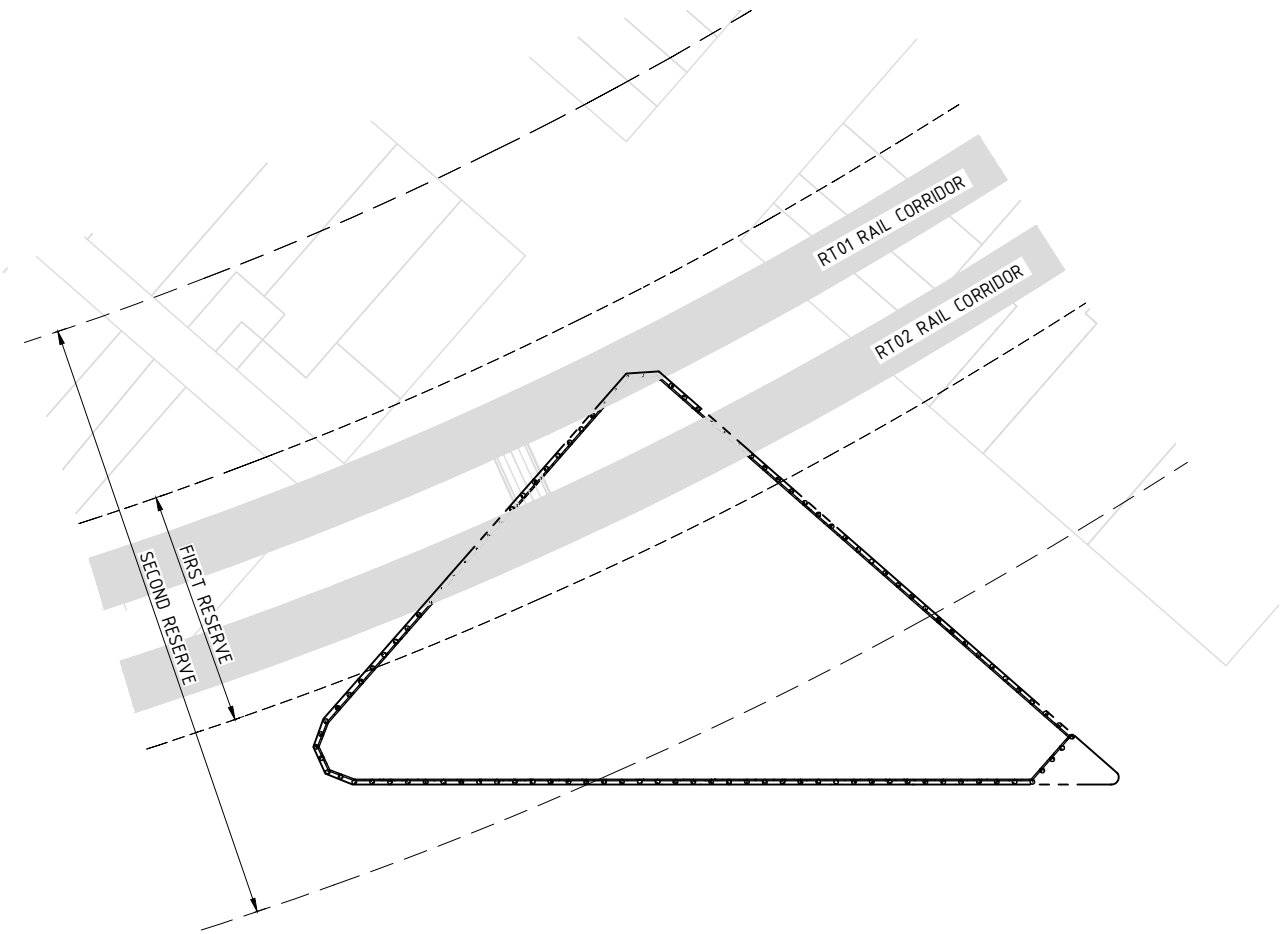


# FIVEWAYS CROWS NEST INSTRUMENTATION AND MONITORING STRATEGY FOR SYDNEY METRO UNDERGROUND INFRASTRUCTURE



**DRAWING INDEX:**

**DRAWING NO:**

- DLV-6466-IM00-000
- DLV-6466-IM01-001
- DLV-6466-IM01-011
- DLV-6466-IM01-012
- DLV-6466-IM02-001
- DLV-6466-IM03-001
- DLV-6466-IM03-002

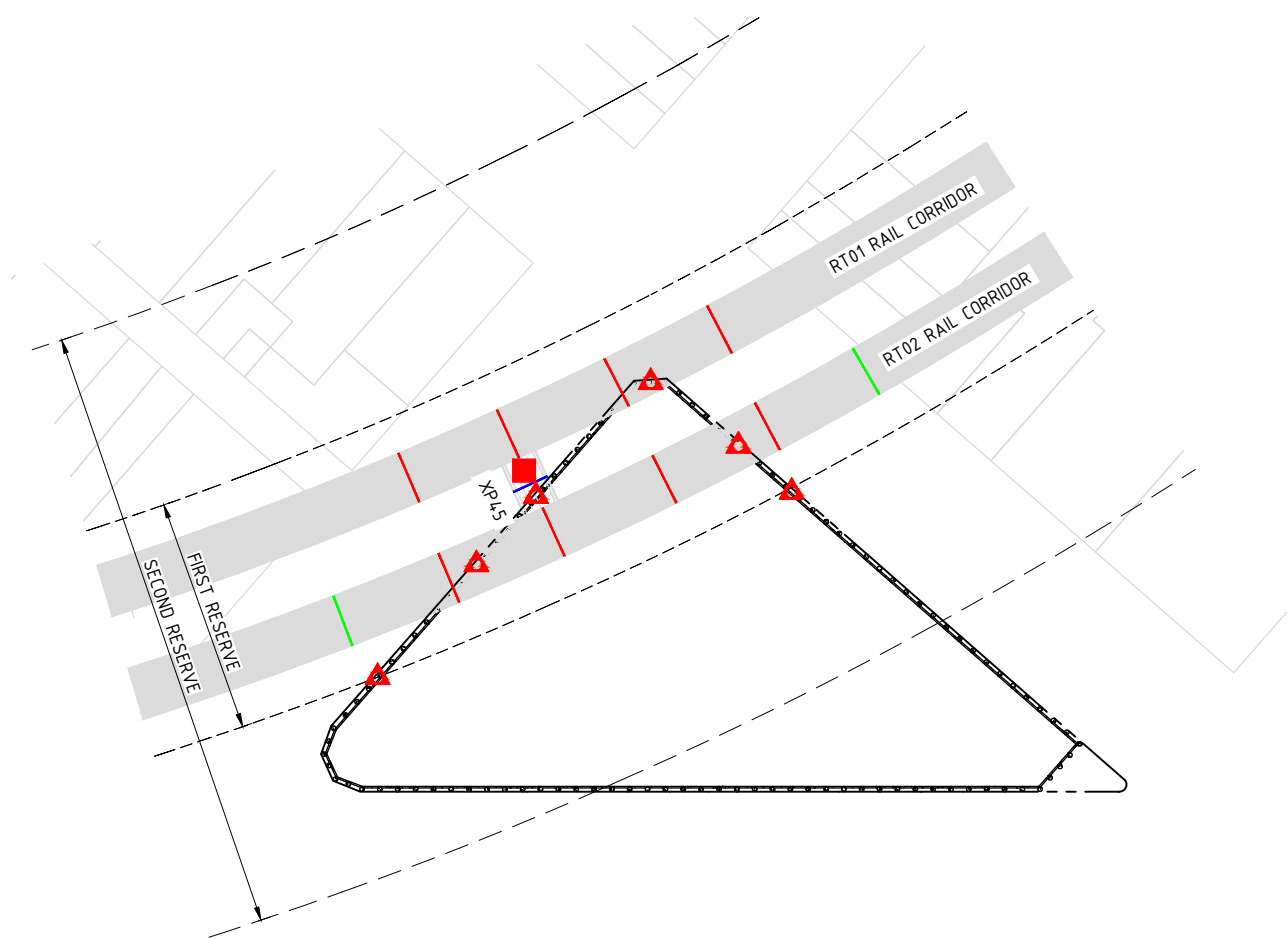
**DRAWING TITLE:**

- COVER PAGE AND INDEX SHEET
- PROPOSED MINIMUM MONITORING REQUIREMENTS
- TYPICAL RUNNING TUNNEL MONITORING ARRANGEMENT
- TYPICAL CROSS PASSAGE MONITORING ARRANGEMENT
- TYPICAL EXCAVATION WALL MONITORING DETAILS
- MONITORING FREQUENCIES AND TRIGGER LEVELS
- MONITORING TRIGGER ACTION RESPONSE

ISSUED FOR CONSTRUCTION

NO	REVISION	BY	CHK	APP	DATE	DESIGNED	S. RAMSAY	<div>DELVE underground</div> <div>www.delveunderground.com</div>	FIVEWAYS CROWS NEST SYDNEY METRO UNDERGROUND INFRASTRUCTURE PROTECTION INSTRUMENTATION AND MONITORING STRATEGY COVER PAGE AND INDEX SHEET		CADFILE: DLV-6466-IM01-001.dwg	
1	FOR REVIEW	RL	SR	-	09.08.24	DRAWN	R. LUAGUE				A3 SCALE: N/A	DATE: 26 FEB 2025
2	FOR CONSTRUCTION	CH	SR	MT	26.02.25						PROJECT No: 6466.0	
							CHECKED	M.TRIM			DWG No:	REV.
							APPROVED	M.TRIM			DLV-6466-IM00-000	2

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INSTRUMENTATION AND MONITORING PLAN  
SCALE 1:1000

TYPE OF INSTRUMENT	LOCATION				
	WITHIN EXISTING RAIL TUNNEL			IN GROUND (SEE NOTE 3)	
	RT01	RT02	XP45	EXCAVATION WALL	SURFACE SETTLEMENT
SURVEY PRISMS	X	X		X	
LASER TILTMETER			X		
VIBRATION METER	X	X			
RAIL TRACK MONITORING	X	X			
GROUND SETTLEMENT MARKERS					X
TUNNEL DILAPIDATION AND VISUAL INSPECTION	X	X	X		

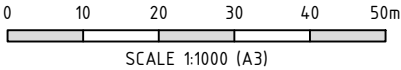
NOTES:

1. RAIL TRACK MONITORING IS OPTIONAL SUBJECT TO SYDNEY METRO'S APPROVAL.
2. TUNNEL DILAPIDATION SURVEY AND VISUAL INSPECTION REQUIRED PRIOR TO COMMENCEMENT OF DEVELOPMENT EXCAVATION. APPROVALS FROM SYDNEY METRO ARE REQUIRED TO ENTER INTO THE METRO ASSETS FOR DILAPIDATION SURVEY, INSTALLATION OF INSTRUMENTS, MONITORING AND VISUAL INSPECTIONS. PERSONS CARRYING OUT THESE ACTIVITIES MUST BE ACCOMPANIED BY SAFETY PERSONNEL FROM SYDNEY METRO OR FROM SYDNEY METRO APPROVED ORGANISATIONS WHEN ENTERING METRO TUNNELS. DILAPIDATION SURVEY TO COVER A MINIMUM OF 70m (10 x TUNNEL DIAMETER) AWAY FROM THE DEVELOPMENT.
3. INSTRUMENTATION AND MONITORING SHOWN IS FOR THE PROTECTION OF SYDNEY METRO UNDERGROUND STRUCTURES ADJACENT TO THE FIVEWAYS DEVELOPMENT. MONITORING FOR BASEMENT EXCAVATION DESIGN VERIFICATION AND PERFORMANCE PER REQUIREMENTS OF STRUCTURAL DESIGNER. EXCLUDES MONITORING REQUIRED FOR COUNCIL/RMS ROADS, SENSITIVE UTILITIES, BUILDINGS, ETC.
4. ALL MONITORING TO BE INSTALLED OUTSIDE OF STRUCTURAL AND KINEMATIC CLEARANCES.
6. MONITORING ARRAY LOCATIONS MAY VARY BY +/- 5m BASED ON TOTAL STATION LINE OF SIGHT.
7. OPTIONAL ARRAYS INCLUDED FOR ROBUSTNESS AND ARE SUBJECT TO DEICORP'S ASSESSMENT.

LEGEND:

- LOCATION OF IN-TUNNEL CONVERGENCE MONITORING ARRAY (MANDATORY MINIMUM)
- LOCATION OF IN-TUNNEL CONVERGENCE MONITORING ARRAY (OPTIONAL) (SEE NOTE 8)
- LOCATION OF IN-TUNNEL WIRELESS LASER TILTMETER MONITORING ARRAY
- ▲ EXCAVATION WALL MONITORING ARRAY (SURVEY MARKERS)
- LOCATION OF IN-TUNNEL VIBRATION METER

ISSUED FOR CONSTRUCTION



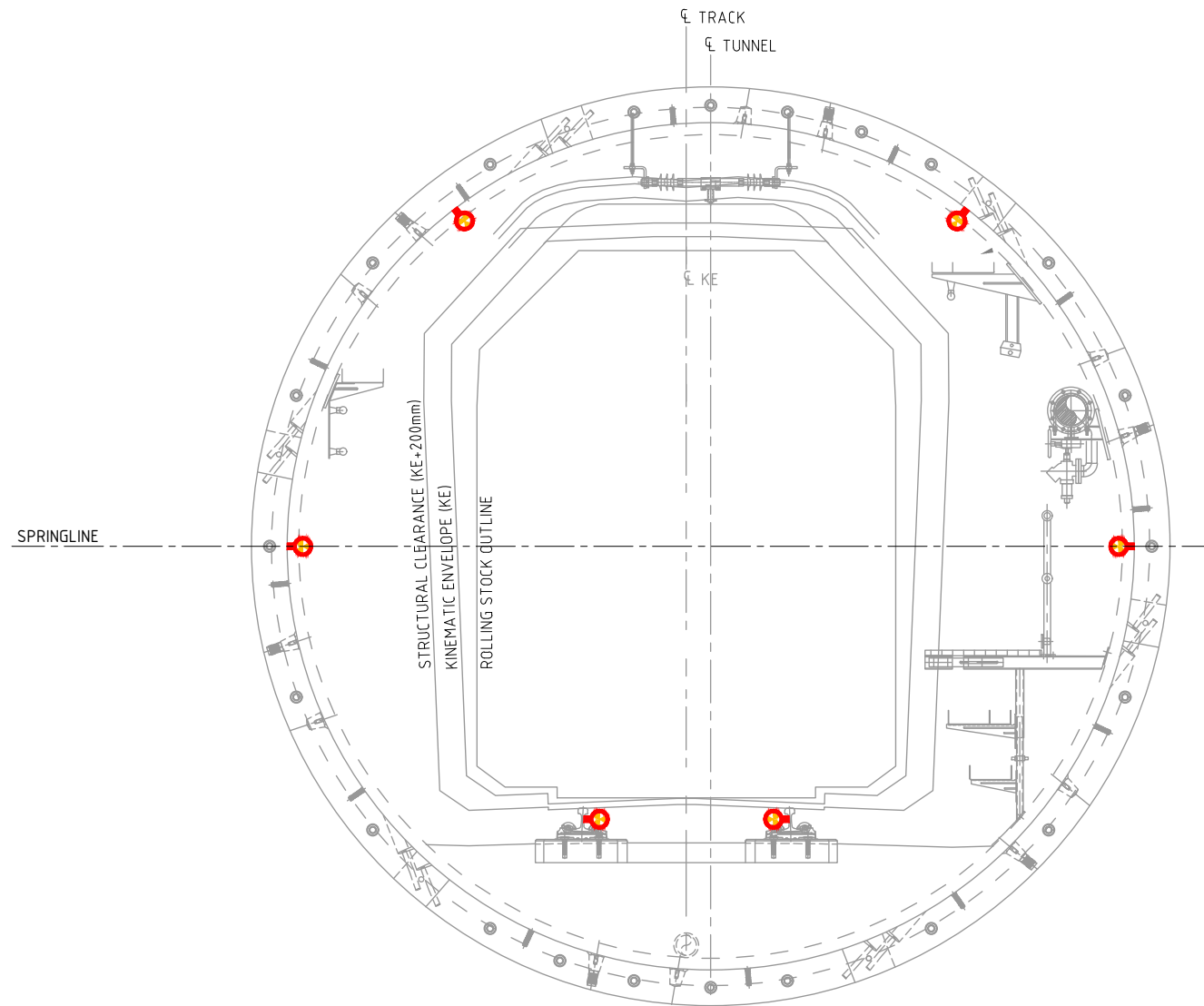
NO	REVISION	BY	CHK	APP	DATE	DESIGNED	S. RAMSAY
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2	FOR CONSTRUCTION	CH	SR	MT	26.02.25	DRAWN	R. LUAGUE
3	FOR CONSTRUCTION	CH	SR	MT	05.03.25		
4	FOR CONSTRUCTION. RE-ISSUED AFTER COMPLETION OF BASELINE DILAPIDATION SURVEY (86645.05.R.001.Rev0)	CH	SR	MT	04.04.25	CHECKED	M.TRIM
						APPROVED	M.TRIM



FIVEWAYS CROWS NEST  
SYDNEY METRO UNDERGROUND INFRASTRUCTURE PROTECTION  
INSTRUMENTATION AND MONITORING STRATEGY  
PROPOSED MINIMUM MONITORING REQUIREMENTS

CADFILE: DLV-6466-IM01-001.dwg	
A3 SCALE: AS SHOWN	DATE: 04 APR 2025
PROJECT No: 6466.0	
DWG No: DLV-6466-IM01-001	REV. 4

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TYPICAL RUNNING TUNNEL MONITORING ARRANGEMENT  
SCALE 1:25

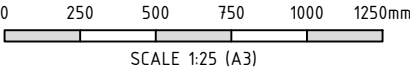
NOTES:

1. ALL MONITORING TO BE INSTALLED OUTSIDE OF STRUCTURAL AND KINEMATIC CLEARANCES.
2. TYPICAL TUNNEL FITOUT SHOWN AND MAY NOT ACCURATELY REPRESENT ACTUAL SYDNEY METRO TUNNEL CONDITIONS.
3. PROPOSED INSTRUMENTATION LOCATIONS MAY VARY BY +/- 5m LONGITUDINALLY BASED ON TUNNEL CONDITIONS.
4. SURVEY PRISMS TO BE INSTALLED WITHIN 500mm OF LOCATION SHOWN.
5. RAIL TRACK MONITORING IS OPTIONAL SUBJECT TO SYDNEY METRO'S APPROVAL.
6. RAIL TRACK MONITORING MAY BE LOCATED ADJACENT TO RAIL ON THE TRACK SLAB, SUBJECT TO SYDNEY METRO APPROVAL.

LEGEND:

- CRACK METER (NOT SHOWN)
- TOTAL STATION (NOT SHOWN)
- SURVEY CONTROL PRISM (NOT SHOWN)
- SURVEY PRISM
- VIBRATION METER

ISSUED FOR CONSTRUCTION



NO	REVISION	BY	CHK	APP	DATE	DESIGNED	S. RAMSAY
1	FOR REVIEW	RL	SR	-	09.08.24	DRAWN	R. LUAGUE
2	FOR CONSTRUCTION	CH	SR	MT	26.02.25	CHECKED	M.TRIM
3	FOR CONSTRUCTION	CH	SR	MT	05.03.25	APPROVED	M.TRIM
4	FOR CONSTRUCTION. RE-ISSUED AFTER COMPLETION OF BASELINE DILAPIDATION SURVEY (86645.05.R.001.Rev0)	CH	SR	MT	04.04.25		



FIVEWAYS CROWS NEST  
SYDNEY METRO UNDERGROUND INFRASTRUCTURE PROTECTION  
INSTRUMENTATION AND MONITORING STRATEGY  
TYPICAL RUNNING TUNNEL MONITORING ARRANGEMENT

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A3 SCALE: AS SHOWN	DATE: 04 APR 2025
PROJECT No: 6466.0	
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- NOTES:
1.

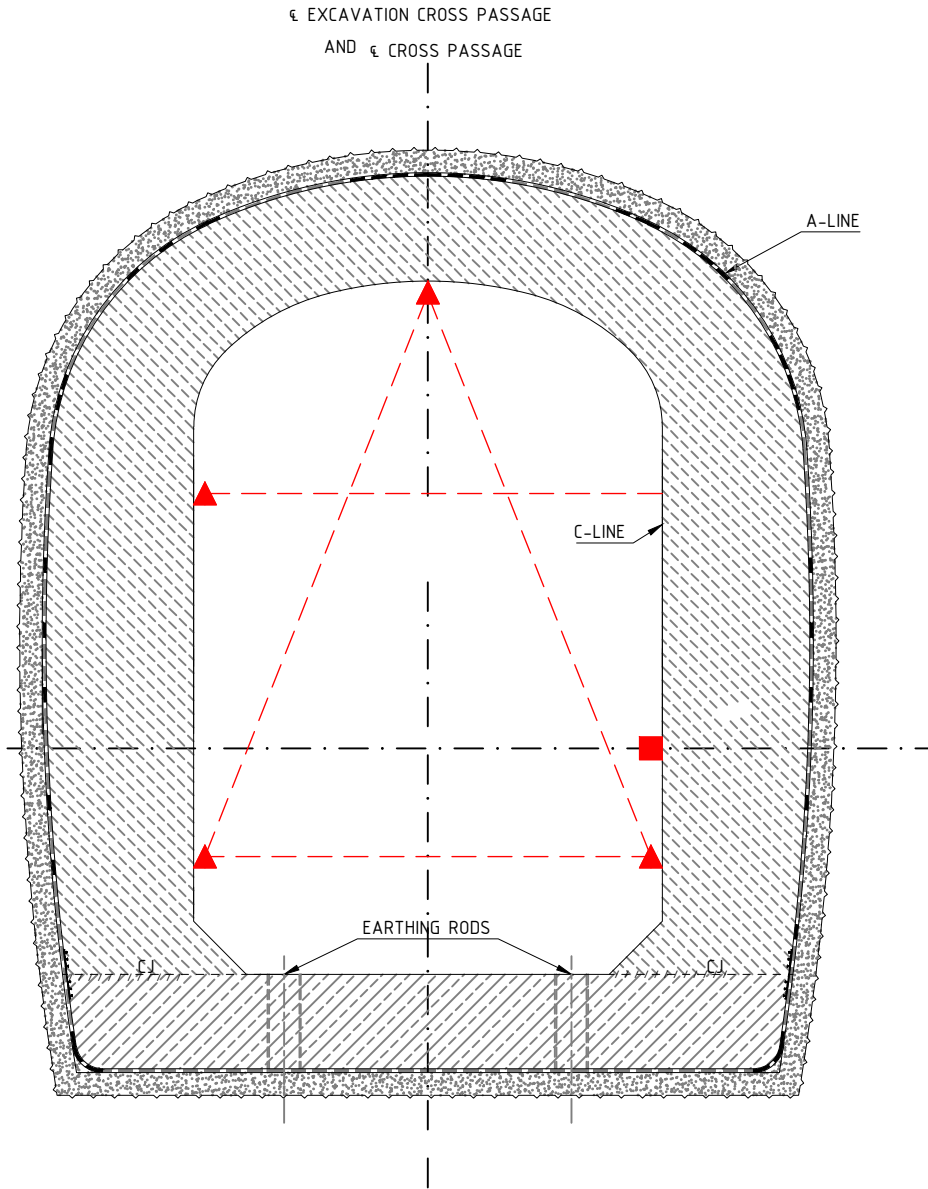
TYPICAL TUNNEL FITOUT SHOWN AND MAY NOT ACCURATELY REPRESENT ACTUAL SYDNEY METRO TUNNEL CONDITIONS.
2.

WIRELESS LASER TILTMETER TO BE INSTALLED WITHIN 500mm OF LOCATION SHOWN.

- LEGEND:
- CRACK METER (NOT SHOWN)

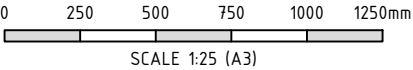
WIRELESS LASER TILTMETER

VIBRATION METER



TYPICAL CROSS PASSAGE MONITORING ARRANGEMENT  
SCALE 1:25

ISSUED FOR CONSTRUCTION



NO	REVISION	BY	CHK	APP	DATE	DESIGNED	S. RAMSAY
1	FOR REVIEW	RL	SR	-	09.08.24	DRAWN	R. LUAGUE
2	FOR CONSTRUCTION	CH	SR	MT	26.02.25	CHECKED	M.TRIM
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4	FOR CONSTRUCTION. RE-ISSUED AFTER COMPLETION OF BASELINE DILAPIDATION SURVEY (86645.05.R.001.Rev0)	CH	SR	MT	04.04.25		



FIVEWAYS CROWS NEST  
SYDNEY METRO UNDERGROUND INFRASTRUCTURE PROTECTION  
INSTRUMENTATION AND MONITORING STRATEGY  
TYPICAL CROSS PASSAGE MONITORING ARRANGEMENT

CADFILE:	DLV-6466-IM01-001.dwg
A3 SCALE:	AS SHOWN
PROJECT No:	6466.0
DWG No:	DLV-6466-IM01-012
REV.	4


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NOTES:

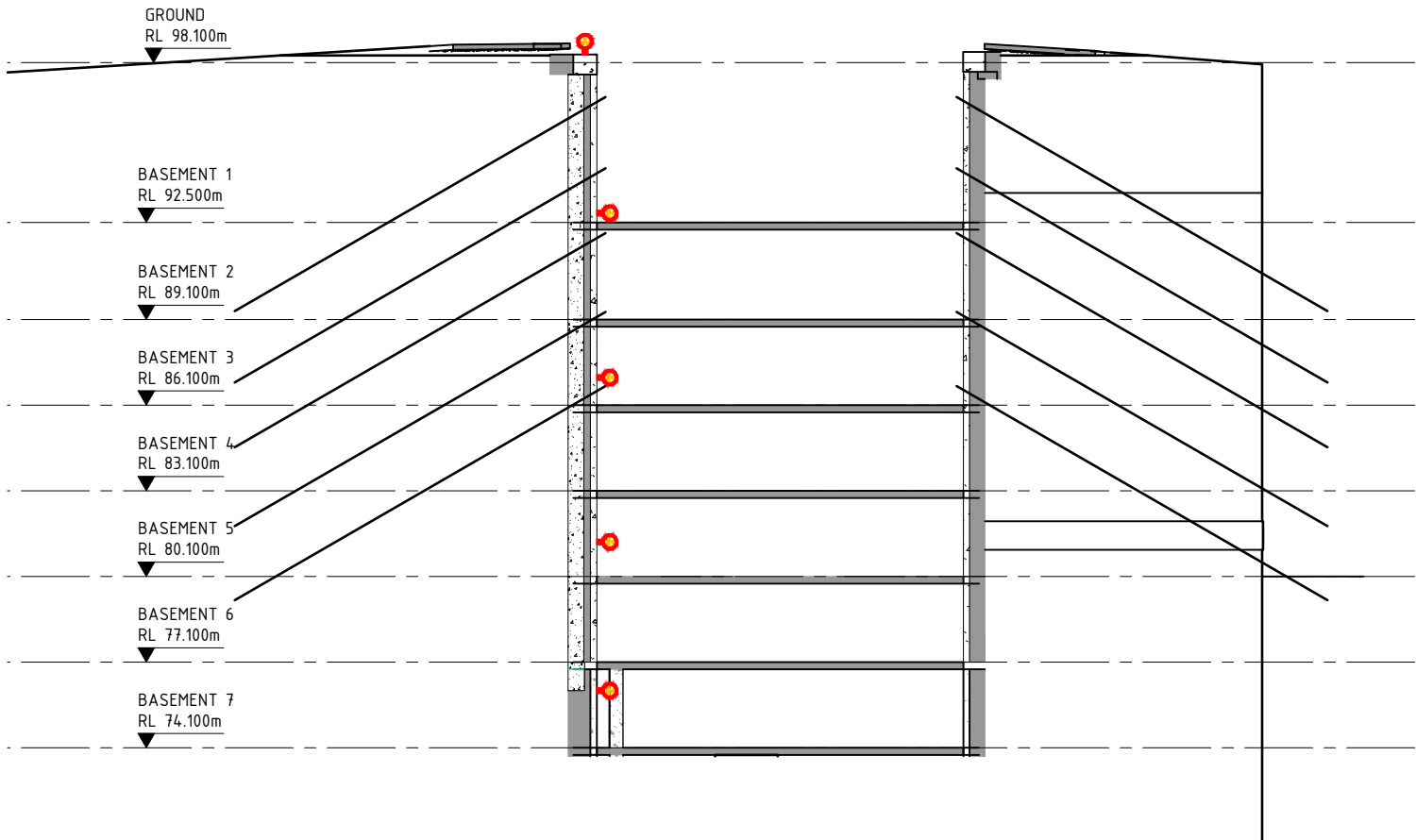
1.

SURVEY PRISMS FROM NUMERICAL MODELLING. STRUCTURAL ENGINEER'S REQUIREMENTS TO SUPERCEDE REQUIREMENTS SHOWN HERE.

LEGEND:

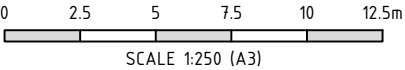


SURVEY PRISMS



INSTRUMENTATION AND MONITORING PLAN  
SCALE 1:250

ISSUED FOR CONSTRUCTION



NO	REVISION	BY	CHK	APP	DATE	DESIGNED	S. RAMSAY
1	FOR REVIEW	RL	SR	-	09.08.24	DRAWN	R. LUAGUE
2	FOR CONSTRUCTION	CH	SR	MT	26.02.25	CHECKED	M.TRIM
						APPROVED	M.TRIM



FIVEWAYS CROWS NEST  
SYDNEY METRO UNDERGROUND INFRASTRUCTURE PROTECTION  
INSTRUMENTATION AND MONITORING STRATEGY  
TYPICAL EXCAVATION WALL MONITORING DETAILS

CADFILE:	DLV-6466-IM02-001.dwg		
A3 SCALE:	AS SHOWN	DATE:	26 FEB 2025
PROJECT No:	6466.0		
DWG No:	DLV-6466-IM02-001		REV. 2

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STAGE	MINIMUM MONITORING FREQUENCY					
	WITHIN EXISTING RAIL TUNNEL				IN GROUND	
	SURVEY PRISMS	LASER TILTMETER	VIBRATION METER	RAIL TRACK MONITORING	SURVEY PRISMS *	GROUND SETTLEMENT MARKERS
PRIOR TO COMMENCEMENT OF DEMOLITION EXCAVATION	2 BASELINE READINGS (SEE NOTE 5)				N/A	2 BASELINE READINGS (SEE NOTE 5)
DURING BASEMENT EXCAVATION	WEEKLY READINGS OR EVERY 2.5m OF BASEMENT EXCAVATION DEPTH, WHICHEVER OCCURS FIRST					
UNTIL COMPLETION OF BUILDING WORKS **	WEEKLY READINGS ***					

\* EXCAVATION WALL MONITORING TO BE INSTALLED AS EXCAVATION PROGRESSES.  
\*\* SEE NOTE 6 FOR DECOMMISSIONING CRITERIA.  
\*\*\* MONITORING AT THE FREQUENCY SHOWN IN THE TABLE IS TO CONTINUE UNTIL 3 CONSECUTIVE STABLE (WITHIN SURVEY ACCURACY) READINGS ARE RECORDED. THEN READINGS ARE TO BE TAKEN WHEN STRUCTURE AT GROUND LEVEL, AT STRUCTURE TOP OUT, AND PRIOR TO OCCUPATION.

TUNNEL

REVIEW LEVEL	TUNNEL VIBRATION TRIGGER VALUE (SEE NOTE 7)
GREEN	< 15mm/s
AMBER	15mm/s
RED	20mm/s

REVIEW LEVEL	TUNNEL MONITORING TRIGGER VALUE	
	TUNNEL	TRACK
GREEN	< 4mm	≤ 4mm
AMBER	4mm	N/A
RED	6mm	> 4mm

BASEMENT EXCAVATION

REVIEW LEVEL	EXCAVATION WALL DISPLACEMENT TRIGGER VALUE
GREEN	N/A (SEE NOTES 3 & 4)
AMBER	
RED	

NOTES:

- CONTRACTOR IS RESPONSIBLE FOR THE EXECUTION AND MONITORING REQUIREMENTS STATED IN THIS DRAWING
- CONTRACTOR IS TO PROVIDE SYDNEY METRO WITH A MONITORING SUMMARY REPORT OF SYDNEY METRO UNDERGROUND INFRASTRUCTURE AT COMPLETION OF CONSTRUCTION AND PRIOR TO OCCUPATION CERTIFICATE.
- BASEMENT EXCAVATION MONITORING IS 'FOR INFORMATION' ONLY AND TO BE USED FOR CONTEXT AND/OR TO CORROBORATE IN-TUNNEL MONITORING DATA.
- INSTRUMENTATION SPECIFIED BY THE STRUCTURAL ENGINEER MAY BE USED IN LIEU OF BASEMENT EXCAVATION MONITORING SUBJECT TO ACCEPTANCE BY DELVE UNDERGROUND.
- BASELINE READINGS TO BE USED TO ESTABLISH THE CURRENT AS-BUILT CONDITIONS OF THE TUNNEL AND TO ESTABLISH THE STABILITY OF THE MONITORING SYSTEM. THE BASELINE MONITORING IS TO BE USED TO IDENTIFY ANY BACKGROUND MOVEMENTS OF THE MONITORING SYSTEM WITH THE TUNNEL ENVIRONMENT. ADDITIONAL BASELINE READINGS MAY BE REQUIRED BEYOND THE MINIMUM SHOWN HERE.
- MONITORING DECOMMISSIONING TO BE DETERMINED BY DEICORP IN COORDINATION WITH SYDNEY METRO.
- FURTHER GUIDANCE ON THE VIBRATION MONITORING REGIME FOR THE PROJECT IS PROVIDED IN THE 'VIBRATION MANAGEMENT PLAN' (20230371.2/2702A/R4/PF).
- CONSTRUCTION STAGE DILAPIDATION INSPECTIONS ARE TO CONFIRM:
  - NO NEW VISIBLE CRACKING FROM BASELINE DILAPIDATION INSPECTION CONDITION
  - CRACKING IDENTIFIED IN THE BASELINE DILAPIDATION MUST NOT INCREASE BY MORE THAN 0.2 mm IN WIDTH OR INCREASE IN LENGTH BY MORE THAN 300 mm IN TOTAL OVER THE STAGES OF DEVELOPMENT CONSTRUCTION
  - CRACKING HAS NOT RESULTED IN CONCRETE SPALLING

ISSUED FOR CONSTRUCTION

NO	REVISION	BY	CHK	APP	DATE	DESIGNED	S. RAMSAY	<div>DELVEunderground</div> <div>www.delveunderground.com</div>	FIVEWAYS CROWS NEST SYDNEY METRO UNDERGROUND INFRASTRUCTURE PROTECTION INSTRUMENTATION AND MONITORING STRATEGY MONITORING FREQUENCIES AND TRIGGER LEVELS		CADFILE: DLV-6466-IM02-001.dwg	
1	FOR REVIEW	RL	SR	-	09.08.24	DRAWN	R. LUAGUE				A3 SCALE: N/A	DATE: 09 MAY 2025
2	FOR CONSTRUCTION	CH	SR	MT	26.02.25						PROJECT No: 6466.0	
3	FOR CONSTRUCTION	CH	SR	MT	05.03.25	CHECKED	M.TRIM				DWG No: DLV-6466-IM03-001	REV. 5
4	FOR CONSTRUCTION. RE-ISSUED AFTER COMPLETION OF BASELINE DILAPIDATION SURVEY (86645.05.R.001.Rev0)	CH	SR	MT	04.04.25	APPROVED	M.TRIM					
5	FOR CONSTRUCTION	CH	SR	MT	09.05.25							

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- NOTES:
- 1. CONTRACTOR IS RESPONSIBLE FOR THE EXECUTION AND MONITORING REQUIREMENTS STATED IN THIS DRAWING.
  - 2. CONTRACTOR TO PROVIDE SYDNEY METRO WITH MONTHLY SYDNEY METRO UNDERGROUND INFRASTRUCTURE PROTECTION MONITORING REPORTS.

TRIGGER LEVEL	MANAGEMENT ACTION
ALERT (GREEN)	MONITORING DATA TO BE REVIEWED AND INTERPRETED. MONITORING TO CONTINUE AS PLANNED. CONSTRUCTION OPERATIONS TO CONTINUE AS PLANNED. DOCUMENT MONITORING READINGS AND RESULTS. PROVIDE SYDNEY METRO WITH DESCRIPTION AND DETAILS OF THE TRIGGER LEVEL EVENT.
ACTION (AMBER)	WITHIN 24 HOURS OF THE TRIGGER LEVEL ALERT EVENT OCCURRING, REVIEW READINGS AND INVESTIGATE ANOMALIES. NOTIFY SYDNEY METRO THAT RECORDED MONITORING RESULTS HAVE EXCEEDED THE ACTION TRIGGER LEVEL. INCREASE MONITORING FREQUENCY. INITIATE ENGINEERING REVIEW OF MONITORING DATA AND CONSTRUCTION ACTIVITIES TO IDENTIFY TRENDS AND COMPARE WITH EXPECTED BEHAVIOR AND INVESTIGATE CAUSES AND POTENTIAL IMPLICATIONS OF OBSERVED MOVEMENTS. ADDITIONAL VIBRATION TRIALS MAY BE REQUIRED. IF THE OBSERVED TRENDS INDICATE THAT THE ALARM (RED) TRIGGER LEVEL WILL BE EXCEEDED, PREPARE FOR THE IMPLEMENTATION OF CONTINGENCY PLANS (INCLUDING, FOR EXAMPLE, THE MODIFICATION OF CONSTRUCTION ACTIVITIES/EQUIPMENT) AND EMERGENCY RESPOSE PLANS WHERE NECESSARY.
ALARM (RED)	IMMEDIATELY INFORM SYDNEY METRO OF ALARM TRIGGER LEVEL EVENT. KEEP SYDNEY METRO INFORMED. PROVIDE SYDNEY METRO WITH MONITORING DATA AND INFORMATION TO ASSESS THE NATURE OF THE ALARM EVENT AND LIKELY EFFECTS. FOLLOW SAME MANAGEMENT ACTIONS AS FOR ACTION TRIGGER LEVEL. IMMEDIATELY COOPERATE WITH AND ADHERE TO ANY REASONABLE INSTRUCTIONS PROVIDED BY SYDNEY METRO IN RELATION TO AN ALARM EVENT, THIS MAY INCLUDE: CONTINUING MONITORING AT INCREASED FREQUENCY. CONTINUE REVIEWING MONITORING TRENDS AND PROVIDE UPDATED PREDICTIONS. IMPLEMENTING CONTINGENCY OR EMERGENCY RESPONSE PLANS, WHERE NECESSARY. TEMPORARILY CEASE CONSTRUCTION OPERATIONS WHICH LIKELY GAVE RISE TO THE ALARM EVENT. ENSURING THE DEVELOPMENT WORKS ARE MADE SAFE BY THE CONTRACTOR. ENSURING THAT ALL PARTIES TEMPORARILY VACATE THE WORKS UNTIL REQUIREMENTS FOR RECOMMENCING WORKS ARE SATISFIED. TEMPORARILY ASSIST SYDNEY METRO TO TAKE ACTIONS TO MINIMISE ANY RISK TO THE WORKS.

ISSUED FOR CONSTRUCTION

NO		REVISION				BY	CHK	APP	DATE	DESIGNED	S. RAMSAY	<div><div>DELVE</div><div>underground</div><div>www.delveunderground.com</div></div>	FIVEWAYS CROWS NEST				CADFILE: DLV-6466-IM02-001.dwg	
1	FOR REVIEW				RL	SR	-	09.08.24	DRAWN	R. LUAGUE	A3 SCALE: N/A		DATE: 04 APR 2025					
2	FOR CONSTRUCTION				CH	SR	MT	26.02.25			PROJECT No: 6466.0							
3	FOR CONSTRUCTION. RE-ISSUED AFTER COMPLETION OF BASELINE				CH	SR	MT	04.04.25	CHECKED	M.TRIM	DWG No:		DLV-6466-IM03-002	REV. 3				
	DILAPIDATION SURVEY (86645.05.R.001.Rev0)								APPROVED	M.TRIM								