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5 November 2021
E24724.G12

Greg Colbran
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Groundwater Take Assessment
2 Mandala Parade, Castle Hill, NSW

1. INTRODUCTION

At the request of Greg Colbran of Deicorp Pty Ltd (the Client), EI Australia (EI) has prepared this Groundwater Take Assessment (GTA) for the proposed development at 2 Mandala Parade, Castle Hill, NSW (the Site).

The following documents were used to assist in the preparation of this GTA:

- Architectural Drawings prepared by Turner – Project No. 19068, Drawing No. DA-110-002 to DA-110-007 (Rev_02), DA-110-008 to DA-110-010 (Rev_03), DA-110-020 to DA-110-210 (Rev_04), and DA-210-101 to DA-210-401 (Rev_03), dated 6 July 2021;
- Shoring Plans prepared by ABC Consultants – Job No. 20025, Dated 12 April 2021;
  - Rev P1, Drawing No. S01.106,
  - Rev P3, Drawing No. S01.101 and S01.125
  - Rev P4, Drawing No. S01.105, S01.111 to S01.114 and S01.122
- A site survey plan prepared by Daw & Walton Consulting Surveyors – Job No. 5042-20, Revision 1, dated 7 August 2020.

EI has previously prepared a Geotechnical Investigation (GI) Report referenced E24724.G03_Rev2 and dated 9 July 2021.

Based on the provided documents and email correspondence with Ms 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. 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 20.5m Below Existing Ground Level (BEGL) at the Doran Drive end of site to 29.0m 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.

1.1. ASSESSMENT OBJECTIVES

The objective of this GTA is to provide an estimation of the groundwater inflow volumes that require pumping out during the construction and operational stage of the development and to assess if tanking is required for control of groundwater inflows into the proposed basement during and after construction.

2. SITE DESCRIPTION

2.1. REGIONAL GEOLOGY

Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Penrith 1:100,000 Geological Series Sheet 9030 (DMR 1991) indicates the site is underlain by Hawkesbury Sandstone, which typically comprises medium to coarse-grained quartz sandstone, minor laminated mudstone and siltstone lenses.

3. SITE MODEL

3.1. SUBSURFACE CONDITIONS AND PERMEABILITY

For the purpose of this GTA, the subsurface conditions from our previously referenced GI report have been adopted. Groundwater and subsurface condition data from boreholes have been used to find the average depth and thickness of each unit as well as the average depth of groundwater across the site. A summary of the average depths of each soil unit and permeability values is shown below in **Table 1**.

Table 1 Subsurface Conditions and Adopted Permeability Values

Unit	Material [2]	Modelled Depth to top of Unit (m BEGL) [1]	Modelled RL of top of Unit (m AHD) [1]	Modelled Thickness (m)	Material Description [2]	Adopted Permeability, k_x (m/s) [3]	Anisotropic permeability k_y / k_x
1	**Fill**	0	98.0	2.0	Silty Sand Fill	1×10^{-4}	1
2	**Residual Soil**	2.0	96.0	1.0	Silty Clay	1×10^{-7}	1
3	**Sandstone**	3.0	95.0	35.0	Sandstone	5×10^{-8}	0.15

Note 1 Approximate depth and level at the time of our assessment. Depths and levels may vary across the site.
Note 2 For more detailed descriptions of the subsurface conditions, reference should be made our original GI report.
Note 3 The permeability of the Unit 3 Sandstone was based on EI's pump-out test results, while the permeability of Units 1 and 2 are based on published data from Look (2009)

3.2. GROUNDWATER OBSERVATIONS

The groundwater levels were measured within the monitoring wells installed by EI as given in **Table 2** below.

Table 2 Summary of Groundwater Levels

Monitoring Well / Borehole ID	Date of Observation	Approximate Depth to Groundwater (m BEGL)	Approximate RL of Groundwater (m AHD)
BH3M	14/7/20	15.4	75.6
BH4M	14/7/20	20.5	77.5
BH3M	11/10/21	15.2	75.8
BH3Ma	11/10/21	2.9	88.2
BH4M	11/10/21	19.9	78.1
BH4Ma	11/10/21	4.6	93.4
BH5M	11/10/21	4.2	89.9
BH7M	11/10/21	4.8	88.4

3.3. SHORING SYSTEM

Based on the provided structural plans by ABC Consultants, the shoring system for the proposed excavation consists of anchored / propped soldier pile walls for the retention of the fill, residual soil and Class V/IV sandstone above the Unit 4, Class II/I sandstone, which is to be cut vertically. The soldier pile wall is to consist of 600mm diameter piles with 2.4m c/c spacing and socketed into the Unit 4 sandstone with pile toe at RL 85.4m.

This assessment does not assess the overall stability of the shoring system, which will need to be designed to satisfy stability considerations by the structural engineer. If the assumptions or shoring design adopted in the model differ from the final design, this report should be revised.

4. GROUNDWATER TAKE ASSESSMENT

4.1. ASSESSMENT OF GROUNDWATER TAKE DURING CONSTRUCTION PHASE

Seepage analysis for groundwater inflows following excavation has been undertaken using SEEP/W, a finite element groundwater seepage analysis software. This model estimates the volume of water which will be required to be dewatered during the construction of the basement and until the dewatering is turned off.

For the purpose of this modelling, it has been assumed that:

- The ground surface is level across the site and lies at an elevation of RL 98.0m AHD.
- The subsurface conditions were horizontal along the site. Permeability values presented in **Table 1** above were adopted for each unit.
- The fill and residual soil layers have the potential to be unsaturated with maximum soil suction pressures of 100kPa.
- Saturated volumetric water content for the fill and clay are 43% and 51%, respectively.
- Dewatering will be required for 12 months, which is the assumed time required to complete the basement construction.
- The perimeter soldier pile will be free draining;
- Temporary dewatering will be undertaken within the basement excavation down to the BEL of RL 69.1m AHD.
- An external design groundwater level of RL 93.4m AHD (which is based on the highest observed groundwater level) was assumed to be constant at 40m away from the shoring wall.
- A “No-Flow” boundary is defined along the symmetric line (the centre of the excavation), at 35m from the perimeter shoring walls.
- The shoring walls surrounding the basement excavation has a total length of about 350m.

The SEEP/W model is presented in **Appendix A.** The estimated groundwater inflow rate into the basement is provided in **Table 3** below:

Table 3 Summary of Groundwater Seepage Analysis Results

Inflow per m length of perimeter wall (m^3/sec)	Inflow per m length of perimeter wall (m^3/day)	Inflow into excavation (m^3/day)	Total Inflow during construction (ML/365 days)
3.91×10^{-7}	0.0338	11.82	4.32

5. CONCLUSIONS AND COMMENTS

Based on the findings of this report and within the limitations of available data, EI concludes that:

- Construction phase groundwater take will be approximately 4.32 ML / 365 days based on the following assumptions:
  - Continuous dewatering will take place at BEL, and construction of the basement will take 365 days;
  - The perimeter shoring wall is assumed to be free draining;
  - Groundwater inflow rates are constant during the excavation and construction of the basement;
- Groundwater within bedrock is confined to any defects within the rock and these are expected to be drained of groundwater as the excavation proceeds, resulting in a considerable reduction of seepage rates into the excavation overtime. Hence, EI considers that the modelled groundwater inflow rates into the excavation (which are constant overtime) are a conservative, upper-bound estimate.
- Measured groundwater levels which were used as the basis of our model should be considered in relation to the monitoring well depth, screening interval and number of defects contained within the excavated bedrock.
- Considering the above, we expect that control of groundwater inflows into the basement during and permanently after construction will be feasible using a suitably designed sump and pump system and hence tanking of basement structures will not be required for groundwater control.
- Should any design or construction conditions differ from that adopted in this report; this assessment report should be reviewed and updated as required.

6. LIMITATIONS

The advice and parameters presented in this Groundwater Take Assessment are for preliminary assessment of the expected groundwater take based upon the proposed development and encountered site conditions of the previous GI. This report is not a dewatering management plan. This assessment does not assess the overall stability of the assumed shoring system. The shoring system will need to be designed to satisfy stability, piping, founding and groundwater cut-off considerations by the structural engineer. A suitably qualified dewatering contractor should be engaged to confirm dewatering requirements.

Your attention is drawn to the document "Important Information", attached as **Appendix B** at 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.

7. CLOSURE

Please do not hesitate to contact the undersigned should you have any questions.

For and on behalf of:
EI AUSTRALIA

Authors

David Saw
Geotechnical Engineer

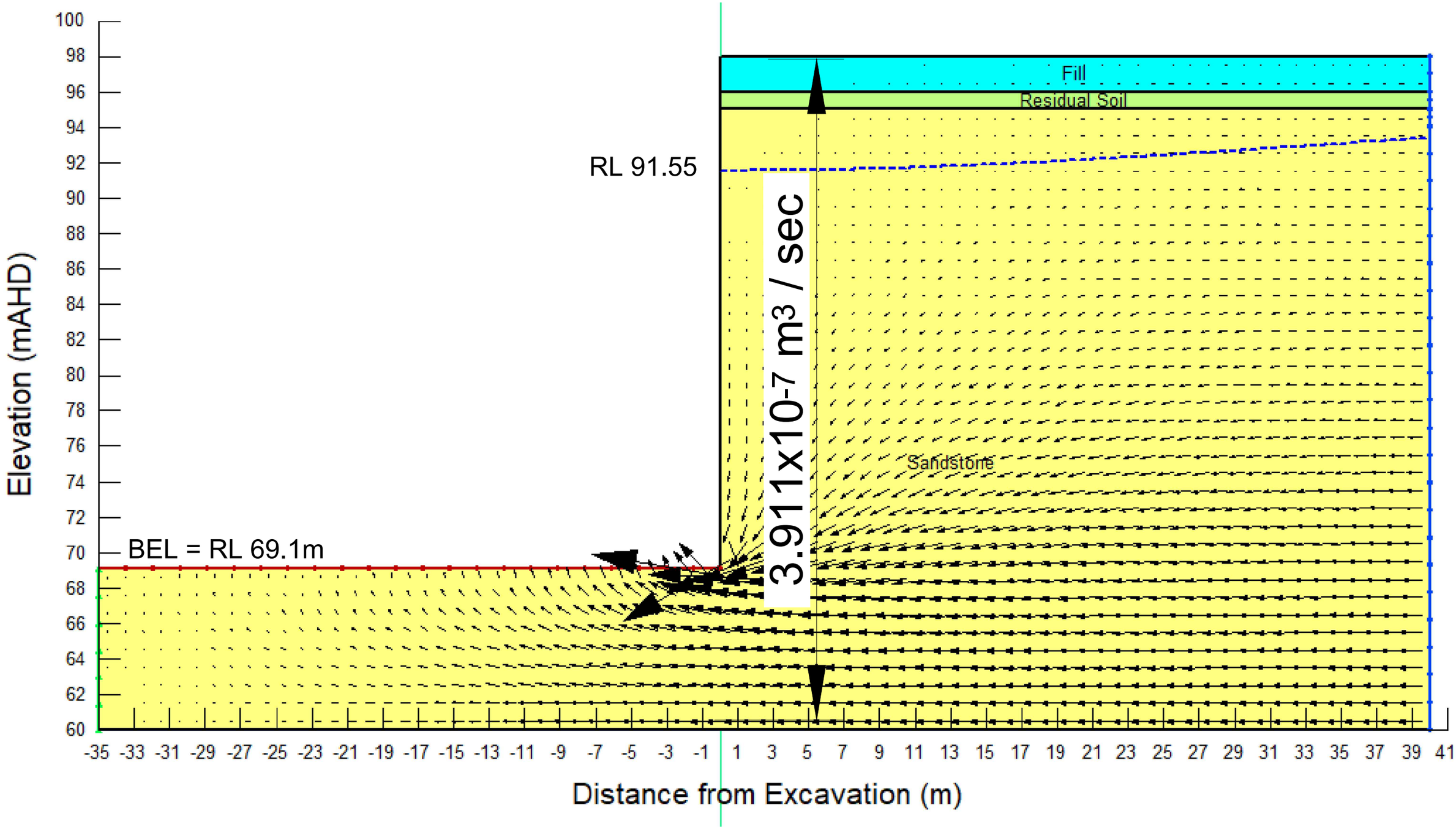
Technical Reviewer

Sam Kazemi
Geotechnical Engineer

Attachments: Appendix A – Seep/W Model
Appendix B – Important Information

APPENDIX A

Seep/W Model



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Deicorp Pty Ltd
Groundwater Take Assessment
2 Mandala Parade, Castle Hill, NSW
SeepW Results

Appendix: A

Project: E24724.G12

APPENDIX B

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.