

'The Use of Shape Accel Arrays (SAAs) for Measuring Retaining Wall Deflection'

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◀ Introduction

- ▶ Measurement of deflection of diaphragm walls is critical.
- ▶ Usual practice to use inclinometers.
- ▶ Inclinometers are sufficient but limited.
- ▶ Shape Arrays are relatively new to the UK construction industry.



◀ Shape Accel Arrays – What Are They?

- ▶ Rope-like array of sensors and microprocessors.
- ▶ Can be used to measure deformation or vibration.
- ▶ Made up of segments, each segment contains three MEMS accelerometers.
- ▶ Joints between segments can move in any direction but can not twist.



◀ Shape Accel Arrays – What Are They?

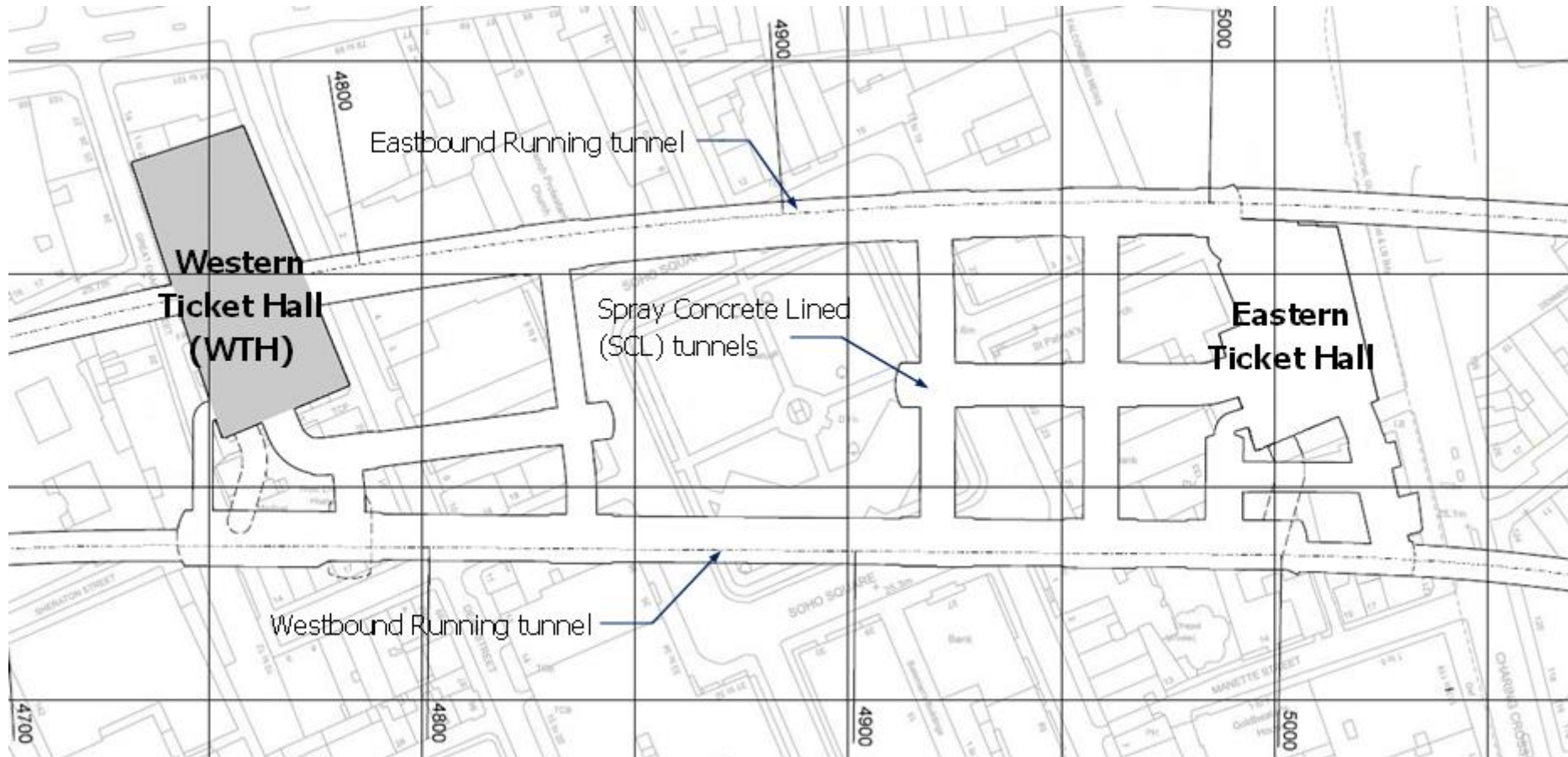
Resolution:	2 arc seconds
Accuracy:	$\pm 0.5\text{mm}/32\text{m}$ when casing grouted $\pm 1.5\text{mm}/32\text{m}$ when casing not grouted
Pressure:	tested to 100m depth water
Vibration:	can measure $\pm 2\text{G}$



◀ Shape Accel Arrays – What Are They?

▶ TO ADD – SAA DEMONSTRATION VIDEO

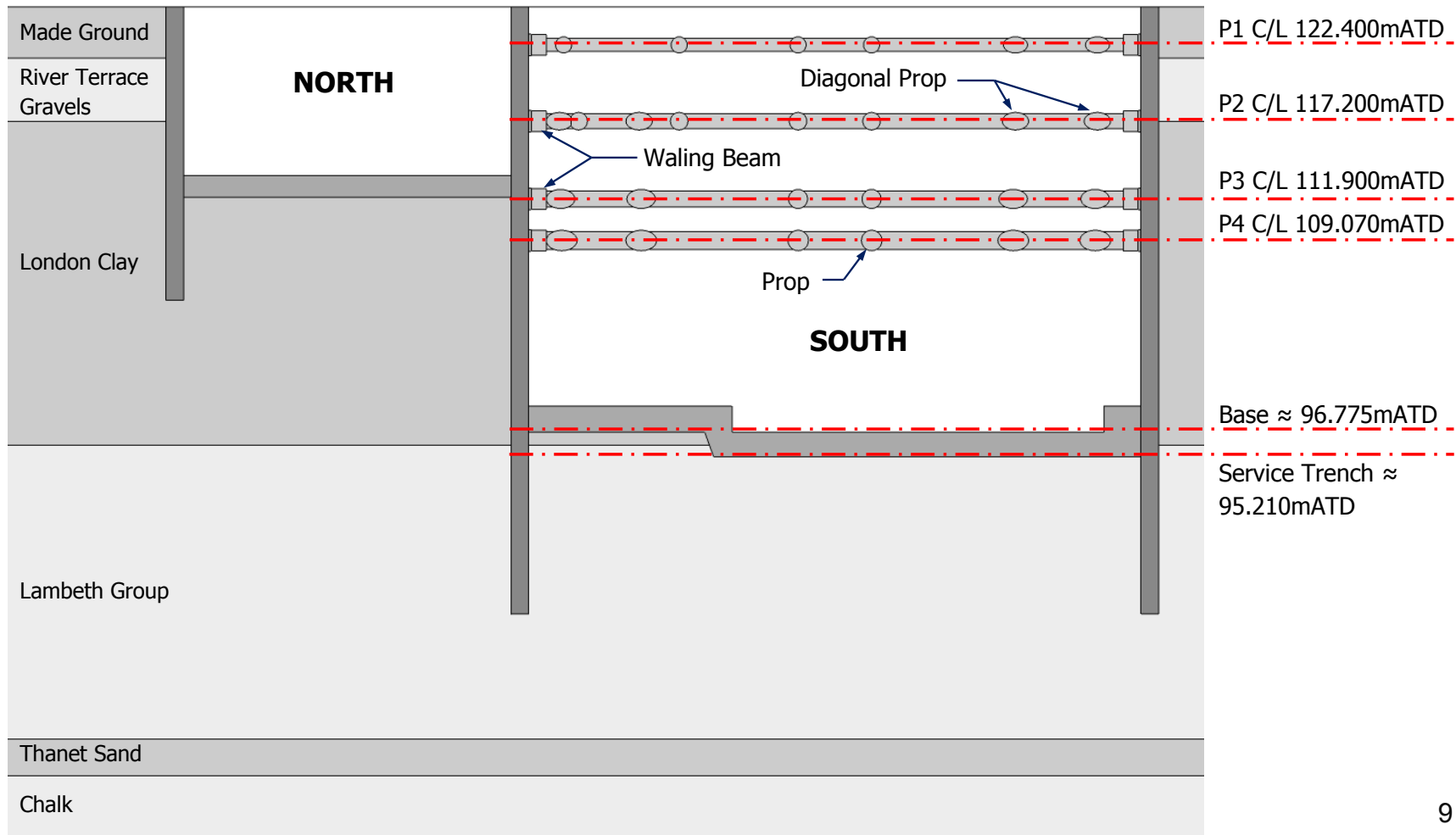
◀ The New Tottenham Court Road Station



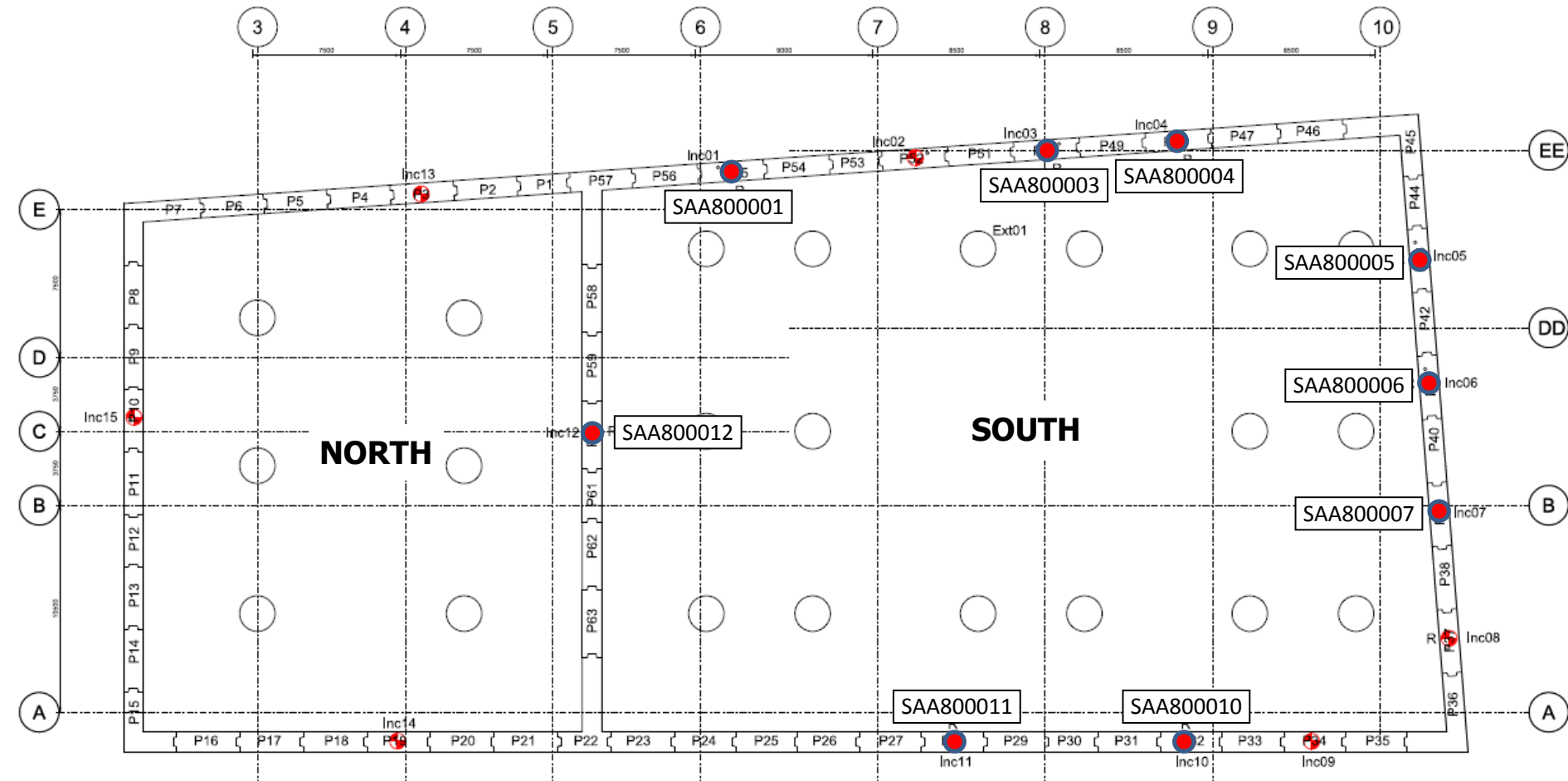
◀ The New Western Ticket Hall



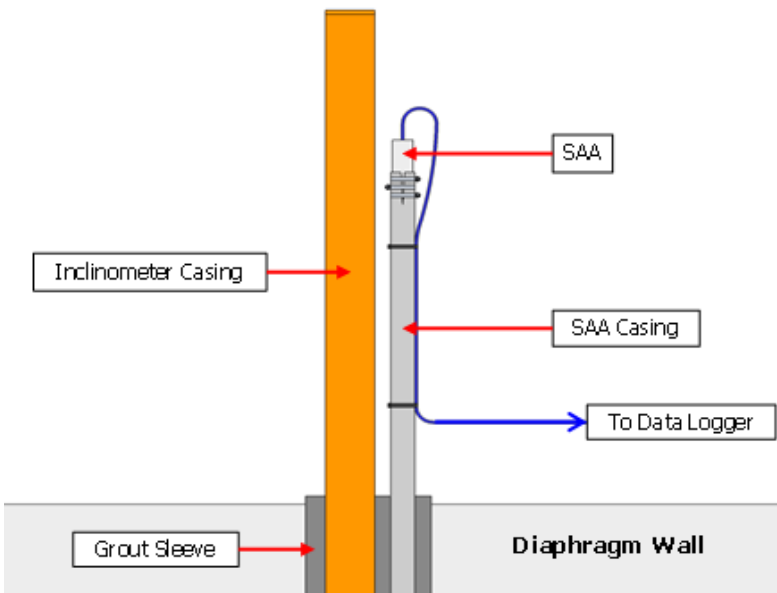
◀ A Cross-Section Through The WTH



◀ Installation of the SAAs

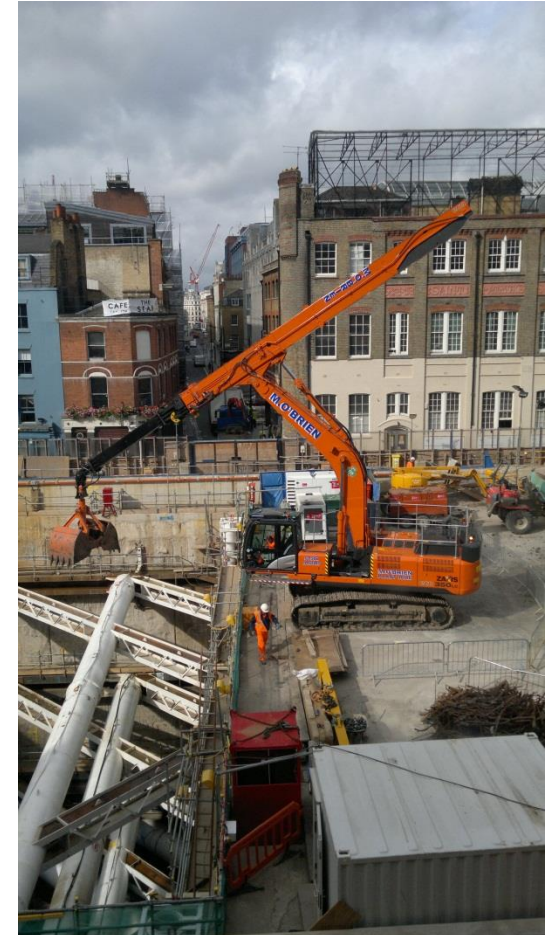


◀ Installation of the SAAs



◀ The Site Settlement Management Plan

- ▶ AMBER and RED triggers of displacement of the D-Wall were provided by Crossrail.
- ▶ These were calculated by the designer, Arup Atkins.
- ▶ A BLACK trigger is reserved for when the stability of the excavation is deemed at risk.
- ▶ Observed displacement compared directly with trigger values.
- ▶ Set procedures to follow in case of a trigger breach.

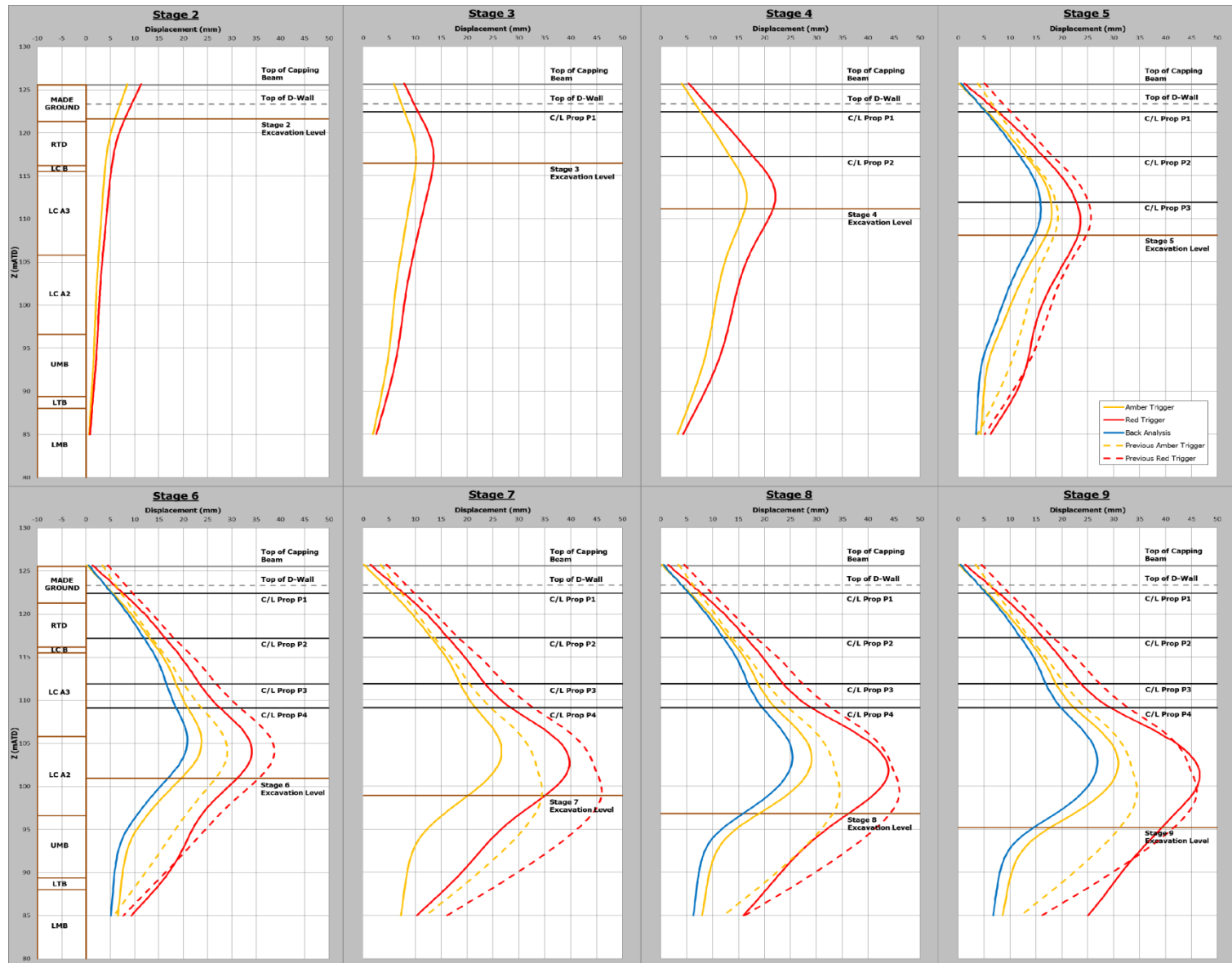


◀ TIME LAPSE....

◀ A Value Engineering Proposal

- ▶ Based upon the observational method.
- ▶ Designer undertook a back analysis of observed movement to P₃ and P₄ level.
- ▶ Calculations refined, and new triggers defined for remaining excavation.
- ▶ AMBER trigger now based upon a run with softened parameters.
- ▶ RED trigger assessed using the original parameters and design methods, but also included a berm and bay construction sequence.



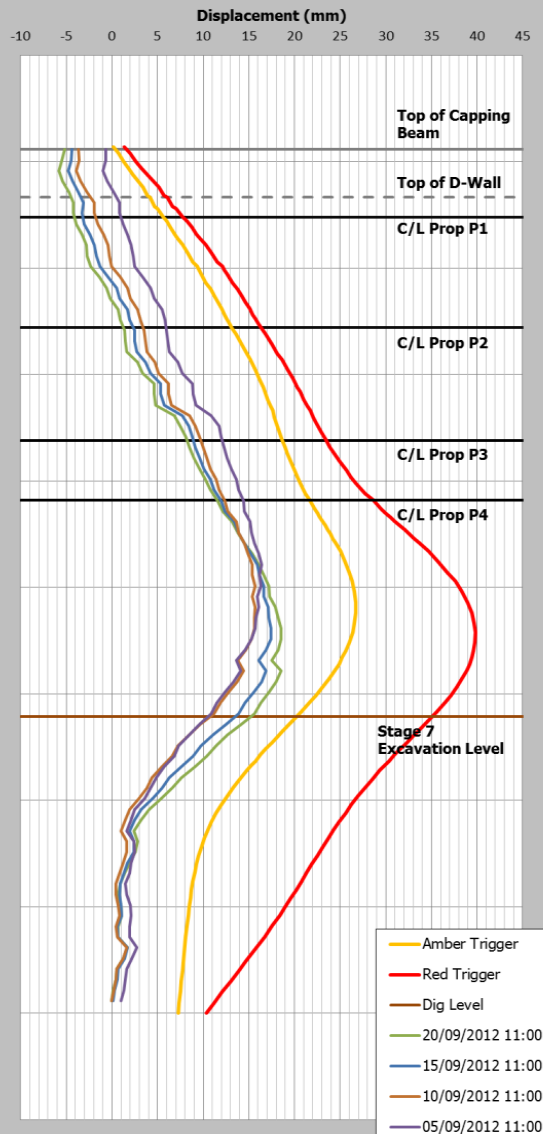


◀ Movement of the Base of the Diaphragm Wall

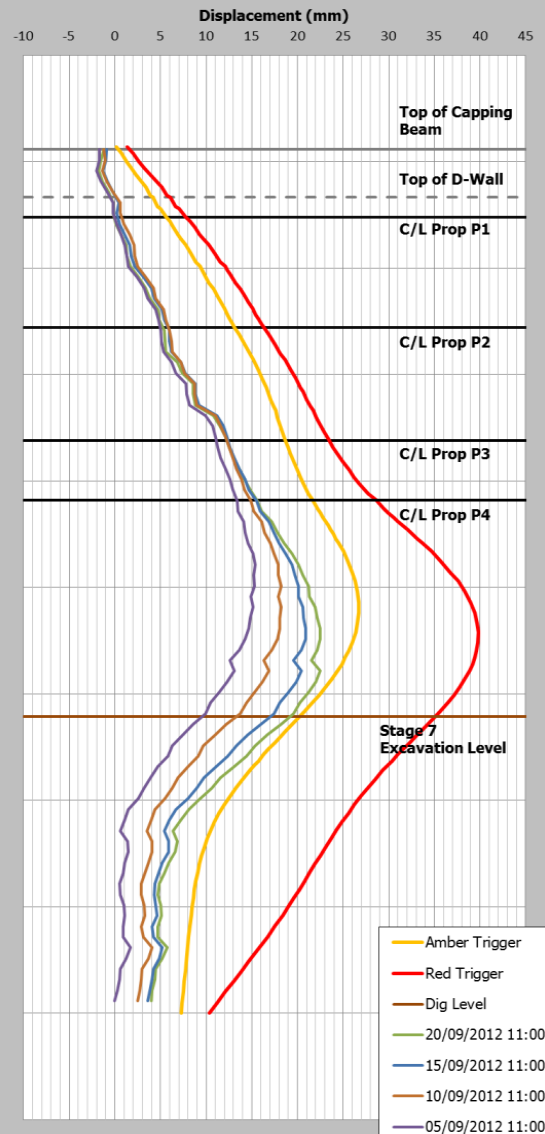
- ▶ Base of the SAA was taken as fixed.
- ▶ In reality the base is moving into the excavation and the top is not moving as much.
- ▶ Manual surveys of 3D Geodetic Prisms at the top of the D-Wall in line with the SAAs took place.
- ▶ From this a correction factor was calculated that was applied to the SAA readings.



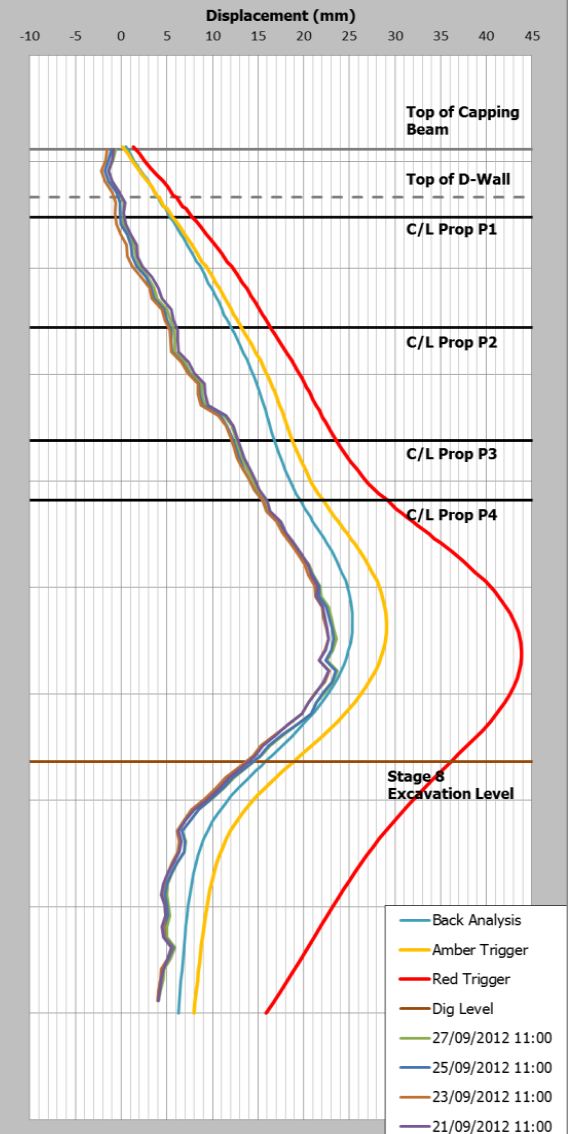
Uncorrected Plot During Stage 7 Excavation



Corrected Plot During Stage 7 Excavation

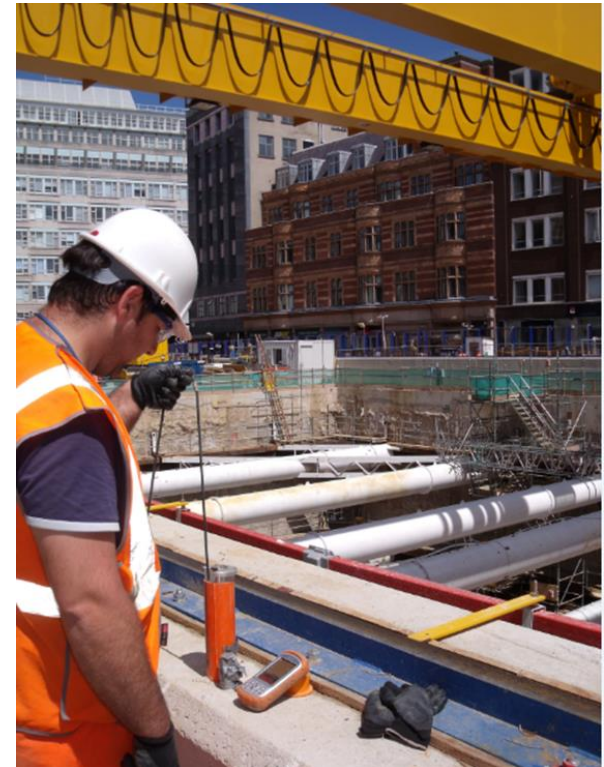


Corrected Plot During Stage 8 Excavation

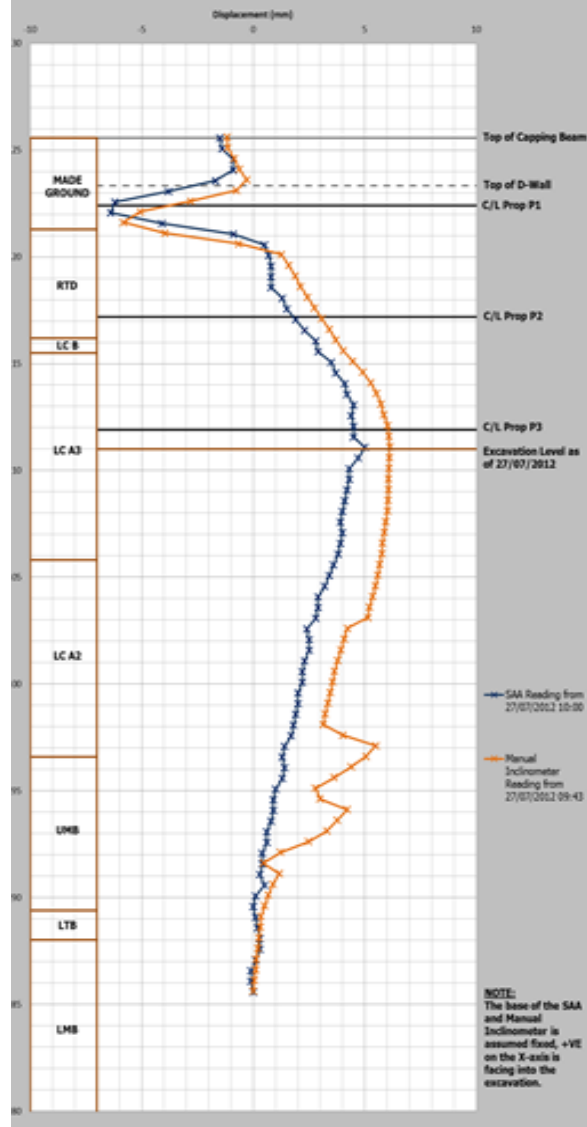


◀ Comparison to the Manual Inclinometers

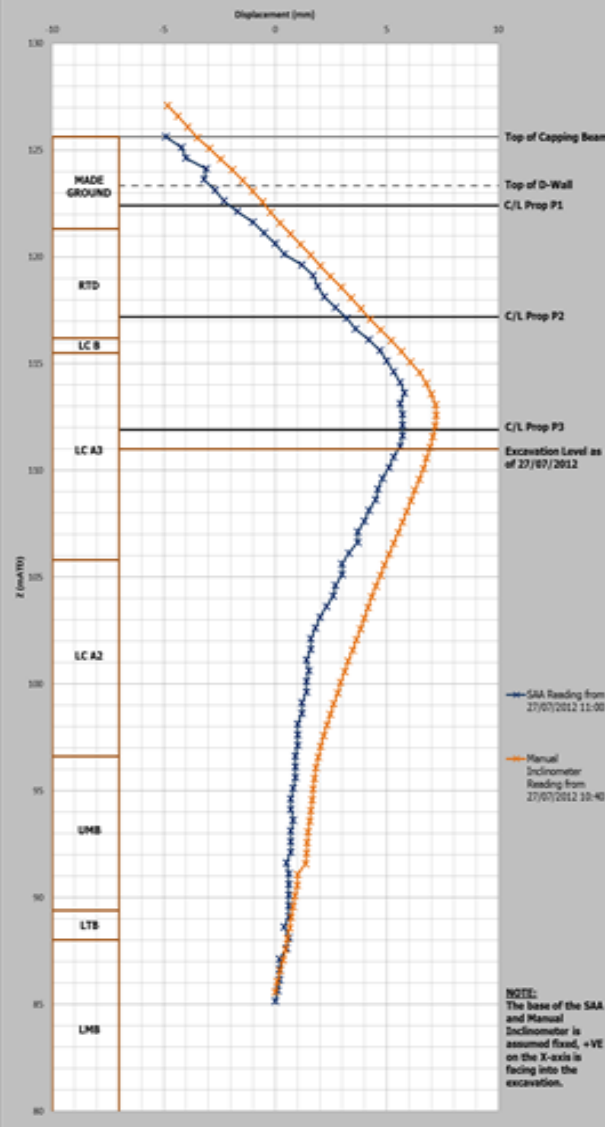
- ▶ Each manual inclinometer took around thirty minutes to read.
- ▶ Manual inclinometers require a trained technician to read.
- ▶ Some of the inclinometer casing was within the gantry crane beam, which had to be stationary whilst readings were taken.



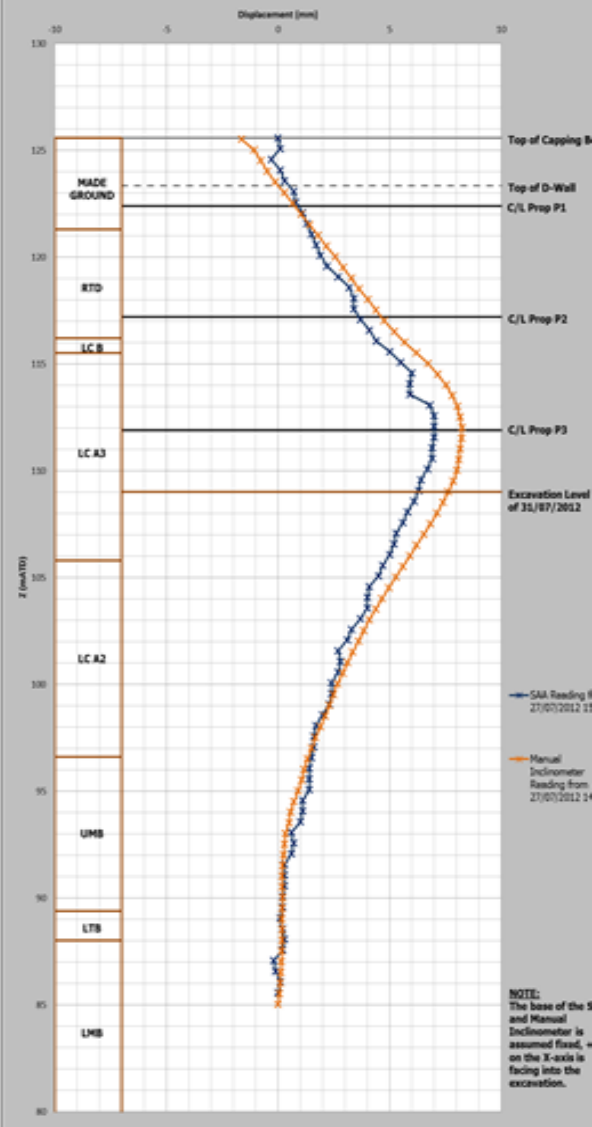
Comparison of displacements relative to the shape of the casing on 15/06/2012 13:00 for SAA800001 and manual inclinometer IM01 on the x-axis



Comparison of displacements relative to the shape of the casing on 12/06/2012 10:00 for SAA800004 and manual inclinometer IM04 on the x-axis



Comparison of displacements relative to the shape of the casing on 15/06/2012 13:00 for SAA800006 and manual inclinometer IM06 on the x-axis



◀ To Summarise

- ▶ Shape Arrays have shown advantages in terms of :
 - ◆ Cost
 - ◆ Time
 - ◆ Quality of data
 - ◆ Frequency of readings.
- ▶ Their use has enabled level P5 Props to be omitted.
- ▶ This has provided significant cost savings, and a reduction in the program of 26 days.
- ▶ Corrections to the data were calculated from manual surveying, ensuring no triggers were breached.

◀ The Western Ticket Hall – January 2013



Thank you for listening, any
questions?

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