Groundwater Take Assessment
182-198 Victoria Road and 28-30 Faversham Street, Marrickville, NSW

1. INTRODUCTION

1.1. BACKGROUND

At the request of TOGA Wicks Park Developments Pty Ltd (the Client), EI Australia (EI) has prepared this Groundwater Take Assessment for 182-198 Victoria Road and 28-30 Faversham Street, Marrickville, NSW (the site).

EI has prepared a Geotechnical Investigation (GI) report for the site, referenced E24098.G03, dated 12 February 2019.

1.2. PROPOSED DEVELOPMENT

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


- Survey prepared by JBW Surveyors Pty Ltd – Plan Ref. 125017 Wicks Park Site ‘A’ Boundaries, dated 1 February 2018. The datum is in Australian Height Datum (AHD). All levels referred to in this report are in reference to AHD.

- Detailed Survey prepared by True North Surveys – Drawing No. 8333DU, Job Ref. 8333, dated 1 September 2016;

Based on the provided documents, EI understands that the proposed development involves the demolition of the existing site structures and the construction of a six to fourteen-storey mixed use building overlying a three-level basement. The third basement level is assumed to require a FFL of RL -6.2m AHD. A Bulk Excavation Level (BEL) of RL -6.4m AHD is assumed for the construction which includes allowance for a concrete basement slab. To achieve the BEL, an excavation depth between about 8.5m to 10.0m Below Existing Ground Level (BEGL) is expected. Locally deeper excavations may be required for footings, service trenches, crane pads, and lift overrun pits.

1.3. ASSESSMENT OBJECTIVES

The objective of this GTA is to provide an estimation of the groundwater take volumes that require pumping out during the construction and operational stage of the development, estimation of the groundwater drawdown as a result of the dewatering, and its associated ground settlements (if any).
2. SITE MODEL

2.1. SUBSURFACE CONDITIONS PERMEABILITY

For the purpose of the groundwater take assessment, the average subsurface conditions outlined in our geotechnical investigation report (E24098.G03, dated 25 January 2019) have been adopted. A summary of the permeability values which were adopted for the assessment of groundwater take volumes are presented in Table 3 below.

Table 1 Summary of Subsurface Conditions and Adopted Design Parameters

<table>
<thead>
<tr>
<th>Material</th>
<th>Depth to Top of Unit (m BEGL)</th>
<th>Approximate RL of Top of Unit (m AHD)</th>
<th>Adopted Permeability (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill</td>
<td>0</td>
<td>2.6</td>
<td>1 x 10^-3</td>
</tr>
<tr>
<td>Residual Soil</td>
<td>0.8</td>
<td>1.8</td>
<td>2.0 x 10^-7</td>
</tr>
<tr>
<td>Sandstone/Shale Bedrock</td>
<td>5.0</td>
<td>-2.4</td>
<td>4.0 x 10^-8</td>
</tr>
</tbody>
</table>

Notes:
1. For more detailed descriptions of subsurface conditions reference should be made to the Geotechnical Investigation Report.
2. Depths and levels presented in Table 1 above are generalised using the most conservative levels from the Geotechnical Investigation across the excavation area for the purpose of groundwater seepage modelling.
3. Permeability values have been correlated for material encountered during the GTA using Look (2014).
4. Permeability value of the Residual Soil and Sandstone/Shale Bedrock was calculated based on the pump out test carried out by EI.

The permeability the Residual Soil and Sandstone/Shale bedrock was calculated based on the pump out test results completed within monitoring wells. The monitoring wells and pump out test results are summarised in Table 2 below.

Table 2 Monitoring Well Details and Pump Out Test Results

<table>
<thead>
<tr>
<th>Monitoring Well/ Test ID</th>
<th>Total Well Depth (m BEGL)</th>
<th>Screen Length (m)</th>
<th>Screened Section</th>
<th>Date of Test</th>
<th>Approximate RL of Groundwater Level (m AHD)</th>
<th>Adopted Permeability (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH3M</td>
<td>7</td>
<td>5</td>
<td>Residual Silty CLAY</td>
<td>23-Jan-19</td>
<td>1.35</td>
<td>2.3 x 10^-7</td>
</tr>
<tr>
<td>BH5M</td>
<td>11</td>
<td>5</td>
<td>Sandstone / Shale Bedrock</td>
<td>9-Jan-19</td>
<td>2.01</td>
<td>4.0 x 10^-8</td>
</tr>
<tr>
<td>BH14M</td>
<td>4</td>
<td>2</td>
<td>Residual Silty CLAY / Clayey SAND</td>
<td>23-Jan-19</td>
<td>1.57</td>
<td>1.8 x 10^-7</td>
</tr>
</tbody>
</table>

2.2. GROUNDWATER OBSERVATIONS AND PUMP OUT TESTS

As part of the GTA and DSI scope, EI had installed 5 monitoring wells (BH1, BH3M, BH5M, BH9M and BH14M) for groundwater monitoring. EI undertook a Groundwater Monitoring Event (GME) on 9 January 2019 and carried out the Pump Out test on 9 January 2019 and 23 January 2019; within all the monitoring wells installed by EI. Groundwater measurements are presented in Table 4 below.

Table 3 Summary of Groundwater Levels

<table>
<thead>
<tr>
<th>Monitoring Well/ Test ID</th>
<th>Date of Observation</th>
<th>Approximate Depth to Groundwater Level (m BEGL)</th>
<th>Approximate RL of Groundwater Level (m AHD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH1M</td>
<td>9-Jan-19</td>
<td>1.1</td>
<td>2.0</td>
</tr>
<tr>
<td>BH3M</td>
<td>9-Jan-19</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td>BH5M</td>
<td>23-01-19</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>BH9M</td>
<td>9-Jan-19</td>
<td>0.3</td>
<td>1.7</td>
</tr>
<tr>
<td>BH14M</td>
<td>23-01-19</td>
<td>0.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Notes:
1. Bulk excavation levels based on the supplied architectural drawings and our geotechnical investigation.

A design groundwater level of RL 1.8m (which is at about the top of the residual clay layer) has been adopted for assessment of groundwater seepage inflow rates and groundwater take volumes within the excavation.
2.3. SHORING SYSTEM

At the time of this assessment, no detailed structural designs were available. Hence, two shoring systems were adopted for the model. The system was assumed as following:

- Solider pile wall: Piles will be socketed 1m below B.E.L. (RL of about -7.4mAHD) and into at least medium bedrock.

This assessment does not assess the overall stability and embedment depth of the shoring system. Once final designs are made available, this assessment should be revised accordingly.

3. GROUNDWATER TAKE ASSESSMENT

3.1. GROUNDWATER SEEPAGE VOLUMES DURING CONSTRUCTION PHASE

Groundwater seepage analysis for flow through and beneath the shoring wall during construction has been undertaken using SEEP/W, a finite element groundwater seepage analysis software. SEEP/W estimates the seepage rate of water entering the excavation from beneath the shoring wall. 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 subsurface conditions were horizontal along the site. The permeability values presented in Table 1 above were adopted for each unit.
- The solider pile shoring walls are assumed to be permeable and free to drain.
- For the simplicity of this model, temporary dewatering will be undertaken within the basement retaining wall perimeter to BEL, or about RL -6.4m.
- An external design groundwater level of RL 1.8m was assumed to be constant at 50 m away from the shoring wall.
- A “No-Flow” boundary is defined along the symmetric line (the centre of the excavation), at 30 m from the perimeter shoring wall.
- The shoring walls surrounding the basement excavation has a total length of about 330m.
- The basement will be constructed in 150 days.

The SEEP/W model is presented in Appendix A and B. Table 4 below provides the estimated groundwater inflow rate into the basement.

<table>
<thead>
<tr>
<th>Shoring System</th>
<th>Inflow per m length of perimeter wall (m³/sec)</th>
<th>Inflow per m length of perimeter wall (m³/day)</th>
<th>Inflow into excavation (m³/day)</th>
<th>Total Inflow during construction (ML/150 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solider Pile Shoring Walls</td>
<td>2.66 x 10⁻⁷</td>
<td>0.02</td>
<td>7.4</td>
<td>1.1</td>
</tr>
</tbody>
</table>

3.2. ASSESSMENT OF GROUNDWATER TAKE DURING OPERATIONAL PHASE

A drained basement using sub-soil drainage and a sump-and-pump system was assumed. Based on the SEEP/W results, the estimated volume of groundwater removed beneath the basement during the operational phase of the development is expected to be approximately 3.37ML per year.
4. CONCLUSIONS AND COMMENTS

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

- Construction and operational phase groundwater take will be approximately:
  - 1.1ML / 150 days during construction
  - 3.4ML / year during operation
- The above estimate is based on the following assumptions:
  - The shoring wall system is a fully drained soldier pile wall retention system;
  - Continuous dewatering in order to maintain the groundwater at a depth of BEL during construction, and construction of the basement will take 150 days;
  - The basement walls and slab will be designed as drained for the development's lifetime.
  - This assessment does not take into consideration any excavation that may be required for footings, service trenches, lift pits, or crane pads. This additional excavation, if required, is not expected to affect the retention or the dewatering system.
- In our opinion, the drawdown as a result of the dewatering will have negligible, if any, adverse impact on the neighbouring properties.
- Based on our assessment, the groundwater volumes expected per year appear to be manageable using a drained basement system for its lifetime. Hence in our opinion “tanking” of the basement is not warranted and a drained basement is possible for the development.
- Should any design or construction conditions differ from that adopted in this report; this GTA should be reviewed and updated as required.
5. 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 GA. 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 TOGA Wicks Park Developments 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 TOGA Wicks Park Developments Pty Ltd. No other warranty expressed or implied is made or intended.

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6. CLOSURE

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

For and on behalf of:

EI AUSTRALIA

Stephen Kim
Stephen Geotechnical Engineer

Nauman Jahangir
Senior Geotechnical Engineer

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

Seep/W Model
TOGA Wicks Park Developments Pty Ltd
Groundwater Take Assessment
182-198 Victoria Road and 28-30 Faversham Street, Marrickville, NSW
SEEP/W Model and Results

Appendix:

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Drawn: SK
Approved: NJ
Date: 12/2/19
Approx Scale: As Shown
APPENDIX B

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

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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.