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DEICORP PTY LTD

Monitoring Plan for Sydney Metro

2 Mandala Parade, Castle Hill NSW

E24724.G10_Rev2
23 February 2022

Document Control

Report Title: Monitoring Plan for Sydney Metro

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Author	Technical Reviewer
	
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Revision	Details	Date	Amended By
	Original	10 January 2022	
	Rev 1	13 January 2022	
	Rev 2	23 February 2022	

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1. Introduction

At the request of Mr. Andrew Coleman of Deicorp Pty Ltd (the Client), EI Australia (EI) has prepared a Monitoring Plan for Sydney Metro (MP) for the proposed development at 2 Mandala Parade, Castle Hill NSW. The purpose of this MP is to provide a methodology for monitoring ground movements caused by the proposed development and to provide recommendation for the management of the potential impact of these movements on the underlying Sydney Metro tunnel assets.

This MP provides recommendations for monitoring locations, frequency, limits, and actions during excavation works to ensure that the proposed works do not adversely impact the geotechnical stability of neighbouring structures and properties.

1.1 Background

The following documents were also provided by the Client to assist in the writing of this report:

- Structural Assessment Report Prepared by ABC Consultants – Report No. 20025.SAR Dated April 2021;
- Structural Drawings prepared by ABC Consultants – Drawing No.S01.101 (Rev P3 dated 12 April 2021), S01.105 (Rev P5 dated 11 November 2021), S01.106 (Rev P1 dated 12 April 2021), S01.111 (Rev P4 dated 12 April 2021), S01.112 (Rev P4 dated 12 April 2021), S01.113 (Rev P4 dated 12 April 2021), S01.114 (Rev P4 dated 12 April 2021), S01.121 (Rev P4 dated 12 April 2021), S01.122 (Rev P5 dated 11 November 2021) and S01.125 (Rev.P3, dated 12.04.2021);
- Survey plan prepared by INTRAX – File no. S119051 dated 9 November 2018;
- TfNSW North Horizontal and Vertical Track Alignments – Drawing Nos. NWRLOTS-NRT-SWD-PW- 550536 and NWRLOTS-NRT-SWD-PW- 550607 (Rev X0 dated 24 August 2018);
- TfNSW Showground Station Box Excavation Structural Plans – Drawing Nos. NWRLTSC-THY-SHW-DN-DRG-325411 (Rev 51 dated 2 October 2015), 325431 (Rev 51 dated 29 April 2016), 325432 (Rev 50 dated 20 August 2015), and 325433 (Rev 52 dated 26 October 2015);
- TfNSW Showground Station Architectural Plans – Drawings Nos. NWRLOTS-NRT-SHW-AR-DRG-613101 (Rev 0 dated 9 November 2016),613105 (Rev 0 dated 9 November 2016), 613110 (Rev 00.01 dated 2 August 2018), 613111 (Rev 00.05 dated 18 January 2019), 613112 (Rev 00.05 dated 31 January 2019), 613113 (Rev 00.06 dated 26 March 2019),613114 (Rev 00.04 dated 12 October 2018), 613115 (Rev 00.05 dated 18 January 2019), 613116 (Rev 00.02 dated 2 August 2018), 613141 (Rev 00.05 dated 18 January 2019), 613145 (Rev 00.04 dated 18 January 2019), 613146 (Rev 00.04 dated 18 January 2019), and 613147 (Rev 00.03 dated 18 January 2019);
- Sydney Metro Corridor Protection Technical Guidelines – Version 2 dated April 2021.

EI has also prepared the following documents for the above site:

- Geotechnical Investigation (GI) report for the site, Ref No.E24724.G03_Rev2, dated 9 July 2021;
- Impact Assessment on Sydney Metro Tunnels report, Ref No.E24724.G06_Rev3, dated 18 February 2022.

Based on the provided documents, and email correspondence with Poonam Chauhan, EI understands that the proposed development involves the construction of four 20-storey mixed-use building overlying a common podium structure with a stepped 6-storey basement. The lowest basement level (B06) will require a Finished Floor Level (FFL) of RL 69.4m AHD. It is understood that a Bulk Excavation Level (BEL) of RL 69.1m will be required for the lowest basement level, which includes allowance for the construction of the basement slab. To achieve the BEL, excavation depths of 19.00m Below Existing Ground Level (BEGL) at the Doran Drive end of site to 26.60m BEGL at the Andalusian Way end of site have been estimated. Locally deeper excavations may be required for footings, service trenches, crane pads and lift overrun pits.

1.2 Sydney Metro Asset

Based on supplied information referenced in **Section 1.1**, we understand that metro infrastructure adjacent to southern elevation of proposed basement outline comprises of Hills Showground Station with metro tracks running east to west. The Sydney Metro Northwest is a rail infrastructure project which was completed in mid-2019. The station box closest retaining wall is at the setback of about 26.0m from proposed shoring system.

The Showground Station metro box at final construction stage comprises of precast concrete walls with minimum 25mm clearance gap separating the walls from subsurface ground.

The metro box excavation methodology adjacent to proposed development involved excavation of soil and low strength sandstone using stabilising berm and mass concreting followed by vertical excavation of high strength sandstone to designed excavation level (RL 72.0m AHD).

A plan showing the locations of these assets is shown on the attached **Figure 1**.

2. Monitoring Requirements

The MP aims to monitor the following:

- The movements induced by the excavation of the proposed development on the Metro Station Box;
- Vibrations induced by construction activities on the proposed development.

2.1 Dilapidation Survey

Prior to excavation, during excavation, and construction, detailed dilapidation surveys may be carried out on the Metro asset.

The dilapidation surveys of the Metro Station should be undertaken at the following times:

- Prior to the commencement of excavation;
- When excavation has been completed;
- Once the full load of the building structure has been applied; or
- If any incidents of concern occur.

During the course of the initial dilapidation survey, cracks will be selected for monitoring. The crack status must be documented and reviewed at each subsequent dilapidation survey.

2.2 Monitoring Movement of Sydney Metro Assets

2.2.1 Monitoring Methodology

Due to the location of the proposed development adjacent to the Sydney Metro assets, it is recommended that monitoring of movements be undertaken. This monitoring is necessary to detect any unexpected deflections at early stage and rectify them accordingly so that the construction works do not adversely affect Sydney Metro assets.

Three inclinometers are recommended to be installed adjacent to the excavation to confirm the movements of the ground as per the analysis (**Hold Point**). Inclinometers should be installed within boreholes to a depth of at least 3.0m below BEL, and fully grouted.

Within the station, survey marks are to be installed at the base of the station box adjacent to the excavation. These survey marks are to be surveyed as a baseline measurement and will measure the station box movements on occasions if the inclinometers exceed alarm and action levels as outlined in **Section 2.2.3**. The survey marks will be installed in 20m intervals along the length of the station box. Survey marks should be fixed such that they are visible from a Total Station setup point. All survey points to be installed by the Project Surveyor.

The proposed locations of survey marks and inclinometers are shown on **Figure 1**.

All survey marks and inclinometers must be protected from damage through the use of adequate marking, monuments/covers. Construction works should be suspended where more than 30% of the devices have malfunctioned and the relevant stakeholders listed in **Table 2-2** below contacted immediately.

All survey and inclinometer data is to be presented to the project geotechnical and structural engineers along with details of the monitoring visit including:

- Date of monitoring;
- Time of monitoring;
- Progress of construction works at time of monitoring;
- Weather conditions during and preceding the monitoring; and
- Any further comments relative to the monitoring.

2.2.2 Monitoring Frequency

During the excavation phase and the construction of the basement and ground floor slabs, readings should be taken as follows:

- Prior to excavation commencement;
  - A copy of the baseline measurements and detailed plans of all monitoring devices, comprising **at least two independent measurements**, are to be submitted to Sydney Metro for their records **prior to commencement of construction of retaining structures and any bulk excavation works**.
- After commencement of excavation, monitoring should be completed **with the following monitoring frequencies** until the full load of the proposed development is applied and certified by the structural engineer;
  - Once per fortnight during excavation, or at each 2m excavation depth interval along the southern elevation, whichever occurs first;
  - After excavation to BEL, once per month until the basement structure reaches ground level;
  - Then, once every second month until the southern tower building structure reaches roof level;

2.2.3 Monitoring Criteria and Actions

Based on the results of EI's Impact Assessment Report, we recommend the maximum deflection criteria outlined in **Table 2-1** below for the survey marks in the Sydney Metro Tunnel.

The following threshold criteria should be adopted during construction:

- **Alert**: If inclinometer displacements are less than 80% of the agreed value, excavation could be continued. Monitoring should continue to be carried out at the nominated intervals and monitoring reports forwarded to the relevant stakeholders as outlined in **Table 2-2**.
- **Alarm**: If inclinometer displacements are greater than 80% but less than 100% of the agreed value, the client, geotechnical engineer, structural engineer and Sydney Metro representative should be notified and the monitoring data reviewed while the excavation continues. Ongoing monitoring events to be undertaken at 24 hour intervals until notified otherwise by nominated engineers in consultation with Sydney Metro, and survey marks within the station box to be measured.
- **Action**: If inclinometer displacements are greater than 100% of the agreed value excavation should cease immediately. Monitoring should be carried out daily until movement is negligible. The client, geotechnical engineer, structural engineer, and Sydney Metro representative should be notified and work should cease until a risk management/contingency plan is implemented to safeguard existing Sydney Metro assets, and survey marks within the station box to be measured.

A summary of the monitoring methodology and criteria is listed below in **Table 2-1**.

Table 2-1 Summary of Monitoring Criteria for Movement Monitoring

Criteria	Survey Marks in Metro Station	Inclinometers
Maximum Deflection Limit	10mm	27mm
Alert Level	< 8mm	<22mm
Alarm Level	8mm – 10mm	22mm-27mm
Action Level	>10mm	>27mm

2.3 Vibration Monitoring

All construction activities, particularly excavation must be carefully monitored and controlled to avoid ground vibration damage to the Sydney Metro asset.

Vibration monitoring must record the peak vibration levels. Visual and audible alarm must be provided in order to be triggered when the predetermined vibration levels are exceeded. The system must be set to have thresholds that correspond to an “Operator Warning Level” and an “Operator Halt Level”, where the warning level is approximately 80% of the halt level. **For this site, a 20 mm/s Halt Level is recommended**, as per the Technical Guidelines (2017) for tunnels supported using a precast concrete segment lining.

An exceedance of the “Operator Warning Level” requires activities to proceed with caution. An exceedance of the “Operator Halt Level” requires activities to be ceased and the Site Superintendent to implement alternative techniques.

We recommend two vibration monitors be installed within the site at the location shown on **Figure 1**, and these must be installed prior to excavation. The vibration monitors should be installed down to the level of the station box, about RL 72.0m, within pier holes with PVC casing. The vibration monitors must be installed prior to commencement of excavation, and are to be ongoing until all excavation is completed.

It should be noted that as the asset is in excess of 20m away from the proposed vibration monitors, vibrations would dissipate as it travels from the site to the asset.

2.4 Stakeholder Details

The following stakeholders listed in **Table 2-2** below should be contacted as per the criteria outlined in this report.

Table 2-2 Stakeholder Contact Details

Stakeholder	Stakeholder Contact	Contact Details
Sydney Metro	Sydney Metro	SydneyMetroCorridorProtection@transport.nsw.gov.au
Developer	Deicorp Pty Ltd Mr. Andrew Coleman	AColeman@deicorp.com.au 02 8665 4100
Geotechnical Consultant	EI Australia Mr Stephen Kim	stephen.kim@eiaustralia.com.au 0475 554 393
Structural Engineer	ABC Consultants Mr Ryan Campbell	ryan@abc-consultants.com.au 0402 343 139

2.5 Completion

On completion of the construction, completion measurement should be taken. Completion set measurements along with all previous measurements should be submitted to Sydney Metro for record keeping.

3. Limitations

Your attention is drawn to the document “Important Information”, attached to the end of this letter report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by EI, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

This letter report was prepared by EI for the sole use of Deicorp Pty Ltd for the particular project and purpose described. No responsibility is accepted for the use of any part of this letter report in any other content or for any other purpose.

EI has used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality and has relied on the accuracy of information provided by Deicorp Pty Ltd. No other warranty expressed or implied is made or intended.

EI retains the property of this letter report subject to payment of all fees due for the services. The letter report shall not be reproduced except in full and with prior written permission by EI.

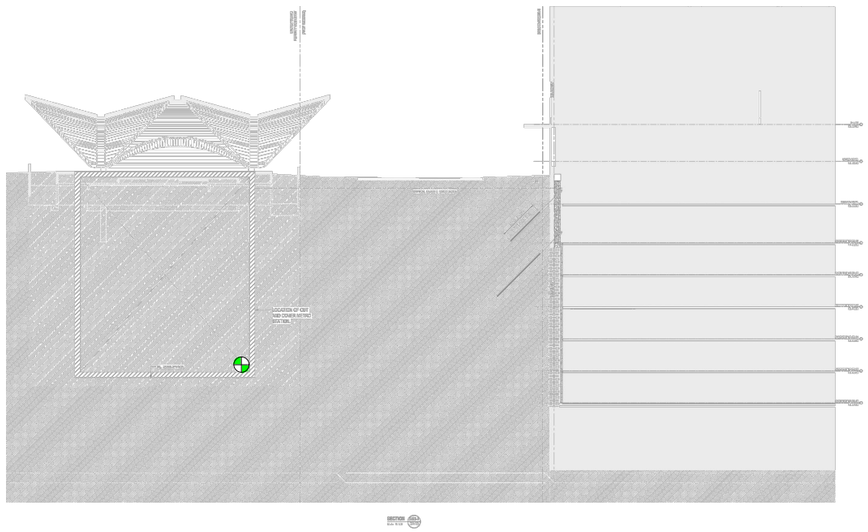
References

- Sydney Metro Corridor Protection Technical Guidelines – Version 2 dated April 2021.

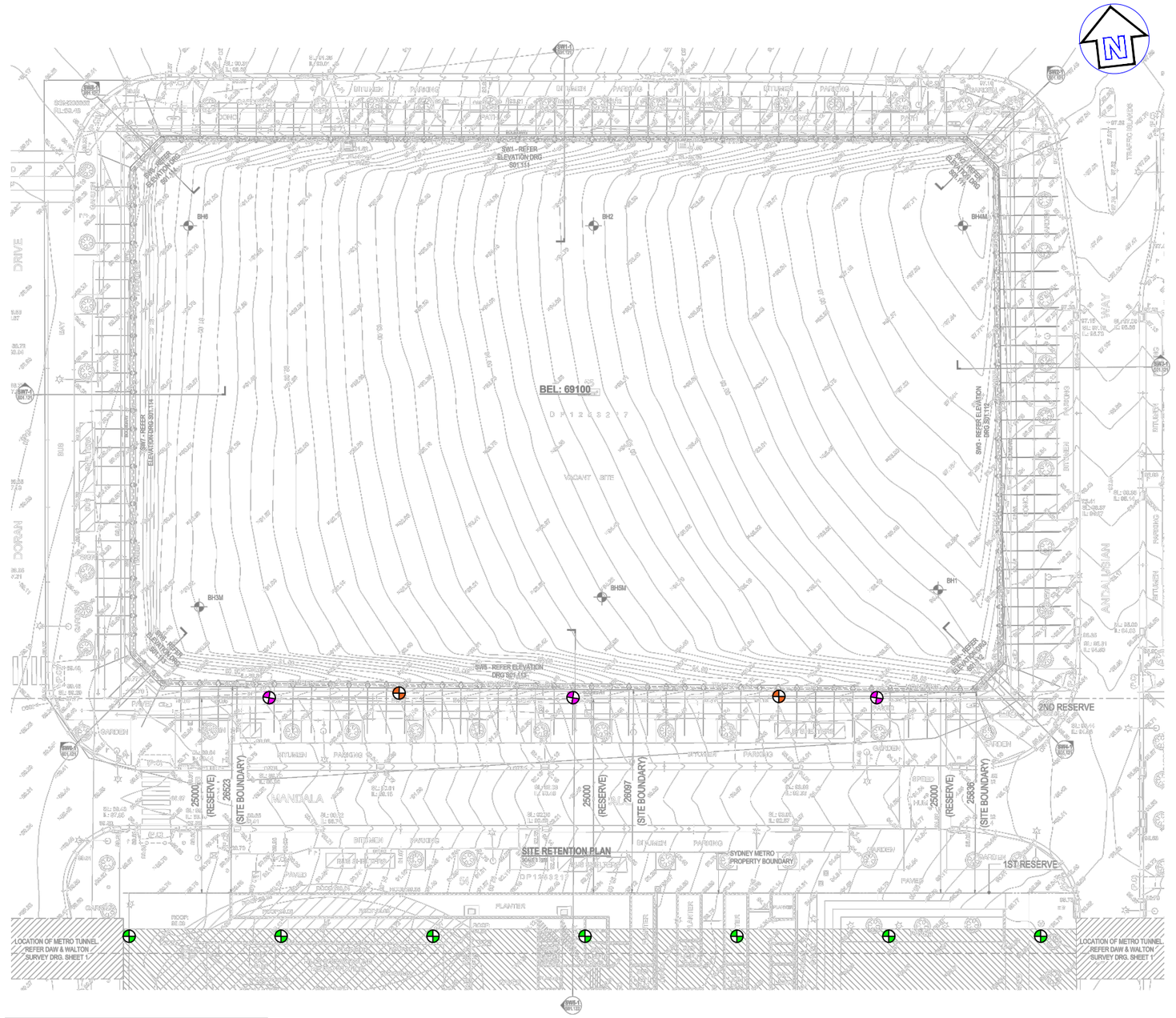
Abbreviations

AHD	Australian Height Datum
AS	Australian Standard
BEL	Bulk Excavation Level
BEGL	Below Existing Ground Level
BH	Borehole
DP	Deposited Plan
EI	EI Australia Pty Ltd
FEA	Finite Element Analysis
FFL	Finished Floor Level
GI	Geotechnical Investigation
RL	Reduced Level
MP	Monitoring Plan
VM	Vibration Monitor

Figures



Typical Section at Monitoring Location



0 5 10 20 30
Approx. Scale (m)

Hills Showground Station

Map Source: Structural Plan prepared by ABC Consultants, Job No.20025, DWG No.S01.105 & S01.122, Revision P5, dated 11 November 2021

LEGEND

- Proposed Inclinometer Location
- Proposed Vibration Monitoring Location
- Proposed Survey Mark Location

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Approved:	S.K.
Date:	23/02/22

Deicorp Pty Ltd
Monitoring Plan for Sydney Metro
2 Mandala Parade, Castle Hill, NSW
Proposed Monitoring Location Plan

Figure: 1

Project: E24724.G10_Rev2

Appendix A – Important Information

Important Information

SCOPE OF SERVICES

The geotechnical report ("the report") has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client And EI Australia ("EI"). The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

EI has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. EI has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations ("conclusions") are based in whole or part on the data, EI will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to EI.

GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies. The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. EI should be kept appraised of any such events, and should be consulted to determine if any additional tests are necessary.

VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that EI be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

REPRODUCTION OF REPORTS

 Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimize the likelihood of misinterpretation from logs.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. EI assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of EI or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

EI will not be liable to update or revise the report to take into account any events or emergent circumstances or fact occurring or becoming apparent after the date of the report.