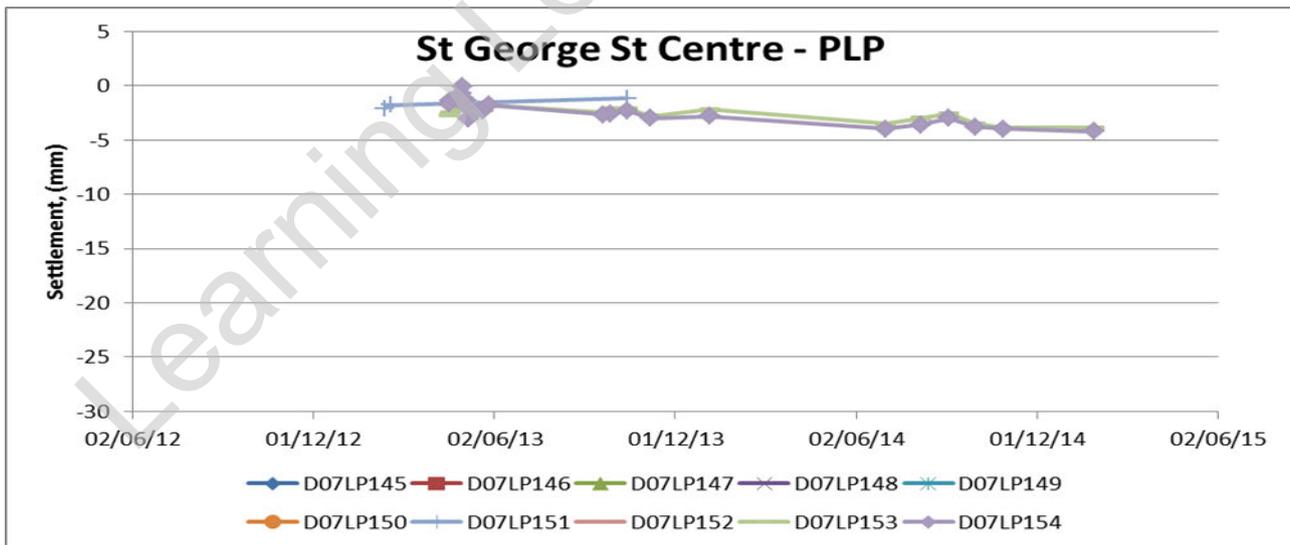


Figure 7.3 Data time-plot

The points on the central reserve kerbline of St. George’s Street show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 7.3. Hanover Square East

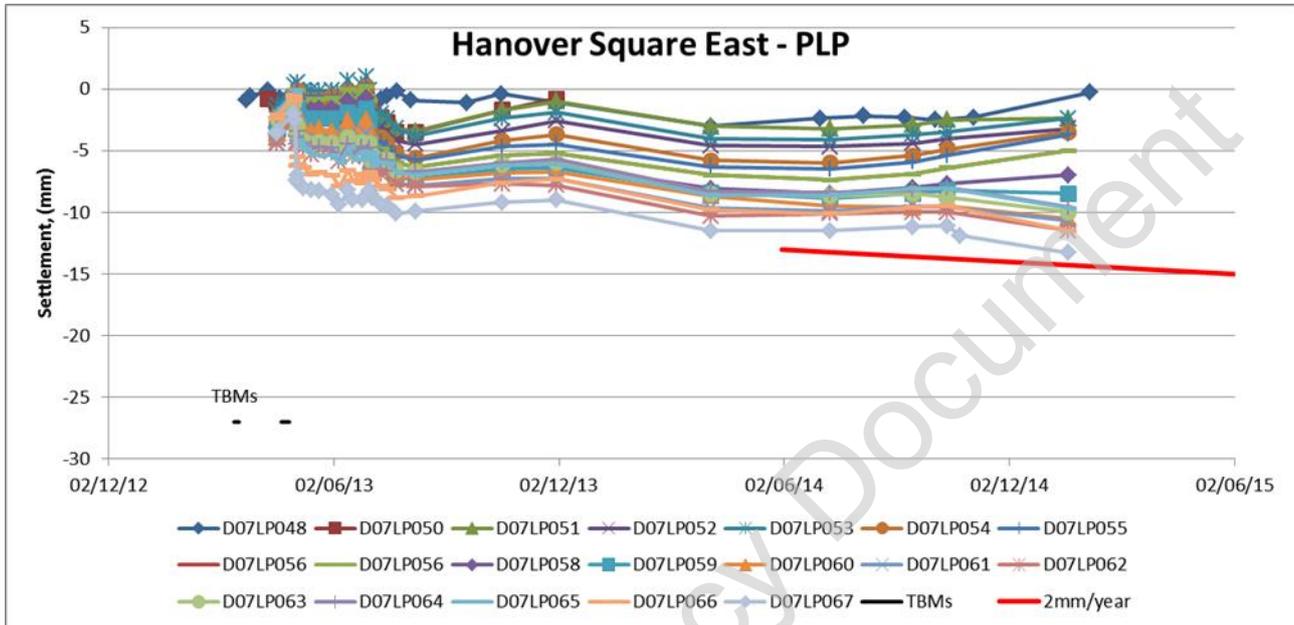


Figure 7.4 Data time-plot

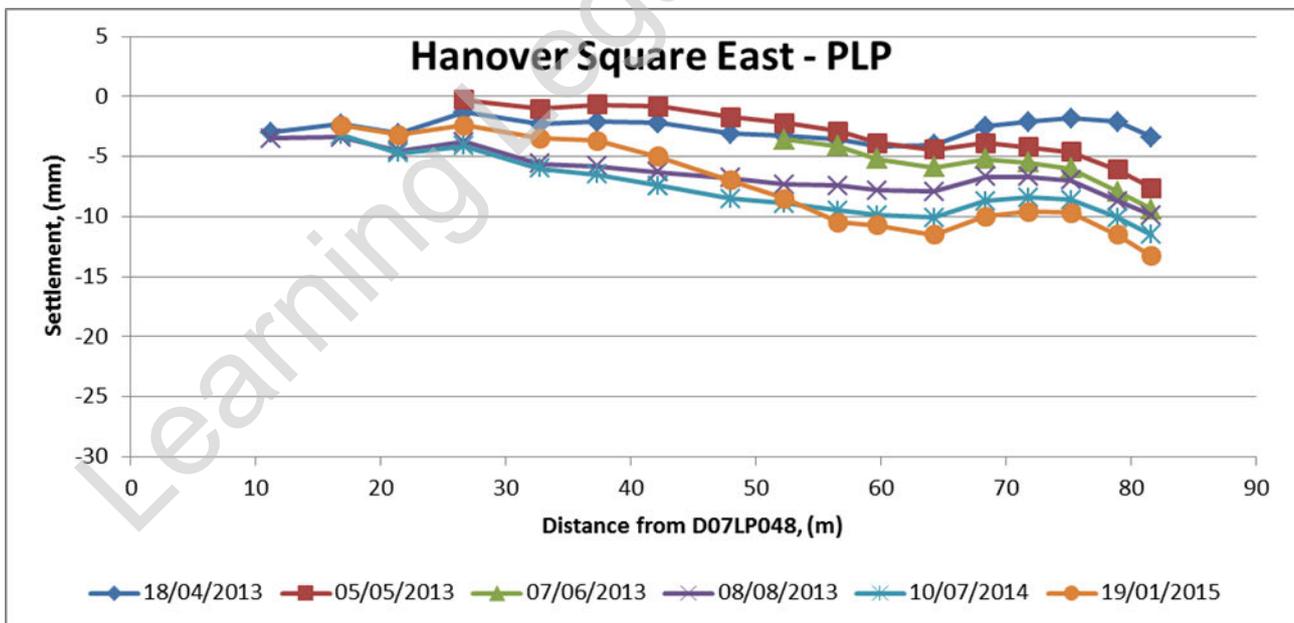


Figure 7.5: Profile Plot: Hanover Square East kerblines

The points on the east outer kerblines of Hanover Square show low impact (~8mm) from C300 works. The overall long term rate of settlement was about 2mm/year, giving a maximum settlement of 14mm at the termination of monitoring. It is noted that most of the points were destroyed due to a re-development on the corner of Hanover Square and Princes Street. The residual risk associated with long-term settlements is considered to be negligible.

### 7.4. Hanover Square North

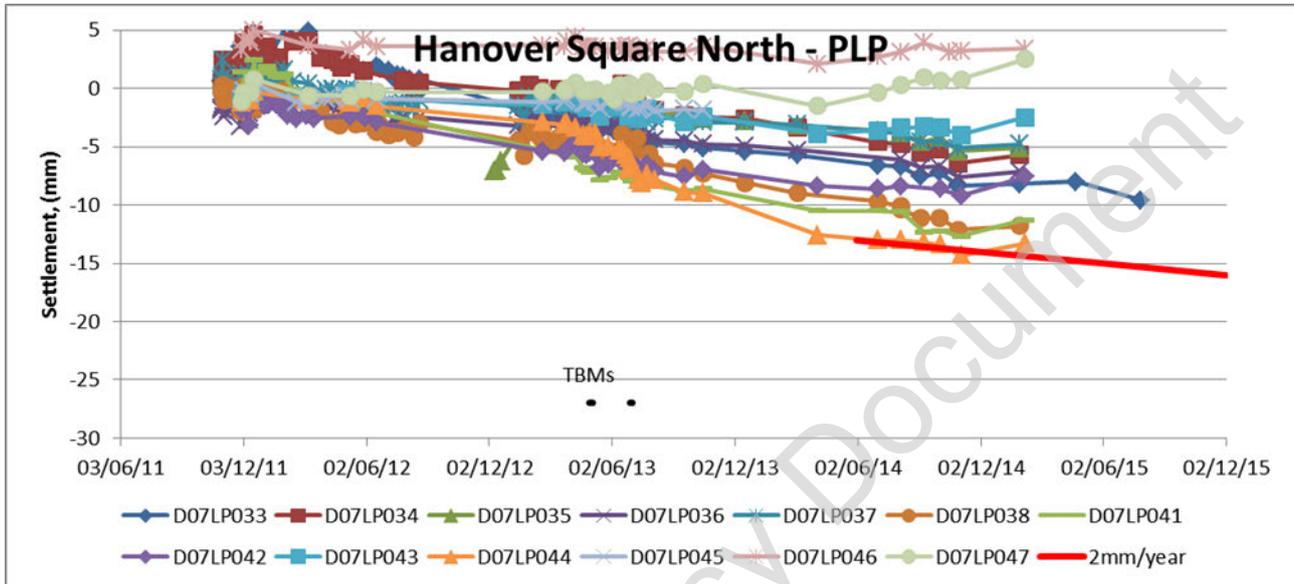


Figure 7.6 Data time-plot - comparison against 2mm/year settlement rate (long-term)

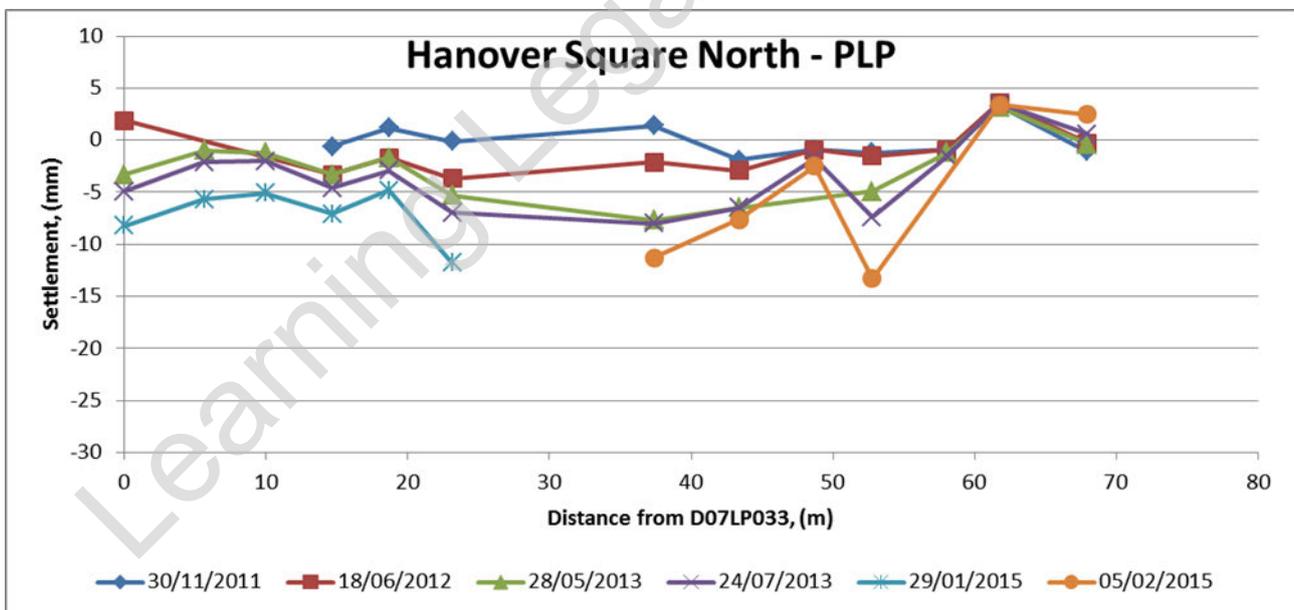


Figure 7.7 Profile Plot: Hanover Square North kerblines

The points on the north outer kerblines of Hanover Square show up to 5mm settlement prior to the TBM drives. There is a negligible impact (<5mm) from C300 works and a further 5mm settlement following the second TBM. The final long term rate of settlement is about 2mm/year.

It is noted that there were a number of re-developments ongoing around the east and north of Hanover Square and the form of the settlement profile plot showing localised peaks suggests that some damage to the kerbs may have occurred due to construction traffic.

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

### 7.5. Hanover Square Gardens

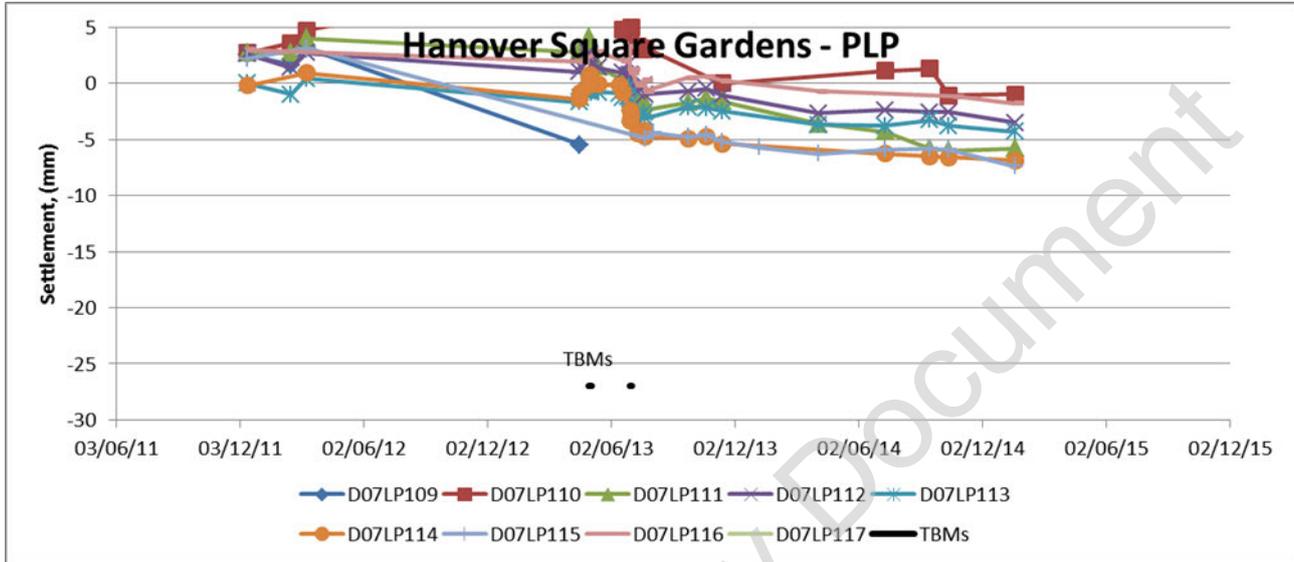


Figure 7.8 Data time-plot

The points within Hanover Square Gardens show low impact (<10mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 7.6. Hanover Square Footpath

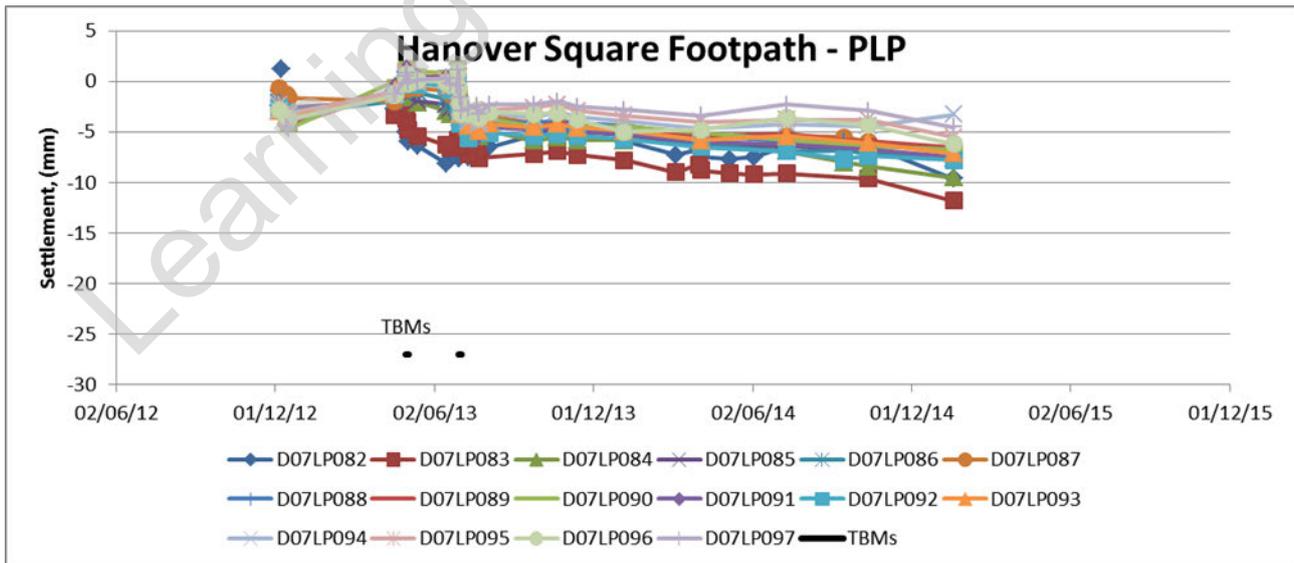


Figure 7.9 Data time-plot

The points on the footpath across Hanover Square Gardens have approximately 10mm settlement. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 7.7. Hanover Square Inner East

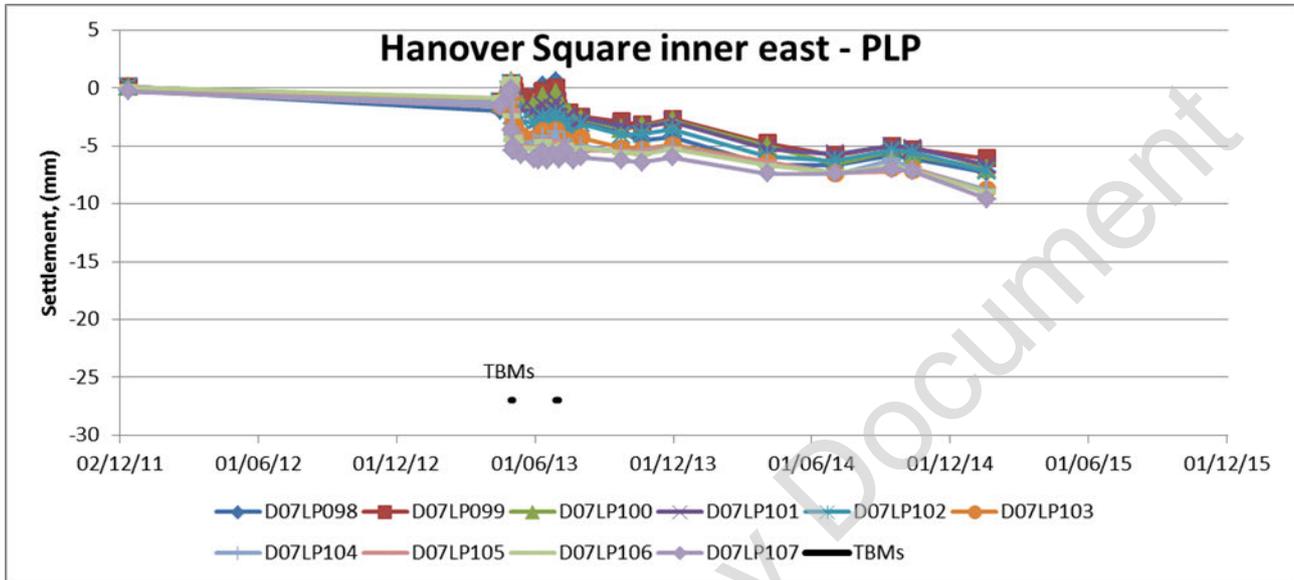


Figure 7.10 Data time-plot

The points on the east inner kerbline of Hanover Square have approximately 10mm settlement. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 7.8. Hanover Square Inner South

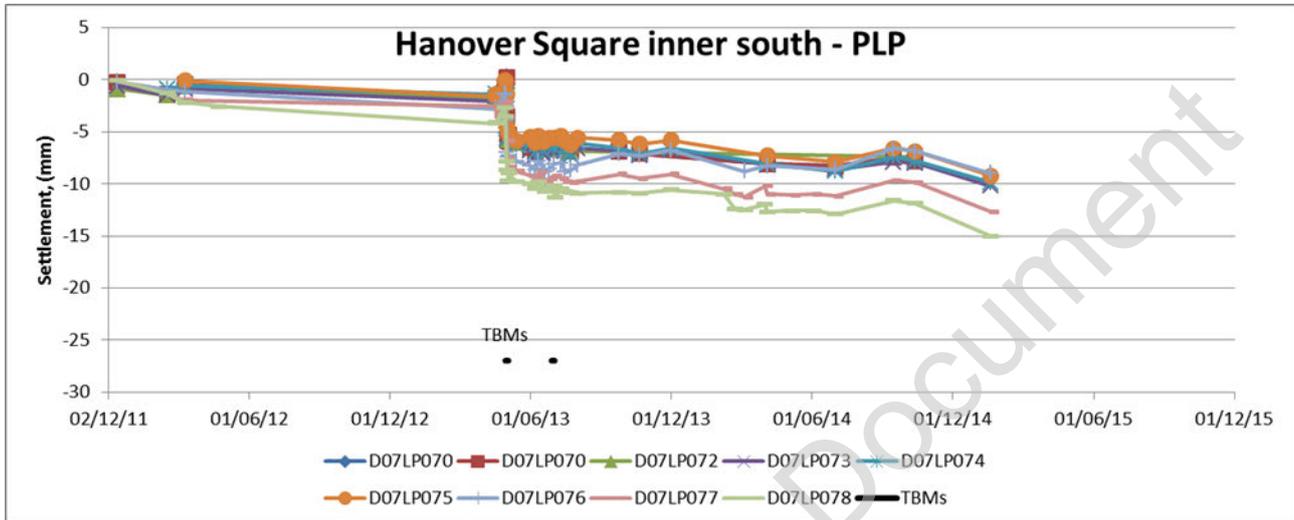


Figure 7.11 Data time-plot

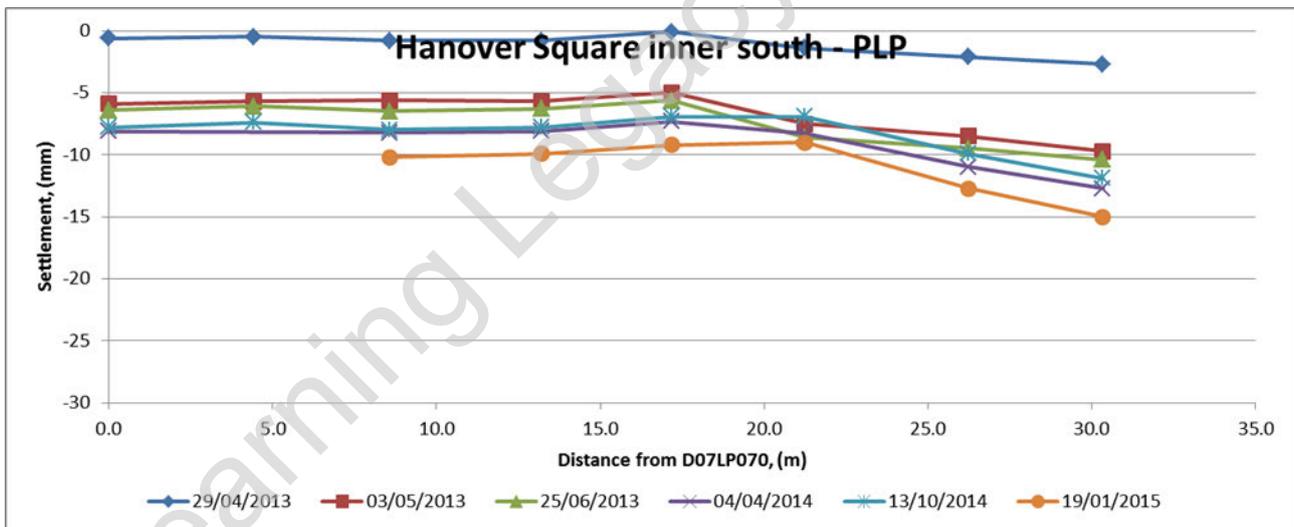


Figure 7.12: Profile Plot: Hanover Square Inner South kerblines

The points on the east outer kerblines of Hanover Square have less than 10mm settlement, except at the western end which is closest to the station works (from Distance 20m). By inspection, the slope is less than 1mm/m. It is probable that settlement on this transect may have continued to increase following termination of monitoring by C300 due to ongoing works on the ETH (refer to C411 monitoring reports).

### 7.9. Harewood Place West

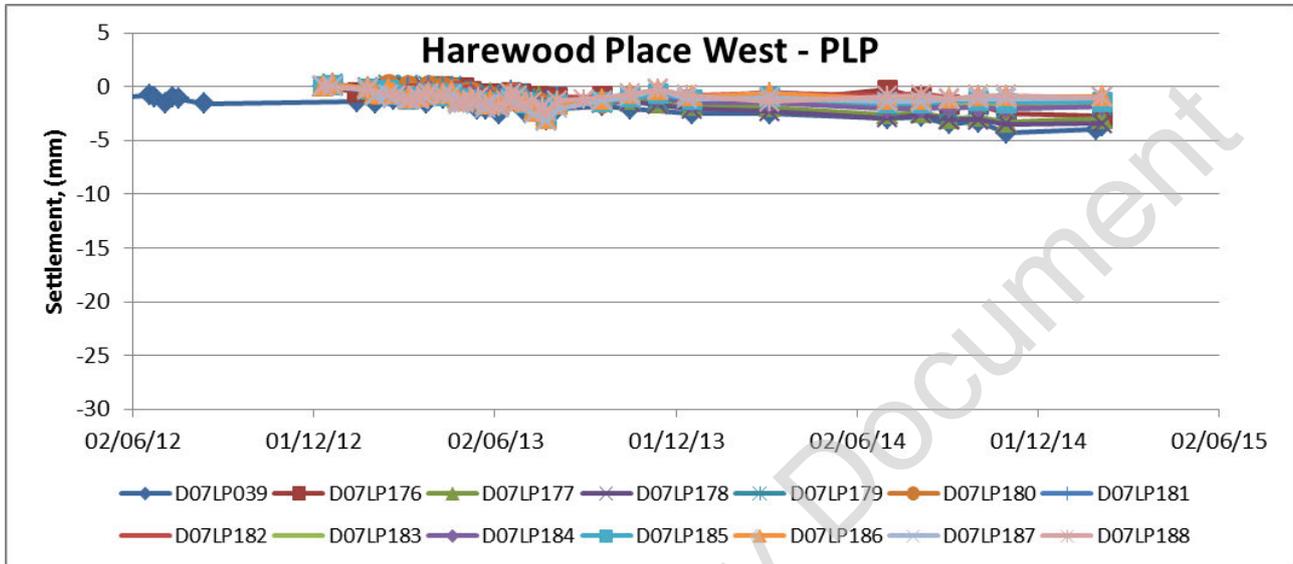


Figure 7.13 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the west outer kerbline of Harewood Place show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

### 7.10. Oxford Street South

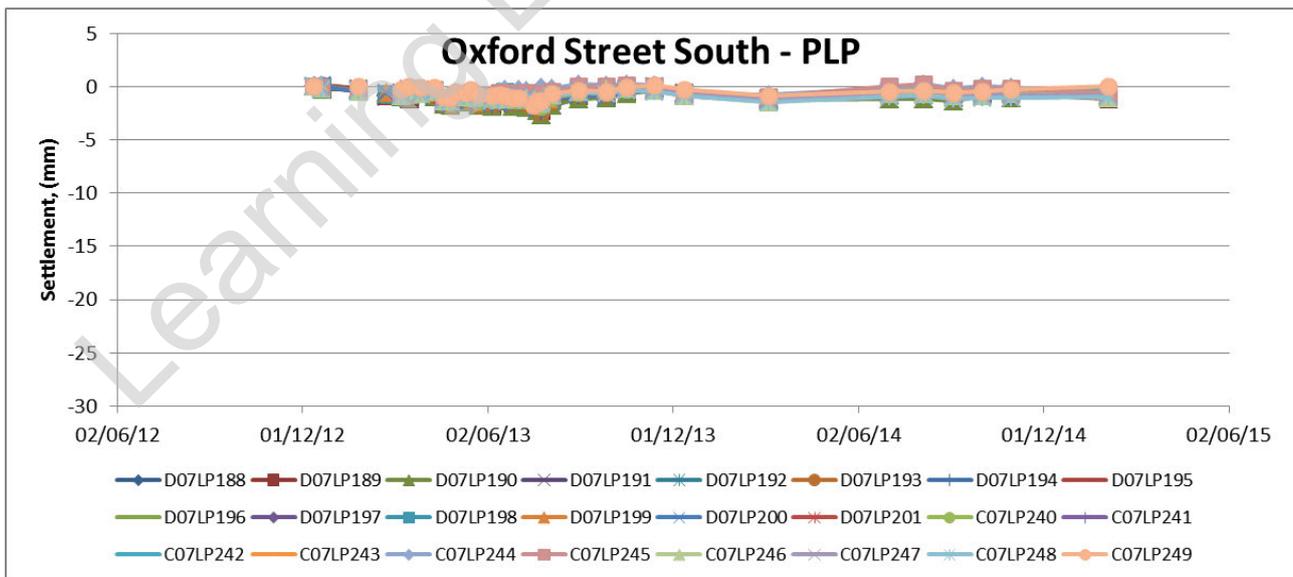


Figure 7.14 Data time-plot - comparison against 2mm/year settlement rate (long-term)

The points on the south kerbline of Oxford Street show negligible impact (<5mm) from C300 works. The overall long term rate of settlement is less than 2mm/year. The residual risk associated with long-term settlements is considered to be negligible.

## 8. Reference Documents

Code	Document
C300-BFK-C4-STP-CRT00_ST005-50023	Management Plan for the Control of Ground Movements - Addendum 17 - BOS - SCL Advance Works
C300-BFK-C4-STP-CRT00_ST005-50036	Management Plans for Control of Ground Movements Addendum 30 TBM Drives 4 - Park Lane to BOS
C300-BFK-C4-STP-CRT00_ST005-50081	Management Plan for the Control of Ground Movements Addendum 32 - TBM Drives 5 - BOS
C300-BFK-C4-STP-CRT00_ST005-50154	Management Plan for the Control of Ground Movements - Addendum 33 - TBM Drives 6 - BOS to TCR
C122-OVE-C2-RGN-CRG01-50011	Instrumentation and Monitoring Plans: Strategy
C121-MMD-C4-RAN-N125-00016	C121 Bond Street Station Monitoring Plan
C300-BFK-C4-RGN-CRT00_ST005-50505	Installation report for PLP's Hyde Park to Bond Street
C300-BFK-C4-RGN-CRT00_ST005-50522	Installation of PLP's in 28 South moltern St
C300-BFK-C4-RGN-CRT00_ST005-50570	Installation of geodetic prisms and BRE's BOS St to TCR
C300-BFK-C4-RGN-CRT00_ST005-50572	Installation of geodetic Prisms, BRE's and Barcodes in Bond Street Area
C300-BFK-C4-RGN-CRT00_ST005-50600	Installation of Geodetic Prisms and retros Paddington to Hyde Park
C300-BFK-C4-RGN-CRT00_ST005-50602	Installation of geodetic prisms hyde park to bond street
C300-BFK-C4-RGN-CRT00_ST005-50604	Installation of BRE's Barcodes and PLP's in Hyde Park to Bonds Street
C300-BFK-C4-RGN-CRT00_ST005-50616	Installation of PLP and barcodes bonhams basements
C300-BFK-C4-RGN-CRT00_ST005-50618	Installation OF PLP's In Brown Hart Gardens and Balderton Street (PMI203)
C300-BFK-C4-RGN-CRT00_ST005-50622	Installations of BRE sockets along macmillian House wall (PMI228)
C300-BFK-C4-RGN-CRT00_ST005-50623	Installation of geodetic Prisms for 20 Hanover square Party Wall (PMI217)
C300-BFK-C4-RGN-CRT00_ST005-50643	Installation of Retro Targets in Bonhams Basement (PMI256)
C300-BFK-C4-RGN-CRT00_ST005-50649	Installation of PLP's and Retros In Duke St UKPN Tunnel (PMI 272)
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_ST005-50758	Adjustment of BRE PLP and Prisms in BOS area
C300-BFK-C4-RGN-CRT00_ST005-50767	Pre installation report for Crown Estates Properties on Regent St (PMI341)
C300-BFK-C4-RGN-CRT00_ST005-50914	Installation Report for additional instrumentation at 105-106 New Bond Street (BFK PMI 441)
C300-BFK-C-RGN-CRT00_ST005-50437	HYDE PARK PLP INSTALLATION REPORT
C300-BFK-C-RGN-CRT00_ST005-50504	Installation report for PLP's In Bond St Area

## Appendix 1. Final Settlement Distribution

Only data for points with readings within 90 days of the termination of monitoring are included.

